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VOLUME 45 NUMBER 2, PART II

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REVIEWS OF

MODERN PHYSICS

VOLUME 45, NUMBER 2, PART II APRIL 1973

Review of Particle Properties
Particle Data Group

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This review of the properties of leptons, mesons, and baryons is an updating of Review of Particle Properties, Particle Data Group (Phys. Letters **39B**, No. 1 (1972)). Data are evaluated, listed, averaged, and summarized in tables. A data booklet is also available.

CONTENTS

I. INTRODUCTION, CREDITS, CONSULTANTS

This review is an updating through January 1973 of our previous review (Particle Data Group, 1972). In this version of the text we concentrate on topics that are either new or essential. For complementary information on our standard procedures the reader is referred

* The Berkeley Particle Data Center is jointly supported by the U.S. Atomic Energy Commission, the Office of the Standard Reference Data of the National Bureau of Standards, and the National Science Foundation.

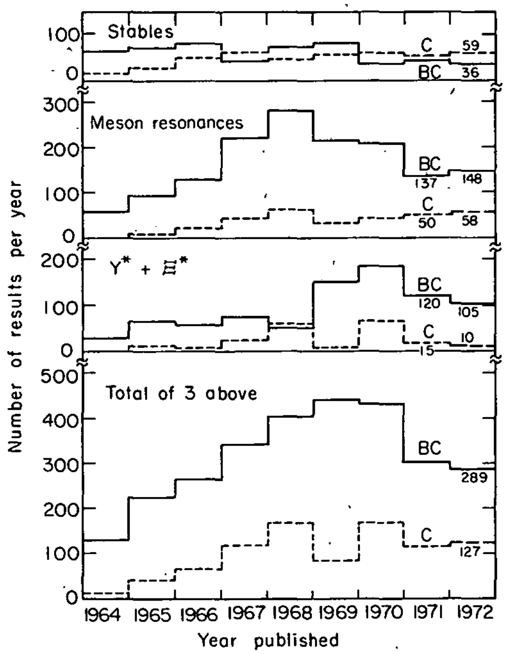

FIG. 1. Statistics on the rate of production of data on particle properties. From the top to the bottom, the number of results per year are presented for stable particles, meson resonances, $Y^*+\Xi^*$'s, and the total of the three above. The full lines correspond to bubble-chamber techniques (BC) and interrupted lines correspond to counters, spark chambers and spectrometers (C). Note that the figure omits N^* and Z^*, the field where counters have overwhelmed bubble chambers, because we punch mainly results from partial wave analyses instead of primary data.

to our January 1970 article (Particle Data Group, 1970).

Again we wish to emphasize that we compile the experimental results of others. It is inappropriate to give us the credit for their countless hours of effort. We urge that references be given directly to the original data, and we provide complete references in the Data Card Listings for that purpose. Only then is it appropriate to state "average value obtained from Rev. Mod. Phys. **45**, No. 2, S1 (1973)." If the list of experiments is so long that this is impractical, we suggest the form: Jones *et al.* 70, Smith *et al.* 69, ··· average value and complete references in *Review of* ···.

The responsibilities of the authors of this compilation can roughly be broken down as follows:

(1) *Stable particles:* A. Barbaro-Galtieri, N. Barash-Schmidt, and T. G. Trippe.

(2) *Meson resonances:* V. Chaloupka, M. Roos, A. H. Rosenfeld, and P. Söding.

(3) *Baryon resonances:* A. Barbaro-Galtieri, C. Bricman, R. L. Kelly, and T. A. Lasinski.

General: All Berkeley authors.

Consultants: The three teams just mentioned must come to a consensus on how to treat the data and must write a number of mini-reviews. It is impractical to spread this responsibility over more than a few people in each team and still expect to meet publication deadlines. Hence we limit our number of authors (to eleven in this edition), but thereby leave gaps in our coverage, both intellectual and geographical. To help us overcome this deficiency, we have solicited the help of consultants:

- Stanley J. Brodsky (Stanford Linear Accelerator Center)
- Chih-Yung Chien (Johns Hopkins University)
- Anatoli Kuznetsov (JINR, Dubna), starting 1973
- R. Gordon Moorhouse (University of Glasgow)
- Horst Oberlack (Lawrence Berkeley Laboratory)
- Oliver E. Overseth (University of Michigan)
- LeRoy R. Price (University of California at Irvine)
- Mark Sakitt (Brookhaven National Laboratory).

The usefulness of this compilation depends in large part on the interaction between the users and authors and consultants. We appreciate comments, criticisms, and suggestions for improvements of all stages of data retrieval, processing, and presentation.

II. COLLECTION AND TREATMENT OF DATA

A. Annual Growth of Data

Figure 1 shows the rate at which we have been recording results, as a function of year published. Through 1969 we subdivided our annual count into two parts:

(1) Highest quality data. These are the results that we accept for averaging and fitting.

(2) Lesser quality data; results which, for one of the reasons mentioned in Section B, below, we encoded but did not accept for averaging.

We have found that this subdivision stays at a fairly constant 60:40 ratio, and is not otherwise very informative, so we now merely count the total.

We see that the number of results per year from bubble chambers, though still dominant, is now dropping; that from counters is roughly constant.

It is of interest to compare the declining rate at which bubble chambers produce results on particle properties with the fact that the number of bubble chamber events measured each year is roughly constant. Apparently experiments have become larger and more specialized, and we now find ourselves encoding more density matrix elements for our compilations of cross sections, and fewer masses and widths of bumps.

It is of interest to compare the decreasing total rate at which we encode data on particle properties with the fact that the rate of publication of experimental papers is about constant. Some differences are that many new experiments are above the resonance region, there are many photon and electron experiments, and many studies of inclusive reactions. Again, compilers are flooded with new data, but the great majority go into collections of cross sections.

B. Selection of Data

All particles are considered to fall into one of the three groups:

(1) Stable particles, immune to decay via the strong interaction
(2) Meson resonances
(3) Baryon resonances

These groups are maintained within the two main parts of the compilation:

(1) Tables of Particle Properties
(2) Data Card Listings.

The Data Card Listings contain the original information (data, references, etc.), weighted averages, comments and "mini-reviews." Immediately preceding the Data Card Listings is an Illustrative Key thereto. We attempt to give complete Data Card Listings up to our closing date (February 1, 1973) for all journals listed in the Illustrative Key. We also include preprints and unpublished conference reports which have come to our attention, but make no attempt at completeness.

Roughly 40% of our encoded results have not been accepted for averaging. They are set off in parentheses; our reasoning is then often given in a footnote below the data. If the reason is not given, it is one of the following:

- The quantity was presented with no error stated.
- The result comes from a preprint or conference report. It is our experience that such results (and particularly the errors) often change before final publication. Accordingly we keep these new results in parentheses until we have corresponded with the authors.
- It involves some assumptions that we do not wish to incorporate.
- It is of poor quality, e.g., bad signal-to-noise ratio.
- Two or more experiments give contradictory results, so that it is senseless to average the data.

When the data for a particle have received special treatment or when they present special problems, this is noted in a mini-review in the Data Card Listings.

The Tables of Particle Properties represent the output of weighted averages and some critical judgment. The extent to which "blind" averaging has been tempered with judgment is explained in footnotes to the Tables. In general, however, the footnotes are less complete than is the collection of notes and mini-reviews in the Data Card Listings. The reader is therefore encouraged to familiarize himself with the Data Card Listings and, ultimately, with the original experiments.

III. CRITERIA FOR RESONANCES

An experimentalist who finds some evidence for a peak in a mass spectrum will of course want to know what has been seen in that region in the past; hence, we strive to have the Data Card Listings serve as an archive for any substantial claim or evidence for a new state.

For the Tables of Particle Properties, on the other hand, we wish to be more conservative, and to include only those peaks or resonances which we feel have a $\gtrsim 90\%$ chance of survival. One's betting odds for survival are of course completely subjective; they are influenced mainly by the amount of information available (such as partial-wave analyses) and somewhat by the degree of controversy over interpretation and how long it will be before more information is available. An arrow ($\rightarrow$) at the left of the Tables of Particle Properties indicates that a questionable candidate has been omitted from the Table, but that it can be found in the corresponding part of the Data Card Listings.

More details on our acceptance criteria are as follows.

1. Partial Wave Analyses

(a) In those cases where energy-independent partial-wave analyses are available (mostly for N^*'s), approximate Breit-Wigner behavior of the amplitude appears to us to be the most satisfactory test for a resonance. We can check that the Argand plot follows roughly a left-hand circle, and that the "speed" of the amplitude also shows a maximum near the resonance energy; further, there should be data well above the resonance, showing that the speed again decreases. Indeed proper behavior of the partial-wave amplitude could accredit a resonance even if its elasticity is too small to make a noticeable peak in the cross section.

Of course, even if Argand plots are available, it may still be a matter of opinion as to what behavior constitutes a resonance. Such an example is the K^+p peak (near $K\Delta$ threshold) called $Z_1(1900)$, which is discussed in a mini-review in the Baryon Data Card Listings. K^+p P_{13} Argand plots are displayed there, and most suggest a resonance; however, there is disagreement between the various analyses as to the speed of the amplitude, i.e., as to whether it has a Breit-Wigner type of behavior. In addition the errors on the amplitudes are still large, and we prefer to wait a bit longer before we put Z_1 in the Baryon Table.

(b) Often where there are insufficient data to perform energy-independent analyses, one resorts to energy-dependent partial-wave analyses (mostly for

Y^*'s). In this case Breit–Wigner behavior is an input. We therefore require that resonance solutions be found by several different analyses, preferably in different channels ($\bar{K}N \rightarrow \bar{K}N$, $\pi\Sigma$, etc.), before putting the claim in the table.

(c) Partial-wave analyses of three-body final states ($\pi N \rightarrow \pi\pi N$) are becoming available. While these analyses are based on the isobar model ($\pi N \rightarrow \rho N$, $\pi\Delta$, etc.) and are subject to theoretical objections of varying importance (triangle graphs, double counting, unitarity), they provide increasingly reliable information on inelastic decay modes of otherwise established resonances.

2. "Bumps"

This category includes most mesons, Ξ^* peaks, and the higher mass ($\gtrsim$2300 MeV) N^*, Y^* peaks. Unless the peak is experimentally shaky, we put it in the table. Thus we accept peaks of high statistical significance or states that are observed via several different production processes.

3. "Diffractive Mesons"

(a) This category includes statistically significant peaks like A_1, A_3, or Q, which are not far above the $\rho\pi$, $f\pi$, or $K^*\pi$ thresholds. Although the threshold behavior in these channels may be described by the "Deck effect" or by its modern version "double Regge-pole exchange", the question of resonance interpretation has for some time been open. Several years ago we put these peaks into the Meson Table, but warned the reader not to conclude that we claim they are necessarily genuine resonances. However, if such effects can be convincingly associated with poles of the S-matrix on some unphysical sheet, we shall call them resonances (see, e.g., Chew, 1968).

(b) Recently Ascoli and collaborators (Ascoli, 1972) have attempted partial-wave analyses of the $\pi\pi\pi$ system in reactions like $\pi N \rightarrow (\pi\pi\pi)N$. There are several important aspects to such analyses:

(i) for a given t, the $\pi\pi\pi$ vertex is assumed to be independent of the NN vertex;

(ii) the $\pi\pi\pi$ reaction is assumed to proceed through quasi-two-body states ($\rho\pi$, $\epsilon\pi$, etc.) in the spirit of the isobar model;

(iii) in order to keep the number of parameters manageable, certain plausible assumptions are made on the vanishing of some of the spin density matrix elements of the ($\pi\pi\pi$) system.

In view of the novelty and difficulty of this analysis, we are reluctant to place these partial-wave analyses in the same category as 1(c) above. However, through such an analysis, the already significant A_2 peak has been confirmed to be a Breit–Wigner type resonance through an observed phase change of 90° relative to other slowly varying partial waves. In contrast, peaks like A_1 and A_3 show an enhancement in a now "pure" J^P mass plot but reveal *no* relative 90° phase change. While this observation suggests that the A_1 and A_3 are not resonances, a mechanism has been suggested by Wright (1972) that reproduces the A_1 "partial wave" and still associates the A_1 with a pole on an unphysical sheet. In the sense of Chew 68, the A_1 may still be called a resonance.

We now ask "How likely is it that peaks of class 2 and 3(a) above (not checked by partial-wave analysis) will eventually be confirmed as resonances?" We know of no experimentally convincing peak that has been shown to have *nothing* to do with a resonance. But be warned that broad peaks may be misleading: they may contain several resonances, or they may include a resonance narrower than the peak, plus some other complications; for example:

- Before 1966 we might have tabulated the πp bumps at 1520 and 1688 MeV as single resonances, whereas partial-wave analysis shows that each contains several resonances.
- Before the $N'(1470, P_{11})$ was confirmed in partial-wave analyses, it was seen as a missing mass or $p\pi\pi$ peak produced peripherally in high-energy pp collisions, and (like A_1, Q, and A_3) was partly explained by the Deck effect and later by double-Regge-pole exchange.

In summary, we enter into the Tables of Particle Properties experimentally convincing peaks unless there is contradictory information; and we expect that most of these peaks will eventually be confirmed as one or more resonances.

IV. PARAMETERS AND CONVENTIONS

A. Quantum Numbers

The symbols $I^G(J^P)C$ represent:

I = isospin
G = G-parity
J = spin
P = space parity
C = charge conjugation parity.

Mesons

The charge conjugation operator C turns particle into antiparticle and has eigenvalues ± 1 only for neutral states; so it is useful to define an extension G which has eigenvalues for charged states too. It is usually[1] defined by

$$G = C \exp(i\pi I_y). \qquad (1)$$

[1] Most texts define it as in Eq. (1); see, e.g., Gasiorowicz (1966); however, sometimes the rotation is taken about I_x. The difference between the two conventions is mentioned in a footnote in Källen (1964).

A neutral nonstrange state is an eigenstate of $\exp(i\pi I_y)$ with eigenvalue $(-1)^I$. Then we can write the eigenvalue equation for the whole multiplet as

$$G=C_n(-1)^I, \tag{2}$$

where C_n (n for neutral) is the eigenvalue C would have if applied to the neutral member of the multiplet. Thus, for a π^0, C has the eigenvalue $+1$, and since $I=1$, $G=-1$. For the charged pion there are no eigenvalues corresponding to C and to the isospin rotation, but Eqs. (1) and (2) still give $G=-1$.

Consider a meson as a bound state of fermion–antifermion, e.g., $\bar{q}q$, with orbital angular momentum l, and with the two fermion spins coupling to give a spin S. Then one can show that the charge-conjugation eigenvalue [defined in Eq. (2)] is

$$C_n=(-1)^{l+S}. \tag{3}$$

Equations (2) and (3) combine to give

$$G=(-1)^{l+S+I}. \tag{4}$$

The parity is

$$P=-(-1)^l. \tag{5a}$$

Equations (3) and (5) combine to give

$$C_nP=-(-1)^S \tag{5b}$$

so all singlet ($^1S_0$, $^1P_1$, $\cdots$) have $C_nP=-1$, and all triplets ($^3S_1$, $\cdots$) have $C_nP=+1$. For proofs of the above, see our 1969 text (Particle Data Group, 1969) and Appendix by C. Zemach.

If, instead of $\bar{q}q$, we consider the meson as a state of boson–antiboson (e.g., $A_2\rightarrow\bar{K}K$), it turns out that some signs cancel, and Eqs. (3) and (4) [not (5)!] apply *unchanged*. Of course the mesons are usually spinless and S is zero, but the equations are more general. Equations (3) and (4) can be considered as selection rules forbidding many decays.

We now use Eqs. (3) and (4) to introduce the concept of "Abnormal-C" mesons, i.e. mesons that cannot be composed of $\bar{q}q$.

The unitary triplets of quarks is of course defined to have isospin and hypercharge properties such that $\bar{q}q$ can combine (according to the $SU(3)$ relations $\{3\}\otimes\{3\}=\{8\}\oplus\{1\}$) so as to form only unitary octets and singlets. The non-observation of "exotic" mesons (i.e. mesons in more complicated supermultiplets) is of course one of the bases of the quark model. But it is slightly less obvious that even some *octets* are forbidden by the model, for example those with $(J^P)C_n=(1^-)$-, (2^+)-, $\cdots$. Such states are also not observed, and this is an additional piece of evidence for the quark model.

In what follows, do not confuse "Abnormal-C" with Normal or Abnormal J^P, both of which are allowed by the quark model. The series, $J^P=0^+$, 1^-, 2^+, $\cdots$ is called Normal because $P=(-1)^J$ as for normal spherical harmonics, and $J^P=0^-$, 1^+, $\cdots$ is called Abnormal.

The top part of Table I shows all the low angular momentum states that can be formed from $\bar{q}q$. Note that half of the J^P states can be formed by both a triplet and a singlet $\bar{q}q$ state, e.g. $^3P_1$, $^1P_1$ or $^3D_2$, $^1D_2$. Equation (3) shows that $^3P_1$ and $^1P_1$ have opposite C_n, so the $\bar{q}q$ model allows both. But the states $^3P_0$ and $^3P_2$ have no ^1P counterparts. According to Eq. (5.1) they have $C_nP=+1$, and with the $\bar{q}q$ model there is no way to form a state with a J^P of $^3P_{0,2}$ (i.e. $J^P=$Normal) and with $C_nP=-1$. As mentioned, such octets have not shown up. With the help of Table I one can also see that the special state $^1S_0$, $C_nP=+1$, cannot be formed, so has Abnormal C.

Baryons and Mesons

Well-established quantum numbers are underlined (except for stable particles, where most of the quantum numbers are established). We have used flimsy evidence to guess many of the remaining ones, and we have indicated with "?" the ones for which there is almost no evidence.

As is customary, we define antiparticles as the result of operating with CPT on particles, so both share the same spins, masses, and mean lives. Whenever there is a particularly interesting test of CPT invariance we include it in the Stable Particles Table.

B. Particle Names

If a *meson* has a well-accepted colloquial name, we use it. If not, we name it by a single symbol which specifies its baryon number B (=0 for mesons), its isospin I, its hypercharge Y, and, for a nonstrange meson, its G parity. For convenience, we also list the strangeness S, which is related to Y and B by

$$S=Y-B.$$

The name conventions for mesons are given in the first part of Table II.

To crowd even more information onto the symbol, we sometimes add a subscript giving J^P. If J^P is not known, but must be "Normal" (0^+, 1^-, 2^+, $\cdots$), e.g., because $K\pi$ decays are seen, we use the subscript N. Thus $K_N(1420)$. If such modes are *not* seen (and are not otherwise forbidden), we *guess* that it is because J is "Abnormal", and we write, for example, $K_A(1240)$.

For *baryons* ($B=1$) no attempt has been made to attach a subscript about J and P. The name conventions for baryons are given in the second part of table 2. For stable baryons of each I and Y we use the symbol standing alone; for resonances, the mass is in parentheses [i.e., $N(1688)$, $\Lambda(1405)$, $\Sigma(1765)$, etc.]. The J^P assignments are reported in the Baryon Table as $\frac{1}{2}^+$, $\frac{3}{2}^-$, $\frac{5}{2}^+$, etc., and also by the symbols P_{11}, D_{13}, F_{15},

Table I. $I^G(J^P)$ of mesons from $\bar{q}q$ model. For the distinction between abnormal J^P and abnormal C, see text below Eq. (5). K mesons share the same values of J^P as the I = 0 and 1 states shown, but are not eigenstates of G. The middle column, which gathers together $(J^P)_{\boxed{\text{N or A}}}$ CP, is a redundant intermediate step intended to make the table easier to read.

Parity	$\bar{q}q$ State: CP −	$\bar{q}q$ State: CP +	$(J^P)_{\square}$ CP ($\square$ = Normal or abnormal)	$I^G(J^P)C_n$	Examples and comments
Parity −	$^1S_0$		$(0^-)_A-$	$0^+(0^-)+$	η, η'
				$1^-(0^-)+$	π
		$^3S_1$	$(1^-)_N+$	$0^-(1^-)-$	ω, ϕ
				$1^+(1^-)-$	ρ
Parity +	$^1P_1$		$(1^+)_A-$	$0^-(1^+)-$	
				$1^+(1^+)-$	B
		$^3P_0$	$(0^+)_N+$	$0^+(0^+)+$	ϵ, S*
				$1^-(0^+)+$	$\pi_N(1016)$
		$^3P_1$	$(1^+)_A+$	$0^+(1^+)+$	
				$1^-(1^+)+$	A1
		$^3P_2$	$(2^+)_N+$	$0^+(2^+)+$	f, f'
				$1^-(2^+)+$	A2
Parity −	$^1D_2$		$(2^-)_A-$	$0^+(2^-)+$	Regge recurrence of $^1S_0$, 0^-
				$1^-(2^-)+$	
		$^3D_1$	$(1^-)_N+$	same as $^3S_1$	
		$^3D_2$	$(2^-)_A+$	$0^-(2^-)-$	Regge recurrence of top abnormal-C state below: $(J^P)C_n = (0^-)-$
				$1^+(2^-)-$	
		$^3D_3$	$(3^-)_N+$	$J > 2$	
Parity +	$^1F_3$		$(3^+)_A-$	$J > 2$	
		$^3F_2$	$(2^+)_N+$	same as $^3P_2$	
		$^3F_3$	$(3^+)_A+$	$J > 2$	
		$^3F_4$	$(4^+)_N+$	etc.	

ABNORMAL C STATES THAT CANNOT COME FROM $\bar{q}q$ MODEL

Abnormal C states Have no $\bar{q}q$ model	$(0^-)_A+$	$0^-(0^-)-$	All except $J^P = 0^-$ are J^P = normal, CP = −1
		$1^+(0^-)-$	
	$(1^-)_N-$	$0^+(1^-)+$	
		$1^-(1^-)+$	
	$(0^+)_N-$	$0^-(0^+)-$	
		$1^+(0^+)-$	
	$(2^+)_N-$	$0^-(2^+)-$	
		$1^+(2^+)-$	
	$(3^-)_N-$	$0^+(3^-)+$	
		$1^-(3^-)+$	

TABLE II. Particle name conventions.

Name	I	Y	S	G
		Mesons		
η	0	0	0	+
ω or ϕ[a]	0	0	0	−
ρ	1	0	0	+
π	1	0	0	−
K^+, K^0	$\frac{1}{2}$	+1	+1	
K^-, $\bar{K}^0$	$\frac{1}{2}$	−1	−1	
		Baryons		
N	$\frac{1}{2}$	+1	0	
Δ	$\frac{3}{2}$	+1	0	
Z_0, Z_1	0, 1	+2	+1	
Λ	0	0	−1	
Σ	1	0	−1	
Ξ	$\frac{1}{2}$	−1	−2	
Ω	0	−2	−3	

[a] Starting in 1973, we use the symbol ω for those $I^G=0^-$ mesons that decay mainly into $3\pi[\omega(784), \omega(1675)]$; we reserve the symbol ϕ for $\phi(1019)$ and possible future higher-mass $I^G=0^-$ mesons that decay mainly into $K\bar{K}$.

which refer to the πp or Kp partial-wave amplitude in which the resonant state occurs (the first subscript refers to the isospin state; $2\times I$ for N and Δ and just I for Z, Λ, and Σ).

When two *baryons* have identical quantum numbers we warn the reader by adding a *prime* to the symbol for the heavier one, e.g., p, $N'(1470, \frac{1}{2}^+)$. In the case of baryon resonances described by Argand diagrams which exhibit more than one resonance, we use one prime for the first, two for the second, $\cdots$; thus the series of which the proton is the stable member becomes: p, $N'(1470, \frac{1}{2}^+)$, $N''(1780, \frac{1}{2}^+)$.

If there is only one resonance on an Argand plot, and thus no need for distinctions, we use no primes.

For *some* pairs of *mesons* with supposedly identical quantum numbers, we also use primes; e.g., η, η'; f, f'.

C. Masses and Widths

An unstable particle of mass M, decaying with a mean life τ, has a wave function

$$\psi(t) \propto \exp\{-i\omega t - t/2\tau\} = \exp\{-(i/\hbar)(M - i\tfrac{1}{2}\Gamma)t\},$$

where $\Gamma = \hbar/\tau$. Its Fourier transform is

$$\psi(m) \propto 1/(M - m - \tfrac{1}{2}i\Gamma)$$

which we call a nonrelativistic Breit–Wigner resonance.

For the metastable particles in the Stable Particle Table, we tabulate τ, but for resonances which decay by the strong interaction, we tabulate Γ, which is the full width at half-maximum of $|\psi(m)|^2$.

In practice, values of M and Γ are extracted from data via *models*, and we cannot average these values if the models are dissimilar. In the next few paragraphs we discuss this point in slightly more detail, using the example of an s-channel resonance.

An *elastic* nonrelativistic Breit–Wigner T-matrix element is usually written

$$T_{11} = \tfrac{1}{2}\Gamma/(M - m - \tfrac{1}{2}i\Gamma). \tag{6}$$

Here $\Gamma(m)$ is the width for decay into the channel 1, with angular momentum l. It contains barrier-penetration factors which can vary rapidly with energy; near threshold, $\Gamma(m)$ should start up as q^{2l+1}, and then level off. Various m dependences are used, mostly variants of the general form

$$\Gamma(m) \propto [q^2/\{1+(qR)^2\}]^l q. \tag{7}$$

For a choice of forms, see Jackson (1964), Pišut and Roos (1968), and Barbaro–Galtieri (1968). Of course the detailed shape of the amplitude and also the value of Γ will depend slightly on the form chosen.

The width is also related to the behavior of T at resonance. It is easy to show (Herndon *et al.*, 1970) that, ignoring terms in $d\Gamma/dm$,

$$\text{“Speed”(res)} = |dT/dm|_{m=M} = x_e/(\tfrac{1}{2}\Gamma(M)), \tag{8}$$

where the elasticity, $x_e = \Gamma_e/\Gamma$, is introduced next. More detailed properties of “Speed” are discussed in the baryon mini-review at the front of the Baryon Data Card Listings of our April 1971 edition (Particle Data Group, 1971).

For an *inelastic* resonance feeding into channel β,

$$T_{1\beta} = \tfrac{1}{2}(\Gamma_1\Gamma_\beta)^{1/2}/(M - m - \tfrac{1}{2}i\Gamma) = (x_1 x_\beta)^{1/2} \times[\tfrac{1}{2}\Gamma/(M - m - \tfrac{1}{2}i\Gamma)], \tag{9}$$

where

$$\Gamma = \sum_1^N \Gamma_\beta, \qquad x_\beta = \Gamma_\beta/\Gamma, \tag{10}$$

and x_1 (called the elasticity) is often written x_e. (Note that in the Data Card Listings we use the symbol P_β rather than x_β.)

The channel cross section $\sigma_{1\beta}$ for the reaction $1\to\beta$ is

$$\sigma_{1\beta} = 4\pi\lambda\!\!\!^{-2}(J+\tfrac{1}{2})|T_{1\beta}|^2, \tag{11}$$

where $J = l \pm \frac{1}{2}$.

Resonances seen in production are even more complicated. Here $\Gamma_1^{1/2}$ disappears from T, and must be replaced with some model-dependent parametrization of the production process.

In conclusion, we have seen that because of the energy dependence of Γ even the amplitude T for a resonance does not have a full-width at half-maximum equal to Γ (but it does peak at or near M). Then kinematic factors enter into the cross section for

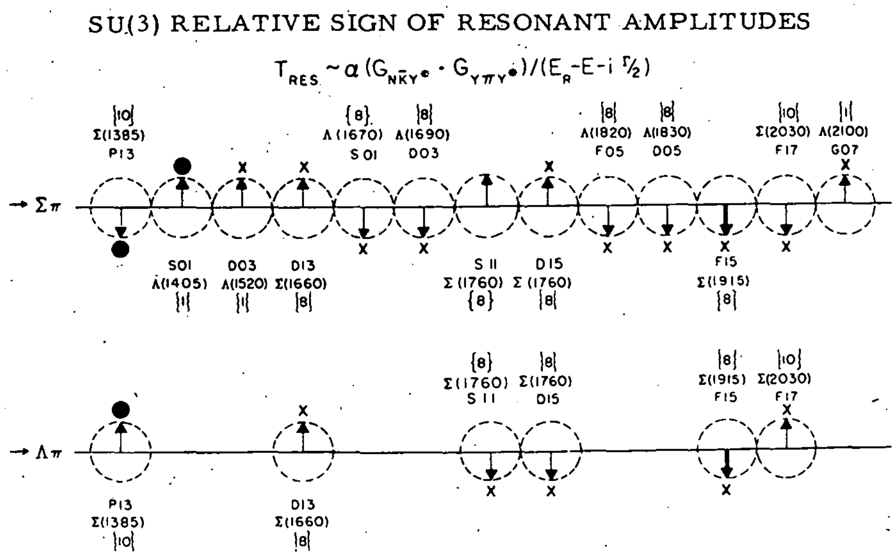

FIG. 2. Plot adapted from Levi Setti (1969) showing the sign convention adopted here for the $\Sigma\pi$ and $\Lambda\pi$ amplitudes. Once the signs of one $I=0$ and one $I=1$ amplitude are fixed, the others can be measured relative to these two. Arrows here indicate signs predicted by $SU(3)$; × marks indicate the observed phases; ● indicates phase chosen according to sign convention described in text. The $\Sigma(1915)$ predictions have been changed from Levi Setti's original figure.

formation [Eq. (11)] or production, and displace the observed peak away from M. For quantitative examples, see Barbaro–Galtieri (1968).

Most of the useful information on the N, Δ, Λ, and Σ *baryon resonances* with $M<2000$ MeV has come from partial-wave analysis. Masses and widths of most of these states are dependent on the model, as well as on the data used by the different groups that performed these analyses; therefore, the masses in the Baryon Table are not averages, but plausible guesses, and the errors are "external errors" based on the consistency among different analyses. For the procedures adopted, different from resonance to resonance, see the appropriate mini-review in the Data Card Listings. *Resonances* with mass $M>2000$ MeV have been detected primarily in total-cross-section experiments.

We can use Eq. (11) to relate the height of the peak at resonance σ_{res} to the elasticity x_e. At resonance the *channel* cross section is

$$\sigma_{res}(1\rightarrow\beta)=4\pi\lambda\!\!\!^{-2}(J+\tfrac{1}{2})x_e x_\beta \qquad (12)$$

and the *total* cross section is

$$\sigma_{res}(\text{total})=4\pi\lambda\!\!\!^{-2}(J+\tfrac{1}{2})x_e. \qquad (13)$$

If J is known, we can solve for x_e. If J is not known, the product $(J+\frac{1}{2})x_e$ is given in the Baryon Table.

Starting this year we give information in the Baryon Table relating to the photon couplings of N and Δ resonances. One of the mini-reviews on N's and Δ's in the Baryon Data Card Listings contains a discussion of these couplings.

D. $SU(3)$ Sign Conventions for Λ and Σ Resonances

Consider the partial width Γ_β of a resonance decaying into the channel β. We can always define a coupling constant such that

$$\Gamma_\beta \propto G_\beta^2.$$

In this case the inelastic [Eq. (9)] amplitude for such a resonance will go as

$$T_{1\beta} \propto G_1 G_\beta/(M-m-\tfrac{1}{2}i\Gamma),$$

where G_1 is the coupling constant for the elastic channel. In the context of exact $SU(3)$ symmetry the relative signs of the product G_1G_β for different resonances are often useful as a consistency check on $SU(3)$ assignments of Λ and Σ resonances. See Appendix II for further details.

In the Data Card Listings for Λ and Σ resonances, we tabulate measured values for $(x_1x_\beta)^{1/2}\propto G_1G_\beta$. Whenever there is an explicit sign, it will be according to the convention advocated by Levi Setti (1969) and used in the table of $SU(3)$ Isoscalar Factors presented in this review. This convention is shown in Fig. 2 from Levi Setti (1969).

E. Muon-Decay Parameters

The μ-decay parameters describe the momentum spectrum (ρ and η), the asymmetry (ξ and δ), and the helicity (h) of the electron in the process $\mu^\pm \rightarrow e^\pm+\nu+\bar{\nu}$. Assuming a local and lepton-conserving interaction, the matrix element may be written as

$$\sum_i \langle \bar{e} \mid \Gamma_i \mid \mu\rangle\langle\bar{\nu}\mid \Gamma_i(C_i+C_i'\gamma_5)\mid \nu\rangle, \qquad (14)$$

where the summation is taken over $i=S, V, T, A, P$. Using the definitions and sign conventions of Kinoshita and Sirlin (1957), we have for the momentum parameters:

$$\rho = [3g_A^2 + 3g_V^2 + 6g_T^2]/D, \quad (15)$$

$$\eta = [g_S^2 - g_P^2 + 2g_A^2 - 2g_V^2]/D, \quad (16)$$

for the asymmetry parameters:

$$\xi = [+6g_S g_P \cos\phi_{SP} - 8g_A g_V \cos\phi_{AV} + 14 g_T^2 \cos\phi_{TT}]/D, \quad (17)$$

$$\delta = [-6g_A g_V \cos\phi_{AV} + 6g_T^2 \cos\phi_{TT}]/D\xi, \quad (18)$$

and for the parameter describing the helicity of the electron:

$$h = \pm[2g_S g_P \cos\phi_{SP} - 8g_A g_V \cos\phi_{AV} - 6g_T^2 \cos\phi_{TT}]/D. \quad (19)$$

Here

$$D = g_S^2 + g_P^2 + 4g_V^2 + 6g_T^2 + 4g_A^2, \quad (20)$$

$$g_i^2 = |C_i|^2 + |C_i'|^2, \quad (21)$$

and

$$\cos\phi_{ij} = \mathrm{Re}\,(C_i^* C_j' + C_i' C_j^*). \quad (22)$$

The quantities g_i are defined to be real non-negative numbers, and the ϕ_{ij} are phase angles between the i-type and j-type interactions. Under the assumption of two-component neutrinos, $C_i' = -C_i$ and $C_j' = -C_j$, the S, P, and T terms vanish, and ϕ_{AV} is the phase angle between C_A and C_V in the complex plane.

By using the above equations and the experimental determinations of ρ, η, ξ, δ, and h, limits can be placed on g_S/g_V, g_A/g_V, g_T/g_V, g_P/g_V, and ϕ_{AV}. The results, given in the Data Card Listings assume neither two-component neutrinos nor time-reversal invariance. If, however, two-component neutrinos are assumed, then $\sin\phi_{AV}$ is the amplitude of time-reversal violation. Note that most experiments study only the upper end of the spectrum where ρ and η are highly correlated, so they can only report ρ for $\eta \equiv 0$ and η for $\rho \equiv \frac{3}{4}$. The values for ρ and η we use here were obtained by combining measurements of both upper and lower ends of the spectrum and turn out to be nearly uncorrelated.

Note also that the radiative corrections are unambiguous only when $g_S = g_T = g_P = 0$. The same limits on g_A/g_V and ϕ_{AV} are obtained, however, as when g_S, g_T, and g_P are left free.

Current values for the asymmetry parameters as well as $|g_A/g_V|$ and ϕ_{AV} are given in the Addendum to the Stable Particle Table. In addition, upper limits on $|g_S/g_V|$, $|g_T/g_V|$ and $|g_P/g_V|$ are given in the μ section of the Stable Particle Data Card Listings.

F. K-Decay Parameters

F.1. Dalitz Plot for $K \to 3\pi$ Decays

The small deviation from uniformity of the Dalitz plot for the 3π decay of the K meson is usually described by a "slope parameter" (Dalitz, 1956). For the τ and τ' decays of the charged K's, and the τ^0 decay mode of the K_L^0, we parametrize the Dalitz plot distribution by the expression

$$|M|^2 \propto 1 + g[(s_3 - s_0)/m_{\pi^+}^2] + h[(s_3 - s_0)/m_{\pi^+}^2]^2 + j[(s_2 - s_1)/m_{\pi^+}^2] + \cdots, \quad (23)$$

where $m_{\pi^+}^2$ has been introduced so as to make the coefficients g, h, and j dimensionless, and

$$s_i = (P_K - P_i)^2 = (m_K - m_i)^2 - 2m_K T_i \qquad i = 1, 2, 3 \quad (24)$$

$$s_0 = \tfrac{1}{3}\sum_i s_i = \tfrac{1}{3}(m_K^2 + m_1^2 + m_2^2 + m_3^2). \quad (25)$$

Here the P_i are 4-vectors, m_i and T_i are mass and kinetic energy of the ith pion, and the index 3 is used for the odd pion.

The coefficient g is a measure of the slope in the variable s_3 (or T_3) of the Dalitz plot, while h measures the quadratic dependence on s_3. The coefficient j is related to the asymmetry of the plot and must be zero if CP invariance holds. Note also that if CP is good, g must be the same for τ^+ and τ^-, and similarly for h.

At present there is no compelling experimental evidence for either the h or the j term (for upper limits on the j term, see section F.3(b) below). Thus we stop the above expansion at the first term and list only g. Since different experiments use different forms for $|M|^2$, in order to compare the experiments we have converted to g whatever coefficients have been measured. See the mini-review in the $K^\pm$ section of the Stable Particle Data Card Listings for details on this point. The results are given in the Addendum to the Stable Particle Table and in the $K^\pm$ and K_L^0 sections of the Stable Particle Data Card Listings.

Relations among $\tau^\pm$, $\tau'^\pm$, and τ^0 are predicted by the $\Delta I = \frac{1}{2}$ rule. See Appendix I for these relations and a discussion of this rule.

F.2. Form Factors in K_{l3} Leptonic Decays

Assuming that only the vector current contributes to these decays, we write the matrix element as

$$M \propto f_+(q^2)[(P_K + P_\pi)_\mu \bar{u}_l \gamma_\mu (1+\gamma_5) u_\nu] + f_-(q^2)[m_l \bar{u}_l (1+\gamma_5) u_\nu], \quad (26)$$

where P_K and P_π are the four momenta of K and π mesons; m_l is the lepton mass; f_+ and f_- are dimensionless form factors which can depend only on $q^2 = (P_K - P_\pi)^2$, the square of the momentum transfer to the leptons. The parameters we list are $\lambda_\pm$, the energy dependence of the $f_\pm(q^2)$ form factor, assuming the form

$$f_\pm(q^2) = f_\pm(0)[1 + \lambda_\pm (q/m_\pi)^2]; \quad (27)$$

and ξ, the ratio of the two form factors,

$$\xi = f_-/f_+. \quad (28)$$

The quantity ξ can be determined in different ways:

(1) By measuring the $K_{\mu 3}/K_{e3}$ branching ratio and comparing it with the theoretical ratio as given in terms of $\xi(0) = f_-(0)/f_+(0)$.

$$\Gamma(K_{\mu 3}^{\pm})/\Gamma(K_{e3}^{\pm}) = 0.6457 + 0.1264 \,\mathrm{Re}\,\xi + 0.0192 \,|\xi|^2 + 1.4115\lambda_+ + 0.4754\lambda_- \,\mathrm{Re}\,\xi + 0.0080\lambda_+ \,\mathrm{Re}\,\xi,$$

$$\Gamma(K_{\mu 3}^{0})/\Gamma(K_{e3}^{0}) = 0.6452 + 0.1246 \,\mathrm{Re}\,\xi + 0.0186 \,|\xi|^2 + 1.3162\lambda_+ + 0.4370\lambda_- \,\mathrm{Re}\,\xi + 0.0064\lambda_+ \,\mathrm{Re}\,\xi. \quad (29)$$

See Cabibbo (1966) and Fearing *et al.* (1970) (for the charge-dependent formulas). Note that the first constant has been changed to 0.6457; the earlier value was a misprint,[2] which we copied from Cabibbo (1966).

(2) By studying the Dalitz plot of the $K_{\mu 3}$ decay. The K_{e3} Dalitz plot distribution is only dependent upon the λ_+ parameter, whereas the $K_{\mu 3}$ distribution is dependent upon λ_-, λ_+, ξ. Often experimenters have measured only the momentum spectrum of either the π or the lepton and compared it with the predicted spectrum. See the note on form factors in the $K^\pm$ Data Card Listings for a discussion of this method. For a formula relating the Dalitz plot variables to ξ see, for example, Brene *et al.* (1961).

(3) By measuring the muon polarization in $K_{\mu 3}$ decay. In the rest frame of the K the μ is expected to be polarized in the direction $\mathbf{A}$ with $\mathbf{P} = \mathbf{A}/|\mathbf{A}|$, where $\mathbf{A}$ is given (Cabibbo and Maksymowicz, 1964) by

$$\mathbf{A} = \alpha_1(\xi)\mathbf{p}_\mu - \alpha_2(\xi)\{(\mathbf{p}_\mu/m_\mu)[m_K - E_\pi + (\mathbf{p}_\pi \cdot \mathbf{p}_\mu/|\mathbf{p}_\mu|^2)(E_\mu - m_\mu)] + \mathbf{p}_\pi\} + m_K \,\mathrm{Im}\,\xi(q^2)(\mathbf{p}_\pi \times \mathbf{p}_\mu). \quad (30)$$

If time-reversal invariance holds, ξ is real, and thus there is no polarization perpendicular to the K-decay plane.

If we remove the assumption of a pure vector current, then the matrix element for the decay, in addition to the terms in Eq. (26), would contain

$$+2m_K f_S \bar{u}_l(1+\gamma_5)u_\nu + (2f_T/m_K)(P_K)_\lambda(P_\pi)_\mu \times \bar{u}_l\sigma_{\lambda\mu}(1+\gamma_5)u_\nu,$$

where f_S is the scalar form factor and f_T is the tensor form factor. In the case of the K_{e3} decays where the f_- term can be neglected, experiments have yielded limits on $|f_S/f_+|$ and $|f_T/f_+|$.

The experimental results for ξ, $\lambda_\pm$, and the upper limits on $|f_S/f_+|$ and $|f_T/f_+|$ are given in the $K^\pm$ and K_L^0 sections of the Stable Particle Data Card Listings. See the note on form factors in the $K^\pm$ Data Card Listings for discussions of these results.

F.3. CP Violation in K^0 Decays

We list parameters for four different reactions in which CP can be tested [For details see Okun and Rubbia (1967), Steinberger (1969), and Wolfenstein (1969)].

(a) $K_S \to \pi^+\pi^-\pi^0$. The quantity measured here is the ratio of amplitudes

$$A_S(K_S \to \pi^+\pi^-\pi^0)/A_L(K_L \to \pi^+\pi^-\pi^0) \equiv x + iy. \quad (31)$$

If CPT invariance holds and there is no $I=3$ state present, then x can be neglected and CP violation would be observed as a nonzero y. We give the result for (31) in the K_L^0 section of the Stable Particle Table and under Branching Ratio $R4$ in the K_S^0 section of the Stable Particle Data Card Listings. Our procedure is to assume that $x=0$, and to list $(A_S/A_L)^2$ in the form of a branching ratio.

(b) *Charge asymmetry in $K_L \to 3\pi$ decays.* As mentioned above, the presence of a term in $(s_2 - s_1)$ in expression (23) describing the Dalitz plot distribution for $\tau^\pm$, τ^0 decays of K mesons would be an indication of CP violation. Rather than listing values of the $(s_2 - s_1)$ coefficient j in Eq. (23), we choose to list $\sigma_\pm$ from the equivalent expression

$$|M|^2 \propto 1 + \sigma_\pm(2/\sqrt{3})(T_+ - T)/T_{\pm\max} + (CP \text{ nonviolating terms}), \quad (32)$$

where $T_\pm$ are the kinetic energies of the charged pions. We have momentarily abandoned the form involving the Mandelstam variables s_i in favor of (32) because the latter has been consistently used by experimenters searching for CP violation. We list $\sigma_\pm$ among the CP-violating parameters at the back of the K_L^0 section of the Stable Particle Data Card Listings. Note that only upper limits have been reported for this quantity.

(c) *Asymmetry in the $K_L \to \pi^\mp l^\pm \nu$ decays.* The quantity measured and compiled here is

$$\delta = \frac{\Gamma(K_L \to \pi^- l^+ \nu) - \Gamma(K_L \to \pi^+ l^- \nu)}{\Gamma(K_L \to \pi^- l^+ \nu) + \Gamma(K_L \to \pi^+ l^- \nu)}. \quad (33)$$

This asymmetry violates CP invariance. If CPT is good, for a pure K_L^0 beam, δ can be written as

$$\delta = 2[(1-|x|^2)/(|1-x|^2)]\,\mathrm{Re}\,\epsilon, \quad (34)$$

where x is the $\Delta S = \Delta Q$-violating parameter defined in Section F.4, and ϵ is the parameter of the expansion

$$|K_L\rangle = [(1+\epsilon)|K\rangle - (1-\epsilon)|\bar{K}\rangle]/[2(1+|\epsilon|^2)]^{1/2}, \quad (35a)$$

$$|K_S\rangle = [(1+\epsilon)|K\rangle + (1-\epsilon)|\bar{K}\rangle]/[2(1+|\epsilon|^2)]^{1/2}. \quad (35b)$$

[2] We thank Drs. H. W. Fearing and J. Smith for calling this mistake to our attention.

We give δ in the Addendum to the Stable Particle Table. In addition, in the K_L^0 CP-violation section of the Stable Particle Data Card Listings, we list δ separately for $K_L^0 \to \pi\mu\nu$ and $K_L^0 \to \pi e\nu$.

(d) $K_L \to 2\pi$ *decay*. The relevant parameters are

$$\eta_{+-} = A(K_L \to \pi^+\pi^-)/A(K_S \to \pi^+\pi^-) = |\eta_{+-}| \exp(i\phi_{+-}), \tag{36}$$

$$\eta_{00} = A(K_L \to \pi^0\pi^0)/A(K_S \to \pi^0\pi^0) = |\eta_{00}| \exp(i\phi_{00}), \tag{37}$$

ϵ, defined in Eqs. (35) above, and

$$\epsilon' = \tfrac{1}{2} i\sqrt{2}[\exp i(\delta_2 - \delta_0)] \operatorname{Im}(A_2/A_0). \tag{38}$$

Here A_i and δ_i are the amplitude and phase of $\pi\pi$ scattering at the K mass, defined by

$$\langle I=0 | T | K \rangle = \exp(i\delta_0) A_0, \tag{39a}$$

$$\langle I=2 | T | K \rangle = \exp(i\delta_2) A_2. \tag{39b}$$

Wu and Yang (1964) have derived the relationships

$$\eta_{+-} = \epsilon + \epsilon', \tag{40a}$$

$$\eta_{00} = \epsilon - 2\epsilon'. \tag{40b}$$

At present many models have been proposed to explain the experimental results on CP violation, but more data are needed before the cause of CP violation can be ascertained.

We give η_{+-}, η_{00}, ϕ_{+-}, and ϕ_{00} in the Addendum to the Stable Particle Table. The phases are measured directly, whereas the magnitudes η_{+-} and η_{00} are derived parameters. We use, as far as we can, the directly measured quantities as input and calculate η_{+-} and η_{00} from the values given by our constrained fits. Therefore, if one looks at the Data Card Listings, most of the $|\eta|$ measurements appear in the form of branching ratios, with appropriate comments. We then give the values of η_{+-} and $|\eta_{00}|^2$ in a separate list at the end of the CP-violating parameters section of the K_L^0 section of the Stable Particle Data Card Listings.

F.4. $\Delta S = \Delta Q$ Rule in K^0 Decays

The relative amount of $\Delta S \neq \Delta Q$ component present is measured by the parameter x, defined as

$$x = A(\bar{K}^0 \to \pi^- l^+ \nu)/A(K^0 \to \pi^- l^+ \nu). \tag{41}$$

We list Re $\{x\}$ and Im $\{x\}$ for both K_{e3} and $K_{\mu3}$ at the end of the Stable Particle Data Card Listings and give values in the Addendum to the Stable Particle Table.

G. η-Decay Parameters

As a test of possible C violation in electromagnetic interactions, a number of experiments have looked for possible charge asymmetries in the decays $\eta \to \pi^+\pi^-\pi^0$ and $\eta \to \pi^+\pi^-\gamma$. For both modes we use the convention

$$\text{Asymmetry} = f(+) - f(-),$$

where $f(\pm)$ means the fraction of the events with the $\pi^{(\pm)}$ energy greater than the $\pi^{(\mp)}$ energy in the η rest frame. We list the asymmetry parameters in the η section of the Stable Particle Data Card Listings and give average values in the Addendum to the Stable Particle Table.

H. Baryon-Decay Parameters

H.1. A/V Ratio for Baryon Leptonic Decays

Consider the decay

$$B_i \to B_f + l + \nu.$$

Assuming V, A theory, neglecting "induced" scalar, "induced" pseudoscalar, and axial weak-magnetism terms, and neglecting the q^2 dependence of the form factors, the baryon part of the matrix element for these decays may be written (Goldberger and Treiman, 1958) as

$$\langle B_f | \gamma_\lambda(g_V - g_A\gamma_5) + (g_W/m_{B_i})\sigma^{\lambda\nu}q_\nu | B_i \rangle, \tag{42}$$

where B_i and B_f represent initial and final baryons, g_A and g_V the axial and vector coupling constants, g_W the weak magnetism coupling constant, and q_ν the sum of the lepton momenta. Here the Pauli representation is used for the γ matrices. The definition of g_A/g_V is

$$g_A/g_V = |g_A/g_V| \exp(i\delta), \tag{43}$$

where δ is $0 + n\pi$ if time-reversal invariance holds (see Jackson *et al.*, 1957).

In neutron beta decay the measurements are consistent with time reversal, so g_A/g_V is nearly real and has been considered to be such in all the baryon leptonic decays. Notice that by using the above definition of the matrix element with the Pauli representations, the value of g_A/g_V in neutron beta decay is negative.

Due to statistical limitation the weak magnetism form factor g_W is usually assumed from CVC and $SU(3)$, so only g_A and g_V are determined experimentally. This determination is accomplished in a variety of ways:

(a) The lepton-neutrino angular correlation provides a measure of the absolute value of g_A/g_V (for relevant formulas see, e.g., Albright, 1959).

(b) The up-down asymmetry of the lepton from polarized baryon decays provides a measure of g_A/g_V with its sign (for relevant formulas, see, e.g., Albright, 1959).

(c) The lepton spectrum, given enough statistics, provides a measure of g_A/g_V with its sign (for relevant formulas see, e.g., Bender, 1968).

(d) The polarization of the decay baryon, from polarized or unpolarized initial baryon, also provides g_A/g_V with its sign (for formulas, see, e.g., Willis and Thompson, 1968).

We compile the ratio g_A/g_V with its sign, for those decays for which it has been measured. For the neutron beta decay we compile also the phase δ.

All the coupling constants and decay rates for baryon leptonic decays are related by Cabibbo's theory (Cabibbo, 1964). The latest fit to this theory can be found in Ebenhöh (1971).

H.2. Asymmetry Parameters in Nonleptonic Hyperon Decays.

The transition matrix for the hyperon decay may be written as

$$M=s+p(\boldsymbol{\sigma}\cdot\mathbf{q}), \tag{44}$$

where s and p are the parity-changing and the parity conserving amplitudes, respectively, $\boldsymbol{\sigma}$ is the Pauli spin operator, and $\mathbf{q}$ is a unit vector along the direction of the decay baryon in the hyperon rest frame.

The asymmetry parameters are defined by the relations

$$\alpha=2\,\mathrm{Re}\,(s^*p)/(|s|^2+|p|^2), \tag{45a}$$

$$\beta=2\,\mathrm{Im}\,(s^*p)/(|s|^2+|p|^2), \tag{45b}$$

$$\gamma=(|s|^2-|p|^2)/(|s|^2+|p|^2). \tag{45c}$$

With the transition matrix (44), the angular distribution of the decay baryon, in the hyperon rest system, is of the form

$$I=1+\alpha\mathbf{P}_Y\cdot\mathbf{q}, \tag{46}$$

where $\mathbf{P}_Y=\langle Y\,|\,\boldsymbol{\sigma}\,|\,Y\rangle$ is the hyperon polarization.

In the notation of Lee and Yang (1957) the polarization $\mathbf{P}_B$ of the decay baryon is[3]

$$\mathbf{P}_B=\frac{(\alpha+\mathbf{P}_Y\cdot\mathbf{q})\mathbf{q}+\beta(\mathbf{P}_Y\times\mathbf{q})+\gamma\mathbf{q}\times(\mathbf{P}_Y\times\mathbf{q})}{1+\alpha\mathbf{P}_Y\cdot\mathbf{q}}, \tag{47}$$

where $\mathbf{P}_B$ is defined in that rest system of the baryon obtained by a Lorentz transformation along $\mathbf{q}$ from the hyperon rest system in which $\mathbf{q}$ and $\mathbf{P}_Y$ are defined. Note that α is the helicity of the decay baryon for unpolarized hyperons.

The three parameters α, β, and γ satisfy the relation

$$\alpha^2+\beta^2+\gamma^2=1. \tag{48}$$

It is then convenient to describe hyperon nonleptonic decays in terms of the two independent parameters α and the angle ϕ defined by

$$\beta=(1-\alpha^2)^{1/2}\sin\phi, \tag{49a}$$

$$\gamma=(1-\alpha^2)^{1/2}\cos\phi, \tag{49b}$$

which has a more nearly Gaussian distribution than β or γ. Evidently

$$-\tfrac{1}{2}\pi\leq\phi\leq\tfrac{1}{2}\pi \quad \text{for} \quad \gamma>0, \tag{50a}$$

$$+\tfrac{1}{2}\pi\leq\phi\leq\tfrac{3}{2}\pi \quad \text{for} \quad \gamma<0. \tag{50b}$$

In discussing time-reversal invariance, the quantity of interest is Δ, defined by

$$\alpha=2\,|s|\,|p|\cos\Delta/(|s|^2+|p|^2), \tag{51a}$$

$$\beta=-2\,|s|\,|p|\sin\Delta/(|s|^2+|p|^2); \tag{51b}$$

that is Δ is the phase angle of s relative to p. Evidently

$$-\tfrac{1}{2}\pi\leq\Delta\leq\tfrac{1}{2}\pi \quad \text{for} \quad \alpha>0, \tag{52a}$$

$$+\tfrac{1}{2}\pi\leq\Delta\leq\tfrac{3}{2}\pi \quad \text{for} \quad \alpha<0. \tag{52b}$$

Under the assumption of time-reversal invariance, the angle Δ must satisfy the relation

$$\Delta=\delta_s-\delta_p, \tag{53}$$

modulo π, where δ_s and δ_p are the pion-baryon scattering phase shifts at the appropriate energy and for the appropriate isospin state. For Λ decay, assuming the validity of the $|\Delta I|=\frac{1}{2}$ rule,

$$\Delta=\delta_s-\delta_p=(6.8\pm2.0)\text{ deg.}^4$$

In the Stable Particle Data Card Listings we give α and ϕ for each decay since they are the most closely related to the experiments and are essentially uncorrelated. Whenever necessary we have changed the signs of the reported values, so as to agree with our conventions. In the Stable Particle Table we give α, ϕ, and Δ with errors; and for convenience we also give the central value of γ, without an error.

V. STATISTICAL PROCEDURES

This section is a much abbreviated version of Section IX in the text of our January 1970 edition (Particle Data Group, 1970) to which the reader is referred for details. See also the mini-review on K^* masses and mass differences in the $K^*(892)$ section of the Meson Data Card Listings.

A. Confidence Levels and Errors

Quoted errors represent one standard deviation (σ). Upper and lower limits represent 68.3% confidence

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[3] Note that Lee and Yang (1957) contains a misprint. The minus sign in the definition of β should be replaced by a 2. In addition, our unit vector $\mathbf{q}$ is the direction of the baryon, whereas their unit vector $\mathbf{p}$ is the direction of the pion.

[4] This value for $\delta_s-\delta_p$ is derived from the phase-shift analyses by Roper *et al.* (1965). The error is our estimation of the uncertainty.

bounds (1σ), unless otherwise stated. The errors in the Tables of Particle Properties and the errors of the averages in the Data Card Listings often include a scale factor S; see section V.B. below.

Quantities that have changed more than 1σ since our April 1972 edition (Particle Data Group, 1972) are italicized in the Tables of Particle Properties. For a discussion see Section V.B in the text of the 1970 edition (Particle Data Group, 1970).

B. Unconstrained Averaging Scale Factors

In the absence of constraints, we calculate a weighted average

$$\bar{x}\pm\delta\bar{x}=\sum w_ix_i/\sum w_i\pm(\sum w_i)^{-1/2};$$

$$w_i=1/(\delta x_i)^2, \qquad (54)$$

where the sums run over N experiments. We also calculate χ^2 and compare it with its expectation value of $N-1$. If $\chi^2>N-1$, we increase the error $\delta\bar{x}$ in Eq. (54) by a factor

$$S=[\chi^2/(N-1)]^{1/2}. \qquad (55)$$

It is easy to design statistical tests for determining whether one experiment (or a group of experiments) is consistent with the other experiments. However, statistics does not tell us who is wrong in case of contradictions. When $S\gg 1$, one can conclude either that:

(1) some (or all) experiments are wrong, or

(2) some (or all) experiments have underestimated their errors, or

(3) the experiments do not measure the same quantity (systematic errors).

We do our best to resolve these cases. If we cannot, we *assume* that *all* experimentalists underestimated their errors by the same scale factor. If we scale up all input errors by this factor, χ^2 returns to $N-1$, and of course the output error scales up by the same factor.

If all the experiments have errors of about the same size, the above procedure is straightforward. If, however, there are both precise and imprecise (large errors) measurements of a particular quantity, one must be very careful not to permit the imprecise ones to "dilute" the scale factor. See our January 1970 edition (Particle Data Group, 1970) for the prescription we use to handle this effect.

We often plot an ideogram to guide the reader in deciding which data he might reject before making his own selected average.

For further discussion of ideograms and scale factors, we refer the reader to Section IX of our January 1970 edition (Particle Data Group, 1970).

C. Constrained Fits

The information on partial-decay fractions P_i[5] and partial widths $\Gamma_i=P_i\Gamma_{\text{total}}$ is frequently given by branching ratios R_j, say, $R_1=P_1/(P_1+P_2)$, $R_2=P_2/P_3$, $R_3=P_1/P_2$, $R_4=P_3/(P_1+P_2+P_3)$, etc.[6]

The number of experimental inputs R_j is often greater than the number of decay modes. In these cases we fit all available information on the P_i, Γ_i, and R_j subject to the constraint $\sum P_i=1$. When, in addition, the input R_j are contradictory so that scale factors may have to be introduced, one has to resort to iterative procedures.

The Data Card Listings give the values of the fitted R_i, P_i, and Γ_i, together with the error matrices of the P_i and of the Γ_i. For details about this procedure, the reader is referred to the text of the January 1970 edition (Particle Data Group, 1970), Sec. IV.B.

VI. PARTICLE DATA GROUP PUBLICATIONS

To obtain a reprint of this report, or any of the items listed below, write either Scientific Information Service, CERN, or Technical Information Division, Lawrence Berkeley Laboratory, whichever is closer.

A. Pocket-Sized Particle Data Booklet

In addition to the present complete, full-size version of the Review of Particle Properties available from CERN and LBL, a pocket-size data booklet is available. It contains the first part of this report, up to the Data Card Listings. The complete set of pocket-size items available comprises the data booklet, a 16-month diary, a mini-atlas contributed by Digital Equipment Corporation, and a plastic cover. Any of these items that you have requested in the past will automatically be sent to you, but please note that our mailing lists are self-cancelling; unless you return the request card that is sent once a year, your name will be removed from our mailing list. If you wish to order any items in bulk we must charge 25 cents (US) for each of the pocket-sized items.

B. Other Compilations

We compile data not only on particle properties, but also on other aspects of strong interactions (πN, KN, pN, $\cdots$ cross sections; partial-wave amplitudes, etc.) Until 1971, our reports were called UCRL 20 000; they are now numbered LBL 50, $\cdots$, 99. In the front of each of these reports is a list of all relevant compilations. A complementary series of compilations is

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[5] We use the symbol P_i for partial-decay fractions throughout the Data Card Listings for stable particles, mesons, and baryons, although for baryons x_i is the commonly accepted symbol. See Eq. (10).

[6] We are also able to fit *products* of rates from formation experiments as given in Eq. (12).

produced by the CERN HERA Group. Both series are available from both LBL and CERN.

C. Magnetic Tapes

The Particle Data Group at LBL also has available for distribution magnetic tapes containing cross section data compilations produced by E. Flaminio *et al.* (πN, KN, $\bar{K}N$, NN, $\bar{N}N$); G. Giacomelli *et al.* (πN); C. Lovelace *et al.* (πN; some KN, $\bar{K}N$); L. D. Roper *et al.* ($\bar{K}N$); P. Spillantini and V. Valente, or H. Oberlack (γN); and F. Wagner *et al.* (KN, $\bar{K}N$; some πN). The original versions of these tapes are available immediately, while updated and corrected versions will be available in the near future. In addition, tapes containing partial-wave amplitudes for πN, KN, and γN exist and may also be requested. If you are interested in more details on the contents of any of these tapes, please write us.

D. Next Edition

We currently produce a new Review of Particle Properties every April. It is published alternately by Physics Letters and by Reviews of Modern Physics.

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TABLES OF PARTICLE PROPERTIES

April 1973

N. Barash-Schmidt, A. Barbaro-Galtieri, C. Bricman, V. Chaloupka
R. L. Kelly, T. A. Lasinski, A. Rittenberg, M. Roos, A. H. Rosenfeld,
P. Söding, and T. G. Trippe

(Closing date for data: Feb. 1, 1973)

Stable Particle Table

For additional parameters, see Addendum to this table.

Quantities in italics have changed by more than one (old) standard deviation since April 1972.

Particle	$I^G(J^P)C_n$	Mass (MeV) Mass² (GeV)²	Mean life (sec) cτ (cm)	Partial decay mode: Mode	Fraction[a]	p or p_{max}[b] (MeV/c)
γ	$0,1(1^-)^-$	$0(<2)10^{-21}$	stable	stable		
ν: ν_e	$J=\frac{1}{2}$	$0(<60$ eV)	stable	stable		
ν_μ		$0(<1.2)$				
e	$J=\frac{1}{2}$	0.5110041	stable	stable		
		±.0000016	$(>2\times10^{21}$ y)			
μ	$J=\frac{1}{2}$	105.6595	2.1994×10^{-6}	$e\nu\bar{\nu}$	100	53
		±.0003	±.0006 S=1.1*	$e\gamma\gamma$	$(<1.6)10^{-5}$	53
		$m^2=$ 0.0112	$c\tau=6.593\times10^4$	3e	$(<6)10^{-9}$	53
	$m_\mu - m_{\pi^\pm}$	= −33.909		$e\gamma$	$(<2.2)10^{-8}$	53
		±.006				
$\pi^\pm$	$1^-(0^-)$	139.5688	2.6024×10^{-8}	$\mu\nu$	100 %	30
		±.0064	±.0024	$e\nu$	$(1.24\pm0.03)10^{-4}$	70
		$m^2=$ 0.0195	$c\tau=780.2$	$\mu\nu\gamma$	c$(1.24\pm0.25)10^{-4}$	30
			$(\tau^+-\tau^-)/\bar{\tau}=$	$\pi^0 e\nu$	$(1.02\pm0.07)10^{-8}$	5
			(0.05 ± 0.07)%	$e\nu\gamma$	c$(3.0\pm0.5)10^{-8}$	70
			(test of CPT)	$e\nu e^+e^-$	$(<3.4)10^{-8}$	70
π^0	$1^-(0^-)^+$	134.9645	0.84×10^{-16}	$\gamma\gamma$	(98.83 ± 0.05)%	67
		±.0074	±.10 S=2.1*	γe^+e^-	(1.17 ± 0.05)%	67
		$m^2=$ 0.0182	$c\tau=2.5\times10^{-6}$	$\gamma\gamma\gamma$	$(<5)10^{-6}$	67
	$m_{\pi^\pm} - m_{\pi^0}$	= 4.6043		$e^+e^-e^+e^-$	d$(3.47)10^{-5}$	67
		±.0037				

Stable Particle Table *(cont'd)*

Particle	$I^G(J^P)C_n$	Mass (MeV) Mass² (GeV)²	Mean life (sec) cτ (cm)	Partial decay mode: Mode	Fraction[a]	p or p_{max}[b] (MeV/c)
$K^{\pm}$	$\frac{1}{2}(0^-)$	*493.715*	1.2371×10^{-8} *	$\mu\nu$	(63.52±0.19)%	236
		±0.037	±.0026 S=1.9	$\pi\pi^0$	(21.06±0.18)% S=1.1*	205
			cτ=370.8	$\pi\pi^-\pi^+$	(5.59±0.03)% S=1.1*	125
		m^2=0.244	$(\tau^+-\tau^-)/\bar{\tau}$ =	$\pi\pi^0\pi^0$	(*1.73±0.05*)% S=1.4*	133
			(.11±.09)%	$\mu\pi^0\nu$	(3.24±0.10)% S=1.9*	215
			(test of CPT)	$e\pi^0\nu$	(4.85±0.06)% S=1.1*	228
			S=1.2*	$e\pi^0\pi^0\nu$	($1.8^{+2.4}_{-0.6}$) 10^{-5}	207
		$m_{K^{\pm}}-m_{K^0}$ = -3.99		$\pi\pi^{\mp}e^{\pm}\nu$	(3.7±0.2) 10^{-5}	203
		±0.13		$\pi\pi^{\pm}e^{\mp}\nu$	(<5) 10^{-7}	203
		S=1.1*		$\pi\pi^{\mp}\mu^{\pm}\nu$	(0.9 ±0.4) 10^{-5}	151
				$\pi\pi^{\pm}\mu^{\mp}\nu$	(<3) 10^{-6}	151
				$e\nu$	(1.38±0.20) 10^{-5}	247
				$e\nu\gamma$	[c] (<7) 10^{-5}	247
				$\pi\pi^0\gamma$	[h, c] (2.66±0.18) 10^{-4}	205
				$\pi\pi^+\pi^-\gamma$	[c] (10 ±4) 10^{-5}	125
				$\pi e\nu\gamma$	[c] (3.7 ±1.4) 10^{-4}	227
				πe^+e^-	(< 0.4) 10^{-6}	227
				$\pi^{\mp}e^{\pm}e^{\pm}$	(< 1.5) 10^{-5}	227
				$\pi\mu^+\mu^-$	(< 2.4) 10^{-6}	172
				$\pi\gamma\gamma$	[c] (< 3.5) 10^{-5}	227
				$\pi\gamma\gamma\gamma$	[c] (< 3) 10^{-4}	227
				$\pi\nu\bar{\nu}$	(< 1.4) 10^{-6}	227
				$\pi\gamma$	(< 4) 10^{-6}	227
				$\pi^{\mp}e^{\pm}\mu^{\pm}$	(< 3) 10^{-8}	214
				$\pi^{\pm}e^{\pm}\mu^{\mp}$	(< 1.4) 10^{-8}	214
				$\mu\nu\nu\bar{\nu}$	(< 7) 10^{-6}	236
K^0	$\frac{1}{2}(0^-)$	497.71 ±0.13 S=1.1*	50% K_{Short}, 50% K_{Long}			
K^0_S	$\frac{1}{2}(0^-)$	m^2=0.248	[e] *0.882×10⁻¹⁰*	$\pi^+\pi^-$	(68.81±0.29)% S=1.1*	206
			±.008 S=2.5 *	$\pi^0\pi^0$	(31.19)%	209
			cτ=2.65	$\mu^+\mu^-$	(< 0.7) 10^{-5}	225
				e^+e^-	(<35) 10^{-5}	249
				$\pi^+\pi^-\gamma$	[c] (2.3 ±0.8) 10^{-3}	206
				$\gamma\gamma$	(< 0.7) 10^{-3}	249
K^0_L	$\frac{1}{2}(0^-)$		5.181×10^{-8}	$\pi^0\pi^0\pi^0$	(21.5 ±0.8)% S=1.4*	139
			±0.041	$\pi^+\pi^-\pi^0$	(12.6 ±0.3)%	133
			cτ=1553	$\pi\mu\nu$	(26.9 ±0.6)% S=1.1*	216
				$\pi e\nu$	(38.8 ±0.6)% S=1.1*	229
				$\pi e\nu\gamma$	[c] (1.3 ±0.8)%	229
		$m_{K_L}-m_{K_S}$ = 0.5402×10¹⁰ ħ sec⁻¹		$\pi^+\pi^-$	(0.157±0.005)%	206
		± 0.0035		$\pi^0\pi^0$	(0.094±0.019)% S=1.5*	209
				$\pi^+\pi^-\gamma$	[c] (< 0.4) 10^{-3}	206
				$\pi^0\gamma\gamma$	(< 2.4) 10^{-4}	231
				$\gamma\gamma$	(4.9 ±0.4) 10^{-4}	249
				$e\mu$	(< 1.6) 10^{-9}	238
				$\mu^+\mu^-$	[i] (< 1.9) 10^{-9}	225
				e^+e^-	(< 1.6) 10^{-9}	249
η	$0^+(0^-)^+$	548.8	[e] Γ=(2.63±0.58)keV	$\gamma\gamma$	(38.0 ±1.0)% S=1.2*	274
		±0.6	Neutral decays	$\pi^0\gamma\gamma$	[e] (3.1 ±1.1)% S=1.2*	258
		S=1.4*	71.1%	$3\pi^0$	(30.0 ±1.1)% S=1.1*	180
		m^2=0.301		$\pi^+\pi^-\pi^0$	(23.9 ±0.6)% S=1.1*	175
				$\pi^+\pi^-\gamma$	(5.0 ±0.1)%	236
			Charged decays	$\pi^0e^+e^-$	(< 0.04)%	258
			28.9%	$\pi^+\pi^-e^+e^-$	(0.1 ±0.1)%	236
				$\pi^+\pi^-\pi^0\gamma$	(< 0.2)%	175
				$\pi^+\pi^-\gamma\gamma$	(< 0.2)%	236
				$\mu^+\mu^-$	(2.2 ±0.8) 10^{-5}	253
				$\mu^+\mu^-\pi^0$	(< 5) 10^{-4}	211
p	$\frac{1}{2}(\frac{1}{2}^+)$	938.2592 ±0.0052 m^2=0.8803	stable (> 2×10²⁸y)			
n	$\frac{1}{2}(\frac{1}{2}^+)$	939.5527 ±0.0052 m^2=0.8828 m_p-m_n=-1.29344 ±0.00007	*(0.918±0.014)10³* cτ = 2.75×10¹³	$pe^-\nu$	100 %	1

0 0 0 0 3 6 0 4 7 7 8

Stable Particle Table *(cont'd)*

Particle	$I^G(J^P)C_n$	Mass (MeV) Mass^2 (GeV)^2	Mean life (sec) $c\tau$ (cm)	Partial decay mode: Mode	Fraction[a]	p or p_{max}[b] (MeV/c)
Λ	$0(\frac{1}{2}^+)$	1115.59 ±0.05 S=1.1* m^2= 1.245	2.521×10^{-10} ±.021 S=1.2* $c\tau$ = 7.56	$p\pi^-$	(64.2 ±0.5)%	100
				$n\pi^0$	(35.8)%	104
				$pe\nu$	$(8.13\pm0.29)10^{-4}$	163
				$p\mu\nu$	$(1.57\pm0.35)10^{-4}$	131
				$p\pi^-\gamma$	c$(0.85\pm0.14)10^{-3}$	100
Σ^+	$1(\frac{1}{2}^+)$	1189.41 ±0.07 S= 1.6* m^2= 1.415 $m_{\Sigma^+}-m_{\Sigma^-}$ = −7.94 ±.09 S= 1.2	0.800×10^{-10} ±.006 $c\tau$ = 2.40	$p\pi^0$	(51.6 ±0.7)%	189
				$n\pi^+$	(48.4)%	185
				$p\gamma$	$(1.24\pm0.18)10^{-3}$ S=1.4*	225
				$n\pi^+\gamma$	c$(1.31\pm0.24)10^{-4}$	185
				$\Lambda e^+\nu$	$(2.02\pm0.47)10^{-5}$	72
			$\frac{\Gamma(\Sigma^+\to\ell^+n\nu)}{\Gamma(\Sigma^-\to\ell^-n\nu)}<.035\leftarrow$	$n\mu^+\nu$	$(<2.4)10^{-5}$	202
				$ne^+\nu$	$(<1.0)10^{-5}$	224
				pe^+e^-	$(<7)10^{-6}$	225
Σ^0	$1(\frac{1}{2}^+)$	1192.48 ±0.10 S= 1.1* m^2=1.422	$<1.0\times10^{-14}$ $c\tau<3\times10^{-4}$	$\Lambda\gamma$	100 %	74
				Λe^+e^-	d$(5.45)10^{-3}$	74
Σ^-	$1(\frac{1}{2}^+)$	1197.34 ±0.07 S= 1.2* m^2 = 1.434 $m_{\Sigma^0}-m_{\Sigma^-}$=−4.86 ±.06	1.484×10^{-10} ±.019 S=1.6* $c\tau$ = 4.45	$n\pi^-$	100 %	193
				$ne^-\nu$	$(1.10\pm0.05)10^{-3}$	230
				$n\mu^-\nu$	$(0.45\pm0.04)10^{-3}$	210
				$\Lambda e^-\nu$	$(0.60\pm0.06)10^{-4}$	79
				$n\pi^-\gamma$	c$(1.0\pm0.2)10^{-4}$	193
Ξ^0	$\frac{1}{2}(\frac{1}{2}^+)^f$	1314.9 ±0.6 m^2= 1.729 $m_{\Xi^0}-m_{\Xi^-}$ =−6.4 ±.6	2.98×10^{-10} ±.12 $c\tau$ = 8.93	$\Lambda\pi^0$	100 %	135
				$p\pi^-$	$(<0.9)10^{-3}$	299
				$pe^-\nu$	$(<1.3)10^{-3}$	323
				$\Sigma^+e^-\nu$	$(<1.5)10^{-3}$	119
				$\Sigma^-e^+\nu$	$(<1.5)10^{-3}$	112
				$\Sigma^+\mu^-\nu$	$(<1.5)10^{-3}$	64
				$\Sigma^-\mu^+\nu$	$(<1.5)10^{-3}$	49
				$p\mu^-\nu$	$(<1.3)10^{-3}$	309
Ξ^-	$\frac{1}{2}(\frac{1}{2}^+)^f$	1321.29 ±0.14 m^2= 1.746	1.672×10^{-10} ±.032 S=1.1* $c\tau$ = 5.01	$\Lambda\pi^-$	100 %	139
				$\Lambda e^-\nu$	g$(0.70\pm0.21)10^{-3}$	190
				$\Sigma^0e^-\nu$	$(<0.5)10^{-3}$	123
				$\Lambda\mu^-\nu$	$(<1.3)10^{-3}$	163
				$\Sigma^0\mu^-\nu$	(<0.5)%	70
				$n\pi^-$	$(<1.1)10^{-3}$	303
				$ne^-\nu$	(<1.0)%	327
Ω^-	$0(\frac{3}{2}^+)^f$	1672.5±.5 m^2= 2.797	$1.3^{+0.4}_{-0.3}\times10^{-10}$ $c\tau$ = 3.9	$\Xi^0\pi^-$	Total of 28 events seen	294
				$\Xi^-\pi^0$		290
				ΛK^-		211

*S = Scale factor = $\sqrt{\chi^2/(N-1)}$, where N ≈ number of experiments. S should be ≈ 1. If S > 1, we have enlarged the error of the mean, δx, i. e., $\delta x \to S\delta x$. This convention is still inadequate, since if S >> 1, the experiments are probably inconsistent, and therefore the real uncertainty is probably even greater than $S\delta x$. See text and ideogram in Stable Particle Data Card Listings.

a. Quoted upper limits correspond to a 90% confidence level.

b. In decays with more than two bodies, P_{max} is the maximum momentum that any particle can have.

c. See Stable Particle Data Card Listings for energy limits used in this measurement.

d. Theoretical value; see also Stable Particle Data Card Listings.

e. See note in Stable Particle Data Card Listings.

f. P for Ξ and J^P for Ω^- not yet measured. Values reported are SU(3) predictions.

g. Assumes rate for $\Xi^-\to\Sigma^0e^-\nu$ small compared with $\Xi^-\to\Lambda e^-\nu$.

h. The direct emission branching ratio is $(1.56\pm.35)\times10^{-5}$.

i. A contradictory unpublished result of ~9×10^{-9} (with 6 events seen) has been reported by Carithers et al. See note in Stable Particle Data Card Listings.

ADDENDUM TO

Stable Particle Table

	Magnetic moment	
e	1.001 159 6577 ±.000 000 0035 $\frac{e\hbar}{2m_e c}$	
μ	1.001 166 16 ±.000 000 31 $\frac{e\hbar}{2m_\mu c}$	**μ Decay parameters** [a] $\rho = 0.752\pm0.003$ $\eta = -0.12 \pm0.21$ $\xi = 0.972\pm0.013$ $\delta = 0.755\pm0.009$ $h = 1.00\pm0.13$ $\lvert g_A/g_V\rvert = 0.86^{+0.33}_{-0.11}$ $\phi = 180° \pm15°$

K±

Mode	Partial rate $(\sec^{-1})$	
$\mu\nu$	$(51.35\pm0.19)10^6$	S=1.2*
$\pi\pi^0$	$(17.02\pm0.15)10^6$	S=1.1*
$\pi\pi^+\pi^-$	$(4.52\pm0.02)10^6$	S=1.1*
$\pi\pi^0\pi^0$	$(1.40\pm0.04)10^6$	S=1.4*
$\mu\pi^0\nu$	$(2.62\pm0.08)10^6$	S=1.9*
$e\pi^0\nu$	$(3.92\pm0.05)10^6$	S=1.1*

$\Delta I = \frac{1}{2}$ rule for $K^\pm \to 3\pi$

$\pi^+\pi^+\pi^-$ $c_g = -.214\pm.005$ S=1.7*
$\pi^-\pi^+\pi^-$ $c_g = -.214\pm.007$ S=2.7*
$\pi^+\pi^0\pi^0$ $c_g = .523\pm.023$ S=1.4*

See also Stable Particle Data Card Listings and Appendix I

Form factors for leptonic decays
$\lambda_+^e = 0.028\pm0.005$
See Stable Particle Data Card Listings for ξ and λ_+^μ.

K_S^0

Mode	Partial rate $(\sec^{-1})$	
$\pi^+\pi^-$	$(0.780\pm.008)10^{10}$	S=1.9*
$\pi^0\pi^0$	$(0.353\pm.005)10^{10}$	S=1.4*

K_L^0

Mode	Partial rate $(\sec^{-1})$	
$\pi^0\pi^0\pi^0$	$(4.15\pm0.16)10^6$	S=1.3*
$\pi^+\pi^-\pi^0$	$(2.43\pm0.05)10^6$	
$\pi\mu\nu$	$(5.19\pm0.12)10^6$	S=1.1*
$\pi e\nu$	$(7.48\pm0.13)10^6$	S=1.1*
$\pi^+\pi^-$	$(3.02\pm0.10)10^4$	
$\pi^0\pi^0$	$(1.82\pm0.38)10^4$	S=1.5*

CP violation parameters

$\lvert\eta_{+-}\rvert = (1.98\pm0.04)10^{-3}$, $\phi_{+-} = (42\pm3)°$ S=1.1*
$\lvert\eta_{00}\rvert = (2.09\pm0.10)10^{-3}$ $\phi_{00} = (43\pm19)°$ S=1.2*
[d] $\delta = (.33\pm.04)10^{-2}$ S=1.5*
$f\ y^2 < 0.27$

$\Delta I = \frac{1}{2}$ rule for $K_L^0 \to 3\pi$
$\pi^+\pi^-\pi^0$ $c_g = .60\pm.02$ S=2.7*
See Data Cards & App. I

$\Delta S = -\Delta Q$
Re x = −.003±.027 S=1.6*
Im x = −.005±.038 S=1.2*

Form Factors for leptonic decays
$\lambda_+^e = 0.025\pm0.005$ S=1.3*
See Stable Particle Data Card Listings for λ_+^μ and ξ

η

Mode	Asymmetry parameter
$\pi^+\pi^-\pi^0$	[e] $(0.24\pm.40)\%$ S=2.0*
$\pi^+\pi^-\gamma$	$(0.61\pm.54)\%$

	Magnetic moment $(e\hbar/2m_pc)$	Decay parameters [b]	Measured α	Measured φ(degree)	Derived γ	Derived Δ(degree)	g_A/g_V [b]	g_V/g_A [b]
p	2.792782 ±.000017							
n	−1.913148 ±.000066	$pe^-\nu$					−1.248±.010 $\delta = (181.1\pm1.3)°$	
Λ	−0.67 ±.06	$p\pi^-$	0.647±0.013	(−6.5±3.5)°	0.76	$(7.6^{+4.0}_{-4.1})°$		
		$n\pi^0$	0.651±0.045					
		$pe\nu$					−0.66±0.06 S=1.2*	
Σ⁺	2.59 ±.46	$p\pi^0$	−0.984±0.017	(22±90)°	0.17	$(184\pm15)°$		
		$n\pi^+$	+0.066±0.016	(167±20)° S=1.1*	−0.97	$(-73^{+136}_{-10})°$		
		$p\gamma$	$-1.03^{+.52}_{-.42}$					
Σ⁻		$n\pi^-$	−0.069±0.008	(10±15)°	0.98	$(249^{+12}_{-115})°$		
		$ne^-\nu$					See Data Cds.	
		$\Lambda e^-\nu$						0.37±0.20
Ξ⁰	-	$\Lambda\pi^0$	−0.39±0.09 S=1.2*	(25±21)° S=1.3*	0.84	$(225^{+16}_{-35})°$		
Ξ⁻	−1.93 ±.75	$\Lambda\pi^-$	−0.40±0.03	(−4±8)° S=1.1*	0.91	$(170^{+18}_{-17})°$		

ADDENDUM TO

Stable Particle Table *(cont'd)*

*S = scale factor. Quoted error includes scale factor; see footnote to main Stable Particle Table for definition.

a. $|g_A/g_V|$ defined by

$$g_V^2 = |C_V|^2 + |C'_V|^2,$$

$$g_A^2 = |C_A|^2 + |C'_A|^2,$$

$$\Sigma \langle \bar{e} | \Gamma_i | \mu \rangle \langle \bar{\nu} | \Gamma_i (C_i + C'_i \gamma_5) | \nu \rangle ;$$

ϕ defined by $\cos\phi = -R_e(C^*_A C'_V + C'_A C^*_V)/g_A g_V$ [for more details, see text Section IV E]

b. The definition of these quantities is as follows [for more details on sign convention, see text Section IV H]:

$$\alpha = \frac{2|s||p|\cos\Delta}{|s|^2+|p|^2};$$

$$\beta = \frac{-2|s||p|\sin\Delta}{|s|^2+|p|^2}.$$

$$\beta = \sqrt{1-\alpha^2}\sin\phi;$$

$$\gamma = \sqrt{1-\alpha^2}\cos\phi.$$

g_A/g_V defined by $\langle B_f | \gamma_\lambda (g_V - g_A \gamma_5) | B_i \rangle$;

δ defined by $g_A/g_V = |g_A/g_V| e^{i\delta}$.

c. The definition of the slope parameter of the Dalitz plot is as follows:

$$|M|^2 = 1 + g\left(\frac{s_3 - s_0}{m^2_{\pi^+}}\right).$$

d. The definition for the charge asymmetry is as follows:

$$\delta = \frac{\Gamma(K^0_L \to \ell^+) - \Gamma(K^0_L \to \ell^-)}{\Gamma(K^0_L \to \ell^+) + \Gamma(K^0_L \to \ell^-)}$$

e. See note in Stable Particle Data Card Listings.

f. The quantity y^2 is defined as follows:

$$y^2 = \frac{\Gamma(K^0_S \to \pi^+\pi^-\pi^0)}{\Gamma(K^0_L \to \pi^+\pi^-\pi^0)}$$

where CPT is assumed valid.

Meson Table

April 1973

In addition to the entries in the Meson Table, the Meson Data Card Listings contain all substantial claims for meson resonances. See Contents of Meson Data Card Listings[1].

Quantities in italics have changed by more than one (old) standard deviation since April 1972.

Name (G \ I: 0, 1; −: ω/φ, π; +: η, ρ)	$I^G(J^P)C_n$ ⊢⊣ estab.	Mass M (MeV)	Full Width Γ (MeV)	M^2 $\pm\Gamma M$[a] $(GeV)^2$	Partial decay mode: Mode	Fraction (%) [Upper limits are 1σ (%)]		p or p_{max}[b] (MeV/c)
$\pi^\pm(140)$ $\pi^0(135)$	$1^-(0^-)+$	139.57 134.96	0.0 7.8 eV ±.9 eV	0.019483 0.018217	See Stable Particle Table			
η(549)	$0^+(0^-)+$	548.8 ±0.6	2.63 keV ±.58 keV	0.301 ±.000	All neutral $\pi^+\pi^-\pi^0$ + $\pi^+\pi^-\gamma$	71 29	See Stable Particle Table	
ε	$0^+(0^+)+$	≲ 700[c]	≳ 600[c]		ππ			
Existence of pole not established. See note on ππ S wave¶.								
ρ(770)	$1^+(1^-)-$	770§ ±5§	146§ ±10§	0.593 ±.112	ππ e^+e^- $\mu^+\mu^-$ For upper limits, see footnote (e)	≈100 0.0043±0005 (d) 0.0067±0012 (d)		359 385 370
ω(784)	$0^-(1^-)-$	783.8[f] ±0.3 S=1.3*	9.8 ±.5 S=1.1*	0.614 ±.008	$\pi^+\pi^-\pi^0$ $\pi^+\pi^-$ $\pi^0\gamma$ e^+e^- For upper limits, see footnote (g)	89.6±0.6 1.3±0.3 9.1±0.5 0.0076±.0017	S=1.1* S=1.5* S=1.9*	328 366 380 392
η′(958) or X^0	$0^+(0^-)+$	958.1 ±0.4 S=1.4*	< 2	0.918 <.002	ηππ $\pi^+\pi^-\gamma$ (mainly $\rho^0\gamma$) γγ For upper limits, see footnote (h)	*71.8±3.9* *26.2±3.5* 1.9±0.3	*S=2.0** *S=2.2**	234 458 479
δ(970) formerly called $\pi_N(975)$	$1^-(0^+)+$	∿ 970	50§ ±30§	0.941 ±.049	ηπ			311
Possibly a virtual bound state of the I = 1 $K\bar{K}$ system¶.								
S^*	$0^+(0^+)+$	∿ 997[c]	50-150[c]	0.993	ππ $K\bar{K}$			479 near threshold
See notes on ππ and $K\bar{K}$ S wave¶.								
Φ(1019)	$0^-(1^-)-$	1019.6 ±0.3 S=1.9	4.2 ±.2	1.040 ±.004	K^+K^- K_LK_S $\pi^+\pi^-\pi^0$ (incl. ρπ) ηγ e^+e^- $\mu^+\mu^-$ For upper limits, see footnote (i)	*46.8±2.7* *35.0±2.8* 15.2±3.6 3.0±1.1 .032±.003 .025±.003	*S=1.6* *S=1.6** S=1.8* S=1.6* S=1.9*	127 110 462 362 510 499
$A_1(1100)$	$1^-(1^+)+$	∿ 1100	200-400	1.21	ρπ	∿ 100		253
Broad enhancement in the $J^P=1^+$ ρπ partial wave; not a Breit-Wigner resonance¶.								
B(1235)	$1^+(1^+)-$	1237§ ±10§	120§ ±20§	1.53 ±.12	ωπ For upper limits, see footnote (j)	only mode seen		351

0 0 0 0 3 6 0 4 7 7 9

Meson Table *(cont'd)*

Name (I: 0, 1; G −: ω/φ, π; G +: η, ρ)	$I^G(J^P)C_n$ (underline = estab.)	Mass M (MeV)	Full Width Γ (MeV)	M^2 $\pm\Gamma M^{(a)}$ $(GeV)^2$	Partial decay mode: Mode	Fraction (%) [Upper limits are 1σ (%)]	p or p_{max}[b] (MeV/c)
f(1270)	$0^+(2^+)+$	1270§ ±5	163§ ±15	1.61 ±.21	ππ	∿ 80	619
					$2\pi^+2\pi^-$	5±2§	556
					$K\bar{K}$	5±3§	394
D(1285)	$0^+(A\ )\pm$	1286§ ±10	30§ ±20	1.65 ±.03	$K\bar{K}\pi$	seen	305
					ηππ	seen	484
					†[δ(970)π	seen]	250
	$J^P = 0^-, 1^+, 2^-$, with 1^+ favoured				$2\pi^+2\pi^-$ (prob. $\rho^0\pi^+\pi^-$)	seen	565
$A_2(1310)$	$1^-(2^+)+$	1310§ ±10	100§ ±10	1.72 ±.13	ρπ	*72.4±2.1*	413
					ηπ	15.3±1.3	529
					ωππ	*7.6±2.2*	353
					$\bar{K}K$	*4.7±0.6*	428
					η′(958)π	<1	279
E(1420)	$0^+(A\ )\pm$	1416§ ±10	60§ ±20	2.01 ±.08	$K\bar{K}\pi$	∿ 40	421
					†[$K^*\bar{K} + \bar{K}^*K$	∿ 20]	131
					ηππ	∿ 60	564
					†[δ(970)π	possibly seen]	356
f′(1514)	$0^+(2^+)+$	1516 ±3	*40* *±10*	2.29 ±.06	$K\bar{K}$	*only mode seen*	572
					For upper limits, see footnote (k)		
$F_1(1540)$	$1\ (A\ )$	1540 ±5	40 ±15	2.37 ±.06	$K^*\bar{K} + \bar{K}^*K$	only mode seen	321
Evidence based on only one experiment							
ρ′(1600)	$1^+(1^-)-$	∿ 1600	∿ 500	2.56	4π	only mode seen	
					†[ρππ	∿80]	575
Resonance interpretation uncertain.					ππ	< 1 (p)¶	788
					For upper limits, see footnote (p)		629
$A_3(1640)$	$1^-(2^-)+$	∿ 1645	100-400	2.71	fπ	∿ 100	310
Broad enhancement in the $J^P = 2^-$ fπ partial wave; not a Breit-Wigner resonance.¶							
ω(1675) formerly called φ(1675)	$0^-(N\ )-$	1664 ±13 S=1.2*	141 ±17	2.77 ±.23	ρπ	dominant	645
					3π	possibly observed	804
					5π	10±10	777
g(1680)	$1^+(3^-)-$	1680§ ±20	160§ ±30	2.82 ±.27	2π	∿ 40 (ℓ)	828
					4π (incl. ππρ, ρρ, $A_2\pi$, ωπ)	∿ 50 (ℓ)	781
					$K\bar{K}$	∿ 3 (ℓ)	677
J^P, M and Γ from the 2π mode[ℓ].					$K\bar{K}\pi$ (incl. $K^*\bar{K}$)	∿ 3 (ℓ)	617
See note (1) for possible heavier states.							
$K^+(494)$	$1/2(0^-)$	493.71		0.244	See Stable Particle Table		
$K^0(498)$		497.71		0.248			
$K^*(892)$	$1/2(1^-)$	891.7 ±0.5	50.1 ±1.1	0.795 ±.045	Kπ	≈ 100	288
					Kππ	< 0.2	216
						< 0.16	309
		(Charged mode; $m^0 - m^\pm = 6.1\pm1.5$ MeV)					

Meson Table *(cont'd)*

Name (G\I: 0, 1; −: ω/φ, π; +: η, ρ)	$I^G(J^P)C_n$ ⊢ estab.	Mass M (MeV)	Full Width Γ (MeV)	M^2 $\pm\Gamma M$[a] $(GeV)^2$	Partial decay mode: Mode	Partial decay mode: Fraction (%) [Upper limits are 1σ (%)]		p or p_{max}[b] (MeV/c)
κ	1/2(0$^+$)	δ_0^1 is near 90°, with slow variation, in mass region 1200-1400 MeV.						
See note on Kπ S wave¶.								
Q { K_A(1240) or C	1/2(1$^+$)	1242 ±10	127 ±25	1.54 ±.16	Kππ	only mode seen		
		seen in $\bar{p}p$ at rest			†[K*π	large]		
K_A(1280 to 1400)	1/2(1$^+$)	1280 to 1400			†[Kρ	seen]		
See note (m).					†[K(ππ)$_{\ell=0}$	possibly seen]		
K_N(1420)	1/2(2$^+$)	1421 ±5§	100 ±10§	2.02 ±.14	Kπ	55.0±3.3	S=1.2*	616
					K*π	29.5±2.7		415
					Kρ	9.2±2.9	S=1.2*	319
		See note (n).			Kω	4.4±1.7		304
					Kη	2.0±1.8		482
L(1770)	1/2(A)	1765 ±10§	140 ±50§	3.11 ±.25	Kππ	dominant		788
					Kπππ	seen		757
					†[K_N(1420)π and other subreactions¶]			
	$J^P=2^-$ favoured, 1$^+$ and 3$^+$ not excluded.							

See note (1) for possible heavier states.

(1) Contents of Meson Data Card Listings

Non-strange (Y = 0) entry	$I^G(J^P)C_n$	entry	$I^G(J^P)C_n$	entry	$I^G(J^P)C_n$	Strange (|Y| = 1) entry	I (J^P)
π (140)	1$^-$(0$^-$)+	→ η_N (1080)	0$^+$(N)+	R-region { A_3 (1640)	1$^-$(2$^-$)+	K (494)	1/2(0$^-$)
η (549)	0$^+$(0$^-$)+	A_1 (1100)	1$^-$(1$^+$)+	R-region { ω (1675)	0$^-$(N)-	K* (892)	1/2(1$^-$)
ε (600)	0$^+$(0$^+$)+	→ M (1150)		R-region { g (1680)	1$^+$(3$^-$)-	κ	1/2(0$^+$)
ρ (770)	1$^+$(1$^-$)-	→ $A_{1.5}$(1170)	1$^-$	R-region { → X (1690)	-	→ K_A(1175)	3/2
ω (784)	0$^-$(1$^-$)-	B (1235)	1$^+$(1$^+$)-	→ X (1795)	1	→ K_A(1265)	3/2
→ M (940)		F (1270)	0$^+$(2$^+$)+	→ η/ρ(1830)	+	Q	1/2(1$^+$)
→ M (953)	+	D (1285)	0$^+$(A)+	→ ω/π(1830)	-	K_N(1420)	1/2(2$^+$)
η′ (958)	0$^+$(0$^-$)+	A_2 (1310)	1$^-$(2$^+$)+	→ S (1930)		→ K_N(1660)	1/2
δ (970)	1$^-$(0$^+$)+	E (1420)	0$^+$(A)+	→ ρ (2100)	1$^+$	→ K_N(1760)	1/2
→ H (990)	0$^-$(A)-	→ X (1430)	0	→ T (2200)	1	L (1770)	1/2(A)
S*(1000)	0$^+$(0$^+$)+	→ X (1440)	1	→ ρ (2275)	1$^+$	→ K_N(1850)	
φ (1019)	0$^-$(1$^-$)-	f′ (1514)	0$^+$(2$^+$)+	→ U (2360)	1	→ K*(2200)	
→ M (1033)		F_1 (1540)	1 (A)	→ N$\bar{N}$ (2375)	0	→ K*(2800)	
→ B_1(1040)	1$^+$	ρ′ (1600)	1$^+$(1$^-$)-	→ X(2500-3600)			

Meson Table *(cont'd)*

→ indicates an entry in Meson Data Card Listings not entered in the Meson Table. We do not regard these as established resonances.

¶ See Meson Data Card Listings.

* Quoted error includes scale factor $S = \sqrt{\chi^2/(N-1)}$. See footnote to Stable Particle Table.

† Square brackets indicate a subreaction of the previous (unbracketed) decay mode(s).

§ This is only an educated guess; the error given is larger than the error of the average of the published values. (See Meson Data Card Listings for the latter.)

(a) ΓM is approximately the half-width of the resonance when plotted against M^2.

(b) For decay modes into ≳ 3 particles, p_{max} is the maximum momentum that any of the particles in the final state can have. The momenta have been calculated by using the averaged central mass values, without taking into account the widths of the resonances.

(c) From pole position $(M - i\Gamma/2)$. For both ε and S* the pole is on Riemann Sheet 2.

(d) The e^+e^- branching ratio is from $e^+e^- \to \pi^+\pi^-$ experiments only. The ωρ interference is then due to ωρ mixing only, and is expected to be small. See note in Meson Data Card Listings. The $\mu^+\mu^-$ branching ratio is compiled from 3 experiments; each possibly with substantial ωρ interference. The error reflects this uncertainty; see notes in Meson Data Card Listings. If eμ universality holds, $\Gamma(\rho^0 \to \mu^+\mu^-) = \Gamma(\rho^0 \to e^+e^-) \times$ phase space correction.

(e) Empirical limits on fractions for other decay modes of ρ(765) are $\pi^\pm\gamma < 0.5\%$, $\pi^\pm\eta < 0.8\%$, $\pi^+\pi^+\pi^-\pi^- < 0.15\%$, $\pi^\pm\pi^+\pi^-\pi^0 < 0.2\%$.

(f) Note that experiments with final state $K_SK_S\omega$ ($\bar{p}p$ at rest) give $M_\omega = 780.6 \pm 0.5$¶.

(g) Empirical limits on fractions for other decay modes of ω(784) are $\pi^+\pi^-\gamma < 5\%$, $\pi^0\pi^0\gamma < 1\%$, η + neutral(s) < 1.5%, $\mu^+\mu^- < 0.02\%$, $\pi^0\mu^+\mu^- < 0.2\%$, $\eta\gamma < 0.5\%$.

(h) Empirical limits on fractions for other decay modes of η′(958): $\pi^+\pi^- < 2\%$, $\pi^+\pi^-\pi^0 < 5\%$, $\pi^+\pi^+\pi^-\pi^- < 1\%$, $\pi^+\pi^+\pi^-\pi^-\pi^0 < 1\%$, $6\pi < 1\%$, $\pi^+\pi^-e^+e^- < 0.6\%$, $\pi^0e^+e^- < 1.3\%$, $\eta e^+e^- < 1.1\%$, $\pi^0\rho^0 < 4\%$, $\pi^0\omega < 8\%$.

(i) Empirical limits on fractions for other decay modes of φ(1019) are $\pi^+\pi^- < 0.03\%$, $\pi^+\pi^-\gamma < 4\%$, $\omega\gamma < 5\%$, $\rho\gamma < 2\%$, $\pi^0\gamma < 0.35\%$, $2\pi^+2\pi^-\pi^0 < 9\%$.

(j) Empirical limits on fractions for other decay modes of B(1235): $\pi\pi < 15\%$, $K\bar{K} < 2\%$, $4\pi < 50\%$, $\phi\pi < 1.5\%$, $\eta\pi < 25\%$, $(K\bar{K})^\pm\pi^0 < 8\%$, $K_SK_S\,\pi^\pm < 2\%$, $K_SK_L\,\pi^\pm < 6\%$.

(k) Empirical limits on fractions for other decay modes of f′(1514) are $\pi^+\pi^- < 20\%$, $\eta\eta < 50\%$, $\eta\pi\pi < 30\%$, $K\bar{K}\pi + K^*\bar{K} < 35\%$, $2\pi^+2\pi^- < 32\%$.

(ℓ) We assume as a working hypothesis that peaks with $I^G = 1^+$ observed around 1.7 GeV all come from g(1680). For indications to the contrary see Meson Data Card Listings.

(m) See Q-region note in Meson Data Card Listings. Some investigators see a broad enhancement in mass (Kππ) from 1250-1400 MeV (the Q region), and others see structure. The Kη, Kω, and Kπ are less than a few percent.

(n) The tabulated mass of 1421 MeV comes only from charged $K_N(1420) \to K\pi$ measurements; the average of the neutral $K_N(1420)$ mass is 1423 MeV. Kππ mode can be contaminated with diffractively produced $Q^\pm$.

(o) Empirical limits on fractions for other decay modes of f(1270) are $\eta\pi\pi < 15\%$; $K^0K^-\pi^+$ + c.c. < 6%.

(p) The tiny partial width for $\rho' \to \pi\pi$ ($\Gamma < 2$ MeV) is based on an OPE model.¶ Empirical limits are $\pi\pi < 20\%$, $K\bar{K} < 8\%$.

Established Nonets, and octet-singlet mixing angles from Appendix IIB, Eq. (2′). Of the two isosinglets, the "mainly octet" one is written first, followed by a semi-colon.

$(J^P)C_n$	Nonet members	$\theta_{lin.}$	$\theta_{quadr.}$
$(0^-)+$	π, K, η; η′	24 ± 1°	10 ± 1°
$(1^-)-$	ρ, K^*, φ; ω	36 ± 1°	39 ± 1°
$(2^+)+$	A_2, $K_N(1420)$, f′; f	29 ± 2°	31 ± 2°

Baryon Table

April 1973

Baryon States for which information can be found in the Data Card Listings. The name, the mass, the quantum numbers, and the status are shown. Those states with four or three stars can be found in the following Table, the others have been omitted because the evidence for the existence of the effect and/or for its interpretation as a resonance is open to considerable question.

N(940)	P11	****	Δ(1236)	P33	****	Λ(1115)	P01	****	Σ(1190)	P11	****	Ξ(1320)	P11	****
N(1470)	P11	****	Δ(1650)	S31	****	Λ(1330)		Dead	Σ(1385)	P13	****	Ξ(1530)	P13	****
N(1520)	D13	****	Δ(1670)	D33	***	Λ(1405)	S01	****	Σ(1440)	PE	Dead	Ξ(1630)		**
N(1535)	S11	****	Δ(1690)	P33	*	Λ(1520)	D03	****	Σ(1480)	PE	*	Ξ(1820)		***
N(1670)	D15	****	Δ(1890)	F35	***	Λ(1670)	S01	****	Σ(1620)	S11	**	Ξ(1940)		***
N(1688)	F15	****	Δ(1910)	P31	***	Λ(1690)	D03	****	Σ(1620)	P11	**	Ξ(2030)		**
N(1700)	S11	****	Δ(1950)	F37	****	Λ(1750)	P01	**	Σ(1620)	PE	**	Ξ(2250)		*
N(1700)	D13	**	Δ(1960)	D35	*	Λ(1815)	F05	****	Σ(1670)	D13	****	Ξ(2500)		**
N(1780)	P11	***	Δ(2160)	P33	*	Λ(1830)	D05	***	Σ(1670)	PE	**			
N(1860)	P13	***	Δ(2420)	H311	***	Λ(1860)	P03	**	Σ(1690)	PE	**			
N(1990)	F17	**	Δ(2850)		***	Λ(1870)	S01	**	Σ(1750)	S11	***			
N(2040)	D13	**	Δ(3230)		***	Λ(2010)	D03	**	Σ(1765)	D15	****	Ω(1670)	P03	****
N(2100)	S11	*				Λ(2020)	F07	**	Σ(1840)	P13	*			
N(2100)	D15	*				Λ(2100)	G07	****	Σ(1880)	P11	**			
N(2175)	F15	*				Λ(2110)		*	Σ(1915)	F15	****			
N(2190)	G17	***	Z0(1780)	P01	*	Λ(2350)		****	Σ(1940)	D13	***			
N(2220)	H19	***	Z0(1865)		*	Λ(2585)		***	Σ(2000)	S11	*			
N(2650)		***	Z1(1900)	P13	*				Σ(2030)	F17	****			
N(3030)		***	Z1(2150)		*				Σ(2070)	F15	*			
N(3245)		*	Z1(2500)		*				Σ(2080)	P13	**			
N(3690)		*							Σ(2100)	G17	**			
N(3755)		*							Σ(2250)		****			
									Σ(2455)		***			
									Σ(2620)		***			
									Σ(3000)		**			

**** Good, clear, and unmistakable. *** Good, but in need of clarification or not absolutely certain.
** Needs confirmation. * Weak.

[See notes on N's and Δ's, on possible Z*'s, and on Y*'s at the beginning of those sections in the Baryon Data Card Listings; also see notes on individual resonances in the Baryon Data Card Listings.]

Particle[a]	I (J^P) ⊢⊣ estab.	π or K Beam T(GeV) p(GeV/c) $\sigma = 4\pi\lambda\!\!\!^-{}^2$ (mb)	Mass M^b (MeV)	Full Width Γ^b (MeV)	M^2 $\pm\Gamma M^c$ (GeV^2)	Partial decay mode: Mode	Fraction %	p or p_{max} [d] (MeV/c)
p	$1/2(1/2^+)$		938.3		0.880	See Stable Particle Table		
n			939.6		0.883			
N'(1470)	$1/2(1/2^+)$ P'_{11}	T=0.53πp	~1470	165 to	2.16	Nπ	60	420
		p=0.66		- 300	±0.41	Nππ	40	368
		σ=27.8				[Nε	5-30][e]	
						[Δπ	20-30][e]	173
						[Nρ	~7][e]	
						pγ[g]	0.05	435
						nγ[g]	0.0	435
N'(1520)	$1/2(3/2^-)$ D'_{13}	T=0.61	1510 to	105 to	2.31	Nπ	50	456
		p=0.74	1540	150	±0.18	Nππ	~50	410
		σ=23.5				[Nε	0-2][e]	
						[Nρ	7-25][e]	
						[Δπ	15-40][e]	224
						Nη	0.2-1.4	
						pγ[g]	0.55	471
						nγ[g]	0.30	471
N'(1535)	$1/2(1/2^-)$ S'_{11}	T=0.64	1500 to	50 to	2.36	Nπ	35	467
		p=0.76	1600	160	±0.18	Nη	55	182
		σ=22.5				Nππ	~10	422
						[Nρ	1-2][e]	
						pγ[g]	0.2-0.4	481
						nγ[g]	0.12	481

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Baryon Table *(cont'd)*

Particle[a]	I (J^P) ⊢⊣ estab.	π or K Beam T(GeV) p(GeV/c) σ = 4πƛ² (mb)	Mass M^b (MeV)	Full Width Γ^b (MeV)	M^2 $\pm\Gamma M^c$ (GeV^2)	Partial decay mode: Mode	Fraction %	p or p_{max} [d] (MeV/c)
N'(1670)[i]	1/2(5/2⁻) D'_{15}	T=0.87	1670 to	115 to	2.79	Nπ	40	560
		p=1.00	1685	175	±0.24	Nππ	60	525
		σ=15.6				[Δπ	50-60][e]	357
						ΛK	<1	200
						Nη	<1[j]	368
						pγ[g]	0.01	572
						nγ[g]	0.02	572
N'(1688)[i]	1/2(5/2⁺) F'_{15}	T=0.90	1680 to	105 to	2.85	Nπ	60	572
		p=1.03	1690	180	±0.21	Nππ	40	538
		σ=14.9				[Nε	12][e]	340
						[Nρ	15][e]	
						[Δπ	13-40][e]	372
						ΛK	<0.1	231
						Nη	<0.3[j]	388
						pγ[g]	0.20	583
						nγ[g]	0.01	583
N''(1700)[i]	1/2(1/2⁻) S''_{11}	T=0.92	1665 to	100 to	2.89	Nπ	60	580
		p=1.05	1765	300	±0.42	Nππ		547
		σ=14.3				[Nε	25-30][e]	355
						[Nρ	10-20][e]	
						ΛK	5	250
						Nη	~3[j]	340
						pγ[g]	0.05-0.1	591
						nγ[g]	0.05	591
N''(1780)[i]	1/2(1/2⁺) P''_{11}	T=1.07	1650 to	50 to	3.17	Nπ	~20	633
		p=1.20	1860	350	±0.51	Nππ		603
		σ=12.2				[Nε	30-40][e,h]	440
						[Δπ	25-35][e,h]	445
						ΛK	<7	353
						Nη	10-20[j]	476
						pγ[g]	0.01	643
						nγ[g]	0.01	643
N(1860)	1/2(3/2⁺) P_{13}	T=1.22	1770 to	180 to	3.46	Nπ	25	685
		p=1.36	1860	330	±0.57	Nππ		657
		σ=10.4				[Nρ	55-65][e,h]	366
						ΛK	~5	437
						Nη	~4[j]	545
N(2190)	1/2(7/2⁻) G_{17}	T=1.94	2000 to	270 to	4.80	Nπ	25	888
		p=2.07	2260	325	±0.67	Nππ		868
		σ=6.21						
N(2220)	1/2(9/2⁺) H_{19}	T=2.00	2200 to	260 to	4.93	Nπ	15	905
		p=2.14	2245	330	±0.65	Nππ		887
		σ=5.97						
N(2650)	1/2(?⁻)	T=3.12	~2650	~360	7.02	Nπ	(J+1/2)x	1154
		p=3.26			±0.95	Nππ	=0.45[f]	1140
		σ=3.67						
N(3030)	1/2(?)	T=4.27	~3030	~400	9.18	Nπ	(J+1/2)x	1366
		p=4.41			±1.21	Nππ	=0.05[f]	1354
		σ=2.62						
Δ'(1236)[m]	3/2(3/2⁺) P'_{33}	T=0.195 (++)	1230 to	110 to	1.53	Nπ	99.4	231
		p=0.304	1236	122	±0.14	Nπ⁺π⁻	0	90
		σ=91.8				Nγ[g]	~0.6	262
	Pole position[m]: M-iΓ/2 = (1211.6±0.7) -i(49.5±1.8)							
Δ(1650)	3/2(1/2⁻) S_{31}	T=0.83	1615 to	130 to	2.72	Nπ	28	547
		p=0.96	1695	200	±0.28	Nππ	72	511
		σ=16.4				[Nρ	8-16][e]	558
						[Δπ	26-32][e]	340
						Nγ[g]	0.30	558

Baryon Table *(cont'd)*

Particle[a]	I (J^P) ⟼ estab.	π or K Beam T(GeV) p(GeV/c) $\sigma = 4\pi ƛ^2$ (mb)	Mass M^b (MeV)	Full Width Γ^b (MeV)	M^2 $\pm\Gamma M^c$ (GeV^2)	Partial decay mode Mode	 Fraction %	 p or p_{max} [d] (MeV/c)
Δ(1670)	$3/2(3/2^-)$ D_{33}	T=0.87 p=1.00 σ=15.6	1650 to 1720	175 to 300	2.79 ±0.40	Nπ Nππ [Δπ Nγ[g]	15 22-30][e] 0.05	560 525 357 572
Δ(1890)	$3/2(5/2^+)$ F_{35}	T=1.28 p=1.42 σ=9.88	1840 to 1920	200 to 350	3.57 ±0.49	Nπ Nππ [Nρ Nγ[g]	17 55-70][e] 0.03	704 677 403 712
Δ(1910)	$3/2(1/2^+)$ P_{31}	T=1.33 p=1.46 σ=9.54	1780 to 1935	200 to 340	3.65 ±0.52	Nπ Nππ [Nρ [Δπ Nγ[g]	25 3-16][e] 4-16][e'] 0.03	716 691 429 543 725
Δ(1950)	$3/2(7/2^+)$ F_{37}	T=1.41 p=1.54 σ=8.90	1930 to 1980	170 to 270	3.80 ±0.44	Nπ Nππ [Nρ [Δπ Nγ[g] ΣK Σ(1385)K	45 8-12][e] 14-19][e] 0.15 ~2 1.4	741 716 471 571 749 460 232
Δ(2420)	$3/2(11/2^+)$ ⟼	T=2.50 p=2.64 σ=4.68	2320 to 2450	270 to 350	5.86 ±0.75	Nπ Nππ	11 >20	1023 1006
Δ(2850)	$3/2(\ ?^+\ )$	T=3.71 p=3.85 σ=3.05	~2850	~400	8.12 ±1.14	Nπ Nππ	(J+1/2)x =0.25[f]	1266 1254
Δ(3230)	$3/2(\ ?\ )$	T=4.94 p=5.08 σ=2.25	~3230	~440	10.4 ±1.4	Nπ Nππ	(J+1/2)x =0.05[f]	1475 1464
Z*	Evidence for states with hypercharge 2 is controversial. See the Baryon Data Card Listings for discussion and display of data.							
Λ	$0(1/2^+)$		1115.6		1.24	See Stable Particle Table		
Λ'(1405)	$0(1/2^-)$ S'_{01}	p<0 K⁻p	1405[n] ±5	40[n] ±10	1.97 ±0.06	Σπ	100	142
Λ'(1520)	$0(3/2^-)$ D'_{03}	p=0.389 σ=84.5	1518[n] ±2	16[n] ±2	2.30 ±0.02	N$\bar{K}$ Σπ Λππ Σππ	45±1 41±1 10±.5 1.0±.1	234 258 250 140
Λ''(1670)	$0(1/2^-)$ S''_{01}	p=0.74 σ=28.5	~1670	15 to 38	2.79 ±0.04	N$\bar{K}$ Λη Σπ	15-35 15-25 30-50	410 64 393
Λ''(1690)	$0(3/2^-)$ D''_{03}	p=0.78 σ=26.1	~1690	27 to 85	2.86 0.09	N$\bar{K}$ Σπ Λππ Σππ	20-30 40-70 <25 <25	429 409 415 352
Λ'(1815)	$0(5/2^+)$ F'_{05}	p=1.05 σ=16.7	1820 ±5[n]	64 to 104	3.30 ±0.15	N$\bar{K}$ Σπ Σ(1385)π	61 11 15-20	542 508 362
Λ'(1830)	$0(5/2^-)$ D'_{05}	p=1.09 σ=15.8	1810 to 1840	60 to 150	3.33 ±0.19	N$\bar{K}$ Σπ Λππ	~10 20-60	554 519 536
Λ(2100)	$0(7/2^-)$ G_{07}	p=1.68 σ=8.68	~2100	60 to 140	4.41 ±0.22	N$\bar{K}$ Σπ Λη ΞK Λω	25 ~ 5 < 3 ~ 2 ~ 1	748 699 617 483 443

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Baryon Table *(cont'd)*

Particle[a]	I (J^P) ⊢⊣ estab.	π or K Beam T(GeV) p(GeV/c) $\sigma = 4\pi\lambda\!\!^-{}^2$ (mb)	Mass M^b (MeV)	Full Width Γ^b (MeV)	M^2 $\pm\Gamma M^c$ (GeV^2)	Partial decay mode: Mode	Fraction %	p or p_{max} [d] (MeV/c)
Λ(2350)	0(?)	p=2.29 σ=5.85	~2350	140 to 324	5.52 ±0.55	$N\bar{K}$	(J+1/2)x =0.7[f]	913
Λ(2585)	0(?)	p=2.91 σ=4.37	~2585	~300	6.66 ±0.77	$N\bar{K}$	(J+1/2)x =1.0[f]	1058
Σ	1(1/2$^+$)		(+)1189.4 (0)1192.5 (-)1197.3		1.41 1.42 1.43	See Stable Particle Table		
Σ'(1385)	1(3/2$^+$)P'_{13}	p< 0 K^-p	(+)1383±1 S=1.3* (-)1386±2 S=2.2*	(+)34±2 S=2.0* (-)36±6 S=3.5*!	1.92 ±0.05	Λπ Σπ	89±2 11±2	208 117
Σ'(1670)[k]	1(3/2$^-$) D'_{13}	p=0.74 σ=28.5	~1670	35-65	2.79 ±0.08	$N\bar{K}$ Σπ Λπ Σππ [Λ(1405)π][e] Λππ	~8 ~40 ~12 5-15	410 387 447 326 207 397
	Parameters here are obtained from partial wave analyses for a D_{13} resonance. Production experiments suggest two such states; see footnote k and the Baryon Data Card Listings.							
Σ'(1750)	1(1/2$^-$) S''_{11}	p=0.91 σ=20.7	1700 to 1790	50 to 100	3.05 ±0.13	$N\bar{K}$ Λπ Ση	seen seen seen	483 507 54
Σ(1765)	1(5/2$^-$) D_{15}	p=0.94 σ=19.6	1765 ±5[n]	~120	3.12 ±0.21	$N\bar{K}$ Λπ Λ(1520)π Σ(1385)π Σπ	~41 ~13 ~15 ~10 ~1	496 518 187 315 461
Σ(1915)[i]	1(5/2$^+$) F'_{15}	p=1.25 σ=13.0	1900-1930	50-100	3.67 ±0.14	$N\bar{K}$ Λπ Σπ	~14 ~6 ~6	612 619 568
	Formation and production experiments do not agree on Σπ/Λπ ratio.							
Σ''(1940)	1(3/2$^-$)D''_{13}	p=1.32 σ=12.0	~1940	~220	3.77 ±0.43	$N\bar{K}$ Λπ Σπ	 seen seen	678 680 589
Σ(2030)	1(7/2$^+$) F_{17}	p=1.52 σ=9.93	~2030	100 to 170	4.12 ±0.27	$N\bar{K}$ Λπ Σπ ΞK	~20 ~20 ~4 < 2	700 700 652 412
Σ(2250)	1(?)	p=2.04 σ=6.76	~2250	100 to 230	5.06 ±0.37	$N\bar{K}$ Σπ Λπ	(J+1/2)x =0.3[f]	849 842 799
Σ(2455)	1(?)	p=2.57 σ=5.09	~2455	~120	6.03 ±0.29	$N\bar{K}$	(J+1/2)x =0.2[f]	979
Σ(2620)	1(?)	p=2.95 σ=4.30	~2620	~175	6.86 ±0.46	$N\bar{K}$	(J+1/2)x =0.3[f]	1064
Ξ[ℓ]	1/2(1/2$^+$)		(0)1314.9 (-)1321.3		1.73 1.75	See Stable Particle Table		
Ξ(1530)[ℓ]	1/2(3/2$^+$) P_{13}		(0) 1531.6±0.4 S=1.3* (-) 1535.0±0.6	(0) 9.1±0.5 (-) 12.9±4.1	2.34 ±0.01	Ξπ	100	144
Ξ(1820)[ℓ]	1/2(?)		1795 to 1870	12 to 99	3.31 ±0.10	$\Lambda\bar{K}$ Ξπ Ξ(1530)π Σ$\bar{K}$		396 413 234 306
	All four decay modes have been seen. Branching ratios not quoted because there may be more than one state here.							
Ξ(1940)[ℓ]	1/2(?)		1894 to 1961	42 to 140	3.72 ±0.18	Ξπ Ξ(1530)π		499 336
	Seen in both final states; not clear if one, or more, states present.							
Ω$^-$	0(3/2$^+$)		1672.5		2.80	See Stable Particle Table		

Baryon Table *(cont'd)*

* Quoted error includes an S(scale) factor. See footnote to Stable Particle Table.

→ An arrow at the left of the Table indicates a candidate that has been omitted because the evidence for the existence of the effect and (or) for its interpretation as a resonance is open to considerable question. For convenience all Baryon States for which information exists in the Baryon Data Card Listings are listed at the beginning of the Baryon Table. In that list, states with only a one or two star (*) rating have been omitted from the Baryon Table; for additional information on such states, see the Baryon Data Card Listings.

a. For the baryon states, the name [such as N' (1470)] contains the mass, which may be different for each new analysis. The convention for using primes in the names is as follows: when there is more than one resonance on a given Argand diagram, the first has been designated with a prime, the second with a double prime, etc. The name (col. 1) is the same as can be found in large print in the Baryon Data Card Listings.

b. For M and Γ of most baryons we report here an interval instead of an average. Averages are appropriate if each result is based on independent measurements, but inappropriate here where the spread in parameters arises because different models or procedures have been applied to a common set of data. Where only one value is given it is either because only one experiment reports that state or because the various experiments agree. An error is quoted only when the various experiments averaged have taken into account the systematic errors.

c. For this column M is the rounded average which also appears in the name column. Γ is taken as the center of the interval given in the column labeled "Γ".

d. For decay modes into ≥ 3 particles p_{max} is the maximum momentum that any of the particles in the final state can have. The momenta have been calculated using the averaged central mass values, without taking into account the widths of the resonances. For isobars, p is computed using the nominal isobar masses. If the isobar plus stable mass is less than the resonance mass, no value for p is given.

e. Square brackets indicate a sub-reaction of the previous unbracketed decay mode. Our estimate is from data in the Baryon Data Card Listings (where available) and from the isobar model Argand plots of HERNDON 72. See the Mini-Review preceding the N^* Data Card Listings.

f. This state has been seen only in total cross sections. J is not known; x is Γ_{el}/Γ.

g. The tabulated radiative fractions involve a sum over two helicities (1/2, 3/2). In the case of I=1/2 resonances, there are two distinct isospin couplings, whence γp and γn. For further information and conventions, see the Mini-Review preceding the Baryon Data Card Listings.

h. These values are particularly crude. Any naive estimate from the Argand plots of HERNDON 72 (see the Mini-Review preceding the N^* Data Card Listings) yields branching fractions the sum of which is greater than one. The values given have been scaled downward to be consistent with the branching fractions from other (non-isobar) channels.

i. Only information coming from partial-wave analyses has been used here. For the production experiments results see the Baryon Data Card Listings.

j. Value obtained in an energy-dependent partial-wave analysis which uses a t-channel-poles-plus-resonance parametrization. The values of the couplings obtained for the resonances may be affected by double counting.

k. In this energy region the situation is still confused. In addition to the $D_{13}(1670)$, formation experiments have found evidence for fairly narrow (Γ ~ 50 MeV) S_{11} and/or P_{11} states near 1620 MeV. It is not clear how many such states really exist. No one has reported a strong coupling of any of these states to $\bar{K}N$, but there is much disagreement about branching ratios πΛ and πΣ.

ℓ. Only Ξ(1530) is firmly established; information on the other states comes from experiments that have poor statistics due to the fact that the cross sections for S=-2 states are very low. For Ξ states, because of the meager statistics, we lower our standards and tabulate resonant effects if they have at least a four-standard-deviation statistical significance and if they are seen by more than one group. So Ξ(2030), with main decay mode $\Sigma\bar{K}$, reported as a 3.5-standard-deviation effect, is not tabulated. See the Baryon Data Card Listings for the other states.

m. See note on Δ(1236) in the Baryon Data Card Listings. Values of mass and width are dependent upon resonance shape used to fit the data. The pole position appears to be much less dependent upon the parametrization used.

n. This is only an educated guess; the error given is larger than the error of the average of the published values (see the Baryon Data Card Listings for the latter).

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PHYSICAL AND NUMERICAL CONSTANTS*

PHYSICAL CONSTANTS

N	$= 6.022169(40)\times10^{23}$ mole^{-1} (based on $A_{C^{12}} = 12$)
c	$= 2.9979250(10)\times10^{10}$ cm sec^{-1}
e	$= 4.803250(21)\times10^{-10}$ esu $= 1.6021917(70)\times10^{-19}$ coulomb
1 MeV	$= 1.6021917(70)\times10^{-6}$ erg
$\hbar$	$= 6.582183(22)\times10^{-22}$ MeV sec $= 1.0545919(80)\times10^{-27}$ erg sec
$\hbar c$	$= 1.9732891(66)\times10^{-11}$ MeV cm $= 197.32891(66)$ MeV fermi
	$= 0.6240088(21)$ GeV mb$^{1/2}$
α	$= e^2/\hbar c = 1/137.03602(21)$
$k_{\text{Boltzmann}}$	$= 1.380622(59)\times10^{-16}$ erg K^{-1}
	$= 8.61708(37)\times10^{-11}$ MeV K^{-1} $= 1$ eV/11604.85(49)K
m_e	$= 0.5110041(16)$ MeV $= 9.109558(54)\times10^{-31}$ kg
m_p	$= 938.2592(52)$ MeV $= 1836.109(11)\, m_e = 6.72211(63) m_{\pi^\pm}$
	$= 1.00727661(8) m_1$ (where $m_1 = 1$ amu $= \frac{1}{12} m_{C^{12}} = 931.4812(52)$ MeV)
m_d	$= 1875.587(10)$ MeV
r_e	$= e^2/m_e c^2 = 2.817939(13)$ fermi (1 fermi $= 10^{-13}$ cm)
$\lambda\!\!\!^{-}_e$	$= \hbar/m_e c = r_e \alpha^{-1} = 3.861592(12)\times10^{-11}$ cm
$a_{\infty\,\text{Bohr}}$	$= \hbar^2/m_e e^2 = r_e \alpha^{-2} = 0.52917715(81)$ Å (1Å $= 10^{-8}$ cm)
σ_{Thomson}	$= \frac{8}{3}\pi r_e^2 = 0.6652453(61)\times10^{-24}$ cm^2 $= 0.6652453(61)$ barns
μ_{Bohr}	$= e\hbar/2m_e c = 0.5788381(18)\times10^{-14}$ MeV gauss^{-1}
μ_{nucleon}	$= e\hbar/2m_p c = 3.152526(21)\times10^{-18}$ MeV gauss^{-1}
$\frac{1}{2}\omega^e_{\text{cyclotron}}$	$= e/2m_e c = 8.794014(27)\times10^{6}$ rad sec^{-1} gauss^{-1}
$\frac{1}{2}\omega^p_{\text{cyclotron}}$	$= e/2m_p c = 4.789484(27)\times10^{3}$ rad sec^{-1} gauss^{-1}

Hydrogen-like atom (nonrelativistic, μ = reduced mass):

$$\frac{v}{c}\Big)_{rms} = \frac{ze^2}{n\hbar c}\,;\; E_n = \frac{\mu}{2} v^2 = \frac{\mu z^2 e^4}{2(n\hbar)^2}\,;\; a_n = \frac{n^2\hbar^2}{\mu z e^2}$$

$R_\infty = m_e e^4/2\hbar^2 = m_e c^2 \alpha^2/2 = 13.605826(45)$ eV (Rydberg)

$pc = 0.3\, H\rho$(MeV, kilogauss, cm); 0.3 (which is $10^{-11}c$) enters because there are ≈ 300 "volts"/esu volt.

1 year (sidereal)	$= 365.256$ days $= 3.1558\times10^{7}$ sec ($\approx \pi\times10^{7}$ sec)
density of dry air	$= 1.205$ mg cm^{-3} (at 20°C, 760 mm)
acceleration by gravity	$= 980.62$ cm sec^{-2} (sea level, 45°)
gravitational constant	$= 6.6732(31)\times10^{-8}$ cm^3 g^{-1} sec^{-2}
1 calorie (thermochemical)	$= 4.184$ joules
1 atmosphere	$= 1033.2275$ g cm^{-2}
1 eV per particle	$= 11604.85(49)$ °K (from $E = kT$)

NUMERICAL CONSTANTS

π	$= 3.1415927$	1 rad	$= 57.2957795$ deg	$\sqrt{\pi}$	$= 1.7724539$
e	$= 2.7182818$	$1/e$	$= 0.3678794$	$\sqrt{2}$	$= 1.4142136$
$\ln 2$	$= 0.6931472$	$\ln 10$	$= 2.3025851$	$\sqrt{3}$	$= 1.7320508$
$\log_{10} 2$	$= 0.3010300$	$\log_{10} e$	$= 0.4342945$	$\sqrt{10}$	$= 3.1622777$

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*Compiled by Stanley J. Brodsky, based mainly on the adjustment of the fundamental physical constants by B. N. Taylor, W. H. Parker, and D. N. Langenberg, Rev. Mod. Phys. 41, 375 (1969). The figures in parentheses correspond to the 1 standard deviation uncertainty in the last digits of the main number.

CLEBSCH-GORDAN COEFFICIENTS AND SPHERICAL HARMONICS

Note: A $\sqrt{\ }$ is to be understood over every coefficient; e.g., for -8/15 read $-\sqrt{8/15}$.

Notation:

	J	J	...
	M	M	...
m_1 m_2			
m_1 m_2	Coefficients		
. .			
. .			

$$Y_1^0 = \sqrt{\frac{3}{4\pi}}\cos\theta$$

$$Y_1^1 = -\sqrt{\frac{3}{8\pi}}\sin\theta\, e^{i\phi}$$

$$Y_2^0 = \sqrt{\frac{5}{4\pi}}\left(\frac{3}{2}\cos^2\theta - \frac{1}{2}\right)$$

$$Y_2^1 = -\sqrt{\frac{15}{8\pi}}\sin\theta\cos\theta\, e^{i\phi}$$

$$Y_2^2 = \frac{1}{4}\sqrt{\frac{15}{2\pi}}\sin^2\theta\, e^{2i\phi}$$

$$Y_\ell^{-m} = (-1)^m Y_\ell^{m*}$$

$$\langle j_1 j_2 m_1 m_2 | j_1 j_2 J M\rangle = (-1)^{J-j_1-j_2}\langle j_2 j_1 m_2 m_1 | j_2 j_1 J M\rangle$$

1/2 × 1/2

m_1	m_2	J	J
		1	
		+1	
+1/2	+1/2	1	
		1	0
		0	0
+1/2	-1/2	1/2	1/2
-1/2	+1/2	1/2	-1/2
		1	
		-1	
-1/2	-1/2	1	

1 × 1/2

m_1	m_2	J	J
		3/2	
		+3/2	
+1	+1/2	1	
		3/2	1/2
		+1/2	+1/2
+1	-1/2	1/3	2/3
0	+1/2	2/3	-1/3
		3/2	1/2
		-1/2	-1/2
0	-1/2	2/3	1/3
-1	+1/2	1/3	-2/3
		3/2	
		-3/2	
-1	-1/2	1	

2 × 1

m_1	m_2	J	J	J
		3		
		+3		
+2	+1	1		
		3	2	
		+2	+2	
+2	0	1/3	2/3	
+1	+1	2/3	-1/3	
		3	2	1
		+1	+1	+1
+2	-1	1/15	1/3	3/5
+1	0	8/15	1/6	-3/10
0	+1	6/15	-1/2	1/10
		3	2	1
		0	0	0
+1	-1	1/5	1/2	3/10
0	0	3/5	0	-2/5
-1	+1	1/5	-1/2	3/10
		3	2	1
		-1	-1	-1
0	-1	6/15	1/2	1/10
-1	0	8/15	-1/6	-3/10
-2	+1	1/15	-1/3	3/5
		3	2	
		-2	-2	
-1	-1	2/3	1/3	
-2	0	1/3	-2/3	
		3		
		-3		
-2	-1	1		

1 × 1

m_1	m_2	J	J	J
		2		
		+2		
+1	+1	1		
		2	1	
		+1	+1	
+1	0	1/2	1/2	
0	+1	1/2	-1/2	
		2	1	0
		0	0	0
+1	-1	1/6	1/2	1/3
0	0	2/3	0	-1/3
-1	+1	1/6	-1/2	1/3
		2	1	
		-1	-1	
0	-1	1/2	1/2	
-1	0	1/2	-1/2	
		2		
		-2		
-1	-1	1		

2 × 1/2

m_1	m_2	J	J
		5/2	
		+5/2	
+2	1/2	1	
		5/2	3/2
		+3/2	+3/2
+2	-1/2	1/5	4/5
+1	+1/2	4/5	-1/5
		5/2	3/2
		+1/2	+1/2
+1	-1/2	2/5	3/5
0	+1/2	3/5	-2/5
		5/2	3/2
		-1/2	-1/2
0	-1/2	3/5	2/5
-1	+1/2	2/5	-3/5
		5/2	3/2
		-3/2	-3/2
-1	-1/2	4/5	1/5
-2	+1/2	1/5	-4/5
		5/2	
		-5/2	
-2	-1/2	1	

3/2 × 1/2

m_1	m_2	J	J
		2	
		+2	
+3/2	+1/2	1	
		2	1
		+1	+1
+3/2	-1/2	1/4	3/4
+1/2	+1/2	3/4	-1/4
		2	1
		0	0
+1/2	-1/2	1/2	1/2
-1/2	+1/2	1/2	-1/2
		2	1
		-1	-1
-1/2	-1/2	3/4	1/4
-3/2	+1/2	1/4	-3/4
		2	
		-2	
-3/2	-1/2	1	

3/2 × 1

m_1	m_2	J	J	J
		5/2		
		+5/2		
+3/2	+1	1		
		5/2	3/2	
		+3/2	+3/2	
+3/2	0	2/5	3/5	
+1/2	+1	3/5	-2/5	
		5/2	3/2	1/2
		+1/2	+1/2	+1/2
+3/2	-1	1/10	2/5	1/2
+1/2	0	3/5	1/15	-1/3
-1/2	+1	3/10	-8/15	1/6
		5/2	3/2	1/2
		-1/2	-1/2	-1/2
+1/2	-1	3/10	8/15	1/6
-1/2	0	3/5	-1/15	-1/3
-3/2	+1	1/10	-2/5	1/2
		5/2	3/2	
		-3/2	-3/2	
-1/2	-1	3/5	2/5	
-3/2	0	2/5	-3/5	
		5/2		
		-5/2		
-3/2	-1	1		

SU(3) CONVENTIONS

for Isoscalar Factor Table on next page

Since January 1970 we have used the convention that the first particle shall be a baryon, the second a meson (R. Levi Setti, Proceedings of Lund Conference, 1969, p. 339 and Table II). Note, for comparison, that the de Swart table of 8×8 is merely labeled with symbols like (I_1 = 1/2, Y_1 = 1, I_2 = 1, Y_2 = 0), which can be read either as (Nπ) or (KΣ). Since there are no decuplet mesons, however, his 8×10 table is unambiguous; it must be read with the meson first.

The de Swart convention violates the other convention that the N,Nπ coupling shall be D + F (as opposed to -D + F). To get D + F one must use the first line of the "N" table, which reads. . . $3\sqrt{5}/10|8_D\rangle + 1/2|8_F\rangle$ as opposed to. . . $-3\sqrt{5}/10|8_D\rangle + 1/2|8_F\rangle$. The first line must then be labeled Nπ rather than KΣ, i.e., with the baryon first.

Levi Setti further advocates the convention of writing the baryon first for SU(2) as well as SU(3). For example, the sign of the amplitudes as plotted on his and our Argand plots comes from using our SU(2) Clebsch-Gordan coefficients (Condon Shortley notation) and writing the baryon first. To make it easier to abide by this universal convention we have changed de Swart's 8×10 (SU(3) table to 10×8, with the help of his Eq. (14.3):

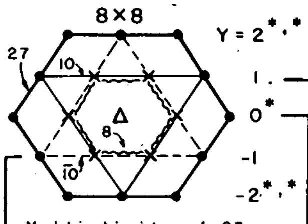
$$\langle\mu_1\mu_2|\mu\rangle = \xi_1(-1)^{I_1+I_2-I}\langle\mu_2\mu_1|\mu\rangle .$$

0 0 0 0 3 6 0 4 7 8 3

SU(3) ISOSCALAR FACTORS

Adapted from J. J. de Swart, Rev. Mod. Phys. 35, 916 (1963)
(See note on previous page concerning conventions)

{8} ⊗ {8} = {27} ⊕ {10} ⊕ {10*} ⊕ {8}₁ ⊕ {8}₂ ⊕ {1}.



Multiplicity of 27;
● = 1, × = 2, Δ = 3

* Five single-coefficient tables are omitted. The one involving a {10*} has a negative coefficient, i.e. (NK|10*) = -1. The others, involving {27} and {10}, are all +1.

$Y = 1 \quad I = 1/2$ N

$\xi_1 \to$	27 (+)	8_D (+)	8_F (−)	10* (−)
Nπ	$\sqrt{5}/10$	$3\sqrt{5}/10$	1/2	−1/2
ΣK	$-\sqrt{5}/10$	$-3\sqrt{5}/10$	1/2	−1/2
Nη	$3\sqrt{5}/10$	$-\sqrt{5}/10$	1/2	1/2
ΛK	$3\sqrt{5}/10$	$-\sqrt{5}/10$	−1/2	−1/2

$Y = 1 \quad I = 3/2$ Δ

$\xi_1 \to$	27 (+)	10 (−)
Nπ	$\sqrt{2}/2$	$-\sqrt{2}/2$
ΣK	$\sqrt{2}/2$	$\sqrt{2}/2$

$Y = 0 \quad I = 0$ Λ

$\xi_1 \to$	27 (+)	8_D (+)	1 (+)	8_F (−)
N$\bar{K}$	$\sqrt{15}/10$	$\sqrt{10}/10$	1/2	$\sqrt{2}/2$
ΞK	$-\sqrt{15}/10$	$-\sqrt{10}/10$	−1/2	$\sqrt{2}/2$
Σπ	$-\sqrt{10}/20$	$-\sqrt{15}/5$	$\sqrt{6}/4$	0
Λη	$3\sqrt{30}/20$	$-\sqrt{5}/5$	$-\sqrt{2}/4$	0

$Y = 0 \quad I = 1$ Σ

$\xi_1 \to$	27 (+)	8_D (+)	8_F (−)	10 (−)	10* (−)
N$\bar{K}$	$\sqrt{5}/5$	$-\sqrt{30}/10$	$\sqrt{6}/6$	$-\sqrt{6}/6$	$\sqrt{6}/6$
ΞK	$\sqrt{5}/5$	$-\sqrt{30}/10$	$-\sqrt{6}/6$	$\sqrt{6}/6$	$-\sqrt{6}/6$
Σπ	0	0	$\sqrt{6}/3$	$\sqrt{6}/6$	$-\sqrt{6}/6$
Ση	$\sqrt{30}/10$	$\sqrt{5}/5$	0	1/2	1/2
Λπ	$\sqrt{30}/10$	$\sqrt{5}/5$	0	−1/2	−1/2

$Y = -1 \quad I = 1/2$ Ξ

$\xi_1 \to$	27 (+)	8_D (+)	8_F (−)	10 (−)
Ξπ	$-\sqrt{5}/10$	$-3\sqrt{5}/10$	1/2	1/2
Σ$\bar{K}$	$\sqrt{5}/10$	$3\sqrt{5}/10$	1/2	1/2
Ξη	$3\sqrt{5}/10$	$-\sqrt{5}/10$	−1/2	1/2
Λ$\bar{K}$	$3\sqrt{5}/10$	$-\sqrt{5}/10$	1/2	−1/2

$Y = -1 \quad I = 3/2$

$\xi_1 \to$	27 (+)	10* (−)
Ξπ	$\sqrt{2}/2$	$-\sqrt{2}/2$
Σ$\bar{K}$	$\sqrt{2}/2$	$\sqrt{2}/2$

The phase factor $\xi_1 = \pm 1$, from de Swart's Table I, enters in his symmetry formula (14.3):

$$\langle \mu_1 \mu_2 | \mu \rangle = \xi_1 (-1)^{I_1 + I_2 - I} \langle \mu_2 \mu_1 | \mu \rangle .$$

This factor is irrelevant if you are doing your own self-consistent calculations; it enters when you try to check someone else who chose $\mu_2 \otimes \mu_1$ instead of $\mu_1 \otimes \mu_2$.

{10} ⊗ {8} = {35} ⊕ {27} ⊕ {10} ⊕ {8}.

* Four single coefficient tables are omitted; only the {27} is -1; the three with {35} are +1.

$Y = 1 \quad I = 1/2$ N

$\xi_1 \to$	27 (−)	8 (+)
Δπ	$-\sqrt{5}/5$	$-2\sqrt{5}/5$
ΣK	$-2\sqrt{5}/5$	$\sqrt{5}/5$

$Y = 1 \quad I = 3/2$ Δ

$\xi_1 \to$	35 (+)	27 (−)	10 (−)
Δπ	1/4	$-\sqrt{5}/4$	$\sqrt{10}/4$
Δη	$\sqrt{5}/4$	3/4	$\sqrt{2}/4$
ΣK	$\sqrt{10}/4$	$-\sqrt{2}/4$	− 1/2

$Y = 0 \quad I = 0$ Λ

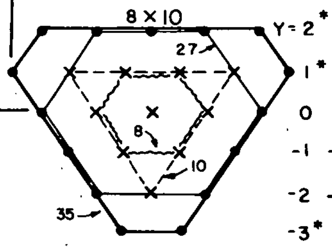
$\xi_1 \to$	27 (−)	8 (+)
Σπ	$-\sqrt{10}/5$	$-\sqrt{15}/5$
ΞK	$-\sqrt{15}/5$	$\sqrt{10}/5$

$Y = 0 \quad I = 1$ Σ

$\xi_1 \to$	35 (+)	27 (−)	10 (−)	8 (+)
Σπ	$\sqrt{3}/6$	$-3\sqrt{5}/10$	$\sqrt{3}/3$	$-\sqrt{30}/15$
Ση	$\sqrt{2}/2$	$\sqrt{30}/10$	0	$-\sqrt{5}/5$
ΞK	$\sqrt{3}/3$	$-\sqrt{5}/5$	$-\sqrt{3}/3$	$\sqrt{30}/15$
Δ$\bar{K}$	$\sqrt{3}/6$	$\sqrt{5}/10$	$\sqrt{3}/3$	$2\sqrt{30}/15$

$Y = 0 \quad I = 2$

$\xi_1 \to$	35 (+)	27 (−)
Σπ	$\sqrt{3}/2$	−1/2
Δ$\bar{K}$	1/2	$\sqrt{3}/2$



Multiplicity of 35;
● = 1, × = 2

$Y = -1 \quad I = 1/2$ Ξ

$\xi_1 \to$	35 (+)	27 (−)	10 (−)	8 (+)
Ξπ	1/4	$-7\sqrt{5}/20$	$\sqrt{2}/4$	$-\sqrt{5}/5$
Ξη	3/4	$3\sqrt{5}/20$	$-\sqrt{2}/4$	$-\sqrt{5}/5$
ΩK	$\sqrt{2}/4$	$-3\sqrt{10}/20$	− 1/2	$\sqrt{10}/5$
Σ$\bar{K}$	1/2	$\sqrt{5}/10$	$\sqrt{2}/2$	$\sqrt{5}/5$

$Y = -1 \quad I = 3/2$

$\xi_1 \to$	35 (+)	27 (−)
Ξπ	$\sqrt{2}/2$	$-\sqrt{2}/2$
Σ$\bar{K}$	$\sqrt{2}/2$	$\sqrt{2}/2$

$Y = -2 \quad I = 0$ Ω^-

$\xi_1 \to$	35 (+)	10 (−)
Ωη	$\sqrt{2}/2$	$-\sqrt{2}/2$
Ξ$\bar{K}$	$\sqrt{2}/2$	$\sqrt{2}/2$

$Y = -2 \quad I = 1$

$\xi_1 \to$	35 (+)	27 (−)
Ωπ	1/2	$-\sqrt{3}/2$
Ξ$\bar{K}$	$\sqrt{3}/2$	1/2

C.M. ENERGY AND MOMENTUM VS. BEAM MOMENTUM

$$E_{cm} dE_{cm} = m_p dT_{beam} = m_p v_{beam} dP_{beam} \approx m_p dP_{beam}$$

PBEAM (MEV/C)	C.M. ENERGY (MEV) γp ep	πp	Kp	pp	MOMENTUM IN C.M. (MEV/C) γp ep	πp	Kp	pp
0	939	1078	1432	1877	0	0	0	0
20	958	1079	1432	1877	20	17	13	10
40	977	1083	1433	1877	38	35	26	20
60	996	1089	1434	1877	56	52	39	30
80	1015	1096	1436	1878	74	68	52	40
	T(PI) = PBEAM - 59 MEV							
100	1033	1105	1439	1879	91	85	65	50
120	1051	1116	1441	1880	107	101	78	60
140	1069	1127	1445	1882	123	117	91	70
160	1087	1139	1449	1883	138	132	104	80
180	1104	1152	1453	1885	153	147	116	90
	T(PI) = PBEAM - 92 MEV							
200	1121	1165	1457	1887	167	161	129	99
220	1137	1178	1462	1889	182	175	141	109
240	1154	1192	1468	1892	195	189	153	119
260	1170	1206	1474	1894	209	202	166	129
280	1186	1219	1480	1897	222	215	178	138
	T(PI) = PBEAM - 107 MEV							
300	1201	1233	1486	1900	234	228	189	148
320	1217	1247	1493	1903	247	241	201	158
340	1232	1261	1500	1906	259	253	213	167
360	1247	1274	1507	1910	271	265	224	177
380	1262	1288	1514	1913	282	277	235	186
	T(PI) = PBEAM - 115 MEV							
400	1277	1302	1522	1917	294	288	247	196
420	1292	1315	1530	1921	305	300	258	205
440	1306	1329	1538	1925	316	311	268	214
460	1320	1342	1546	1929	327	322	279	224
480	1335	1356	1554	1933	337	332	290	233
	T(PI) = PBEAM - 120 MEV							
500	1349	1369	1563	1938	348	343	300	242
520	1362	1382	1572	1943	358	353	310	251
540	1376	1395	1580	1947	368	363	321	260
560	1390	1408	1589	1952	378	373	331	269
580	1403	1421	1598	1957	388	383	341	278
	T(PI) = PBEAM - 123 MEV							
600	1416	1434	1607	1962	397	393	350	287
620	1430	1446	1616	1967	407	402	360	296
640	1443	1459	1625	1973	416	412	370	304
660	1456	1472	1634	1978	425	421	379	313
680	1468	1484	1644	1984	434	430	388	322
	T(PI) = PBEAM - 125 MEV							
700	1481	1496	1653	1989	443	439	397	330
720	1494	1509	1662	1995	452	448	406	339
740	1506	1521	1671	2001	461	457	415	347
760	1519	1533	1681	2007	470	465	424	355
780	1531	1545	1690	2013	478	474	433	364
	T(PI) = PBEAM - 127 MEV							
800	1543	1557	1699	2019	486	482	442	372
820	1555	1569	1709	2025	495	490	450	380
840	1567	1580	1718	2031	503	499	459	388
860	1579	1592	1728	2037	511	507	467	396
880	1591	1604	1737	2043	519	515	475	404
	T(PI) = PBEAM - 129 MEV							
900	1603	1615	1747	2049	527	523	483	412
920	1615	1627	1756	2056	535	531	492	420
940	1626	1638	1765	2062	542	538	500	428
960	1638	1649	1775	2069	550	546	508	435
980	1649	1661	1784	2075	558	554	515	443
	T(PI) = PBEAM - 130 MEV							
1000	1660	1672	1794	2082	565	561	523	451
1020	1672	1683	1803	2088	573	569	531	458
1040	1683	1694	1812	2095	580	576	538	466
1060	1694	1705	1822	2102	587	583	546	473
1080	1705	1716	1831	2108	594	591	553	481
	T(PI) = PBEAM - 131 MEV							
1100	1716	1726	1840	2115	601	598	561	488
1120	1727	1737	1850	2122	609	605	568	495
1140	1738	1748	1859	2129	616	612	575	502
1160	1748	1758	1868	2135	622	619	583	510
1180	1759	1769	1877	2142	629	626	590	517
	T(PI) = PBEAM - 131 MEV							
1200	1770	1780	1887	2149	636	633	597	524
1220	1780	1790	1896	2156	643	639	604	531
1240	1791	1800	1905	2163	650	646	611	538
1260	1801	1811	1914	2170	656	653	618	545
1280	1812	1821	1923	2177	663	660	624	552
	T(PI) = PBEAM - 132 MEV							
1300	1822	1831	1932	2184	669	666	631	559
1320	1832	1841	1941	2191	676	673	638	565
1340	1843	1851	1950	2198	682	679	645	572
1360	1853	1862	1959	2205	689	685	651	579
1380	1863	1872	1968	2212	695	692	658	585
	T(PI) = PBEAM - 133 MEV							
1400	1873	1881	1977	2219	701	698	664	592
1420	1883	1891	1986	2226	708	704	671	599
1440	1893	1901	1995	2233	714	711	677	605
1460	1903	1911	2004	2240	720	717	684	612
1480	1912	1921	2013	2247	726	723	690	618
	T(PI) = PBEAM - 133 MEV							

PBEAM (MEV/C)	C.M. ENERGY (MEV) γp ep	πp	Kp	pp	MOMENTUM IN C.M. (MEV/C) γp ep	πp	Kp	pp
1500	1922	1930	2022	2254	732	729	696	624
1520	1932	1940	2031	2261	738	735	702	631
1540	1942	1950	2039	2268	744	741	709	637
1560	1951	1959	2048	2275	750	747	715	643
1580	1961	1969	2057	2282	756	753	721	650
	T(PI) = PBEAM - 133 MEV							
1600	1970	1978	2065	2289	762	759	727	656
1620	1980	1988	2074	2296	768	765	733	662
1640	1989	1997	2083	2304	773	770	739	668
1660	1999	2006	2091	2311	779	776	745	674
1680	2008	2016	2100	2318	785	782	751	680
	T(PI) = PBEAM - 134 MEV							
1700	2018	2025	2109	2325	791	788	756	686
1720	2027	2034	2117	2332	796	793	762	692
1740	2036	2043	2126	2339	802	799	768	698
1760	2045	2053	2134	2346	807	805	774	704
1780	2054	2062	2143	2353	813	810	779	710
	T(PI) = PBEAM - 134 MEV							
1800	2064	2071	2151	2360	818	816	785	716
1820	2073	2080	2159	2367	824	821	791	721
1840	2082	2089	2168	2374	829	827	796	727
1860	2091	2098	2176	2381	835	832	802	733
1880	2100	2107	2184	2388	840	837	808	739
	T(PI) = PBEAM - 134 MEV							
1900	2108	2115	2193	2395	845	843	813	744
1920	2117	2124	2201	2402	851	848	818	750
1940	2126	2133	2209	2409	856	853	824	756
1960	2135	2142	2217	2416	861	859	829	761
1980	2144	2150	2226	2423	867	864	835	767
	T(PI) = PBEAM - 135 MEV							
2000	2153	2159	2234	2430	872	869	840	772
2020	2161	2168	2242	2437	877	874	845	778
2040	2170	2176	2250	2444	882	879	851	783
2060	2179	2185	2258	2451	887	885	856	789
2080	2187	2194	2266	2458	892	890	861	794
	T(PI) = PBEAM - 135 MEV							
2100	2196	2202	2274	2465	897	895	866	799
2120	2204	2211	2282	2472	902	900	872	805
2140	2213	2219	2290	2479	907	905	877	810
2160	2221	2227	2298	2486	912	910	882	815
2180	2230	2236	2306	2493	917	915	887	821
	T(PI) = PBEAM - 135 MEV							
2200	2238	2244	2314	2500	922	920	892	826
2220	2246	2253	2322	2507	927	925	897	831
2240	2255	2261	2330	2514	932	930	902	836
2260	2263	2269	2338	2520	937	934	907	841
2280	2271	2277	2346	2527	942	939	912	846
	T(PI) = PBEAM - 135 MEV							
2300	2280	2286	2353	2534	947	944	917	852
2320	2288	2294	2361	2541	951	949	922	857
2340	2296	2302	2369	2548	956	954	927	862
2360	2304	2310	2377	2555	961	959	932	867
2380	2312	2318	2384	2561	966	963	937	872
	T(PI) = PBEAM - 135 MEV							
2400	2320	2326	2392	2568	970	968	941	877
2420	2328	2334	2400	2575	975	973	946	882
2440	2336	2342	2407	2582	980	977	951	887
2460	2344	2350	2415	2589	984	982	956	892
2480	2352	2358	2423	2595	989	987	960	897
	T(PI) = PBEAM - 136 MEV							
2500	2360	2366	2430	2602	994	991	965	901
2520	2368	2374	2438	2609	998	996	970	906
2540	2376	2382	2445	2616	1003	1001	975	911
2560	2384	2390	2453	2622	1007	1005	979	916
2580	2392	2398	2460	2629	1012	1010	984	921
	T(PI) = PBEAM - 136 MEV							
2600	2400	2405	2468	2636	1017	1014	988	926
2620	2408	2413	2475	2643	1021	1019	993	930
2640	2415	2421	2483	2649	1025	1023	998	935
2660	2423	2429	2490	2656	1030	1028	1002	940
2680	2431	2436	2498	2663	1034	1032	1007	944
	T(PI) = PBEAM - 136 MEV							
2700	2439	2444	2505	2669	1039	1037	1011	949
2720	2446	2452	2512	2676	1043	1041	1016	954
2740	2454	2459	2520	2682	1048	1045	1020	958
2760	2462	2467	2527	2689	1052	1050	1025	963
2780	2469	2474	2534	2696	1056	1054	1029	968
	T(PI) = PBEAM - 136 MEV							
2800	2477	2482	2542	2702	1061	1058	1034	972
2820	2484	2490	2549	2709	1065	1063	1038	977
2840	2492	2497	2556	2715	1069	1067	1042	981
2860	2499	2505	2563	2722	1074	1071	1047	986
2880	2507	2512	2570	2728	1078	1076	1051	990
	T(PI) = PBEAM - 136 MEV							
2900	2514	2520	2578	2735	1082	1080	1056	995
2920	2522	2527	2585	2742	1086	1084	1060	999
2940	2529	2534	2592	2748	1091	1088	1064	1004
2960	2537	2542	2599	2755	1095	1093	1069	1008
2980	2544	2549	2606	2761	1099	1097	1073	1013
	T(PI) = PBEAM - 136 MEV							

PBEAM (GEV/C)	C.M. ENERGY (GEV) γp ep πp	Kp	pp	MOMENTUM IN C.M. (GEV/C) γp ep πp	Kp	pp
3.0	2.56	2.61	2.77	1.10	1.08	1.02
3.2	2.63	2.68	2.83	1.14	1.12	1.06
3.4	2.70	2.75	2.89	1.18	1.16	1.10
3.6	2.77	2.82	2.96	1.22	1.20	1.14
3.8	2.83	2.88	3.02	1.26	1.24	1.18
	T(PI) = PBEAM - .137 GEV					
4.0	2.90	2.95	3.08	1.29	1.27	1.22
4.2	2.96	3.01	3.14	1.33	1.31	1.26
4.4	3.03	3.07	3.19	1.36	1.34	1.29
4.6	3.09	3.13	3.25	1.40	1.38	1.33
4.8	3.15	3.19	3.31	1.43	1.41	1.36
	T(PI) = PBEAM - .138 GEV					
5.0	3.21	3.25	3.36	1.46	1.44	1.40
5.2	3.27	3.31	3.42	1.49	1.48	1.43
5.4	3.32	3.36	3.47	1.53	1.51	1.46
5.6	3.38	3.42	3.52	1.56	1.54	1.49
5.8	3.43	3.47	3.58	1.59	1.57	1.52
	T(PI) = PBEAM - .138 GEV					
6.0	3.49	3.52	3.63	1.61	1.60	1.55
6.2	3.54	3.58	3.68	1.64	1.63	1.58
6.4	3.59	3.63	3.73	1.67	1.65	1.61
6.6	3.65	3.68	3.78	1.70	1.68	1.64
6.8	3.70	3.73	3.83	1.73	1.71	1.67
	T(PI) = PBEAM - .138 GEV					
7.0	3.75	3.78	3.87	1.75	1.74	1.70
7.2	3.80	3.83	3.92	1.78	1.76	1.72
7.4	3.85	3.88	3.97	1.81	1.79	1.75
7.6	3.89	3.93	4.02	1.83	1.82	1.78
7.8	3.94	3.97	4.06	1.86	1.84	1.80
	T(PI) = PBEAM - .138 GEV					
8.0	3.99	4.02	4.11	1.88	1.87	1.83
8.2	4.04	4.07	4.15	1.91	1.89	1.85
8.4	4.08	4.11	4.20	1.93	1.92	1.88
8.6	4.13	4.16	4.24	1.95	1.94	1.90
8.8	4.17	4.20	4.29	1.98	1.96	1.93
	T(PI) = PBEAM - .138 GEV					
9.0	4.22	4.25	4.33	2.00	1.99	1.95
9.2	4.26	4.29	4.37	2.03	2.01	1.97
9.4	4.31	4.33	4.41	2.05	2.03	2.00
9.6	4.35	4.38	4.46	2.07	2.06	2.02
9.8	4.39	4.42	4.50	2.09	2.08	2.04
	T(PI) = PBEAM - .139 GEV					
10.0	4.43	4.46	4.54	2.12	2.10	2.07
10.5	4.54	4.57	4.64	2.17	2.16	2.12
11.0	4.64	4.67	4.74	2.22	2.21	2.18
11.5	4.74	4.77	4.84	2.28	2.26	2.23
12.0	4.84	4.86	4.93	2.33	2.31	2.28
	T(PI) = PBEAM - .139 GEV					
12.5	4.94	4.96	5.03	2.38	2.36	2.33
13.0	5.03	5.05	5.12	2.43	2.41	2.38
13.5	5.12	5.15	5.21	2.47	2.46	2.43
14.0	5.21	5.24	5.30	2.52	2.51	2.48
14.5	5.30	5.32	5.39	2.57	2.56	2.53
	T(PI) = PBEAM - .139 GEV					
15.0	5.39	5.41	5.47	2.61	2.60	2.57
16.0	5.56	5.58	5.64	2.70	2.69	2.66
17.0	5.73	5.75	5.81	2.78	2.77	2.75
18.0	5.89	5.91	5.97	2.87	2.86	2.83
19.0	6.05	6.07	6.12	2.95	2.94	2.91
	T(PI) = PBEAM - .139 GEV					
20.0	6.20	6.22	6.27	3.03	3.02	2.99
22.0	6.49	6.51	6.56	3.18	3.17	3.14
24.0	6.78	6.79	6.84	3.32	3.31	3.29
26.0	7.05	7.07	7.11	3.46	3.45	3.43
28.0	7.31	7.33	7.37	3.59	3.59	3.56
	T(PI) = PBEAM - .139 GEV					
30.0	7.56	7.58	7.62	3.72	3.71	3.69
32.0	7.81	7.82	7.86	3.85	3.84	3.82
34.0	8.04	8.06	8.10	3.97	3.96	3.94
36.0	8.27	8.29	8.33	4.08	4.08	4.06
38.0	8.50	8.51	8.55	4.20	4.19	4.17
	T(PI) = PBEAM - .139 GEV					
40.0	8.72	8.73	8.77	4.31	4.30	4.28
42.0	8.93	8.94	8.98	4.41	4.41	4.39
44.0	9.14	9.15	9.18	4.52	4.51	4.50
46.0	9.34	9.35	9.39	4.62	4.62	4.60
48.0	9.54	9.55	9.58	4.72	4.72	4.70
	T(PI) = PBEAM - .139 GEV					
50.0	9.73	9.74	9.78	4.82	4.81	4.80
60.0	10.65	10.66	10.69	5.28	5.28	5.26
70.0	11.50	11.51	11.54	5.71	5.71	5.69
80.0	12.29	12.30	12.32	6.11	6.10	6.09
90.0	13.03	13.04	13.06	6.48	6.48	6.46
	T(PI) = PBEAM - .139 GEV					
100.0	13.73	13.74	13.76	6.83	6.83	6.82
200.0	19.40	19.40	19.42	9.67	9.67	9.66
500.0	30.65	30.65	30.66	15.31	15.31	15.30
1000.0	43.33	43.33	43.34	21.65	21.65	21.65
1500.0	53.06	53.06	53.07	26.52	26.52	26.52
	T(PI) = PBEAM - .140 GEV					

0 0 0 0 3 6 0 4 7 8 4

SPECIAL RELATIVITY, PHASE SPACE, AND CROSS SECTIONS

Notation. 4-vector in c.m. $p = (w, \vec{p})$; in lab $P = (W, \vec{P})$, $T = W - m$.
Solid-angle element $d\omega = 2\pi d\cos\theta$; $d\Omega = 2\pi d\cos\Theta$.
$p^2 = w^2 - \vec{p}^2 = m^2$ is an invariant. Cross section σ is invariant.

Lorentz Transformation

$$\begin{pmatrix} w \\ p_x \\ p_y \\ p_z \end{pmatrix} = \begin{pmatrix} \bar{\gamma} & -\bar{\eta} & 0 & 0 \\ -\bar{\eta} & \bar{\gamma} & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{pmatrix} \begin{pmatrix} W \\ P_x \\ P_y \\ P_z \end{pmatrix}$$

If θ and Θ are measured with respect to the transformation axis x,

$$\frac{p_\perp}{p_x} = \tan\theta = \frac{|\vec{P}|\sin\Theta}{-\bar{\eta}W + \bar{\gamma}|\vec{P}|\cos\Theta}. \quad (1)$$

If particle 1 is beam, 2 is target, then $(W_2, \vec{P}_2) = (m_2, \vec{0})$ and

$$\bar{\gamma} = (W_1 + m_2)/\sqrt{s},\ \bar{\eta} \equiv \bar{\gamma}\bar{\beta} = |\vec{P}_1|/\sqrt{s},\ |\vec{p}_1| = |\vec{p}_2| = \bar{\eta}m_2 = |\vec{P}_1|m_2/\sqrt{s}. \quad (2)$$

For $m_1 = m_2$, $\bar{\gamma}^2 = 1 + T_1/2m_1$.

General Lorentz Transformation [characterized by $\vec{\beta}$, with $\bar{\gamma} = (1 - \vec{\beta}^2)^{-1/2}$ and $\vec{\eta} = \bar{\gamma}\vec{\beta}$]: $w = \bar{\gamma}W - \vec{\eta}\cdot\vec{P}$; $\vec{p} = \vec{P} - \vec{\eta}\,\frac{W + w}{\bar{\gamma} + 1}$.

A Useful Transformation: Consider two 4-vectors $Q = (E, \vec{Q})$ and $q = (e, \vec{q})$. In the rest frame of Q $[Q' = (M, \vec{0})]$, q becomes $(q \to q')$

$$e' = Q\cdot q/M \quad \text{and} \quad \vec{q}' = \vec{q} - f\vec{Q},$$

where $Q^2 = M^2$ and $f = (e + e')/(E + M)$. These equations follow from example (b), p. 34 of Hagedorn.* They are particularly useful when Q is a sum of four-vectors that correspond to a resonant state.

Invariants. Notation: $1 + 2 \to 1' + 2'$.

$$s = (p_1 + p_2)^2 = m_1^2 + m_2^2 + 2(w_1w_2 - \vec{p}_1\cdot\vec{p}_2), \quad (3)$$

$$t = (p_i' - p_i)^2 = m_i^2 + m_i'^2 - 2(w_iw_i' - \vec{p}_i\cdot\vec{p}_i'), \quad (i = 1, 2), \quad (4)$$

$$u = (p_1' - p_2)^2 = (p_2' - p_1)^2 \quad \text{[use (6), below].} \quad (5)$$

General relation: $s + t + u = m_1^2 + m_1'^2 + m_2^2 + m_2'^2$. (6)

In lab system $P_2 = (m_2, \vec{0})$, and writing $W = m + T$,

$$s = m_1^2 + m_2^2 + 2W_1m_2 = (m_1 + m_2)^2 + 2T_1m_2, \quad (3,\text{lab})$$

$$t = m_2^2 + m_2'^2 - 2W_2'm_2 = (m_2 - m_2')^2 - 2T_2'm_2. \quad (4,\text{lab})$$

In c.m. system $dt = +2|\vec{p}_i|\,|\vec{p}_i'|\,d\cos\theta$. (4,cm)

For elastic scattering ($m_1 = m_1'$, $m_2 = m_2'$), (4) and (5) in c.m. become

$$t = -2\vec{p}^2(1 - \cos\theta) = -4\vec{p}^2\sin^2\theta/2, \quad (4,\text{el})$$

$$u = (m_1^2 - m_2^2)^2/s - 2\vec{p}^2(1 + \cos\theta) = (m_1^2 - m_2^2)^2/s - 4\vec{p}^2\cos^2\theta/2. \quad (5,\text{el})$$

For elastic scattering, using (4,lab), (4,el), and (2),

$$T_2' = \frac{2\vec{P}_1^2 m_2}{s}\sin^2\left(\frac{\theta}{2}\right) \text{(useful for calculating } \delta\text{-ray energies).} \quad (7)$$

Two-Body States. Energies and momenta in c.m.

$$w_1 = \frac{s + m_1^2 - m_2^2}{2\sqrt{s}},\ \vec{p}_1^2 = \vec{p}_2^2 = \frac{1}{4s}\,[s - (m_1 + m_2)^2]\,[s - (m_1 - m_2)^2]. \quad (8)$$

3- and 4-Body States. Let $m_{ij}^2 = (p_i + p_j)^2$, etc.; then

$$\sum_{i<j} m_{ij}^2 = \Sigma m_i^2 + m_{123}^2 = \text{const. } (i, j = 1, 2, 3) \text{ [follows from (6)]} \quad (9)$$

$$\left.\begin{aligned} &= 2\Sigma m_i^2 + m_{1234}^2 = \text{const.} \\ \sum_{i<j<k} m_{ijk}^2 &= \Sigma m_i^2 + 2m_{1234}^2 = \text{const.} \end{aligned}\right\} (i, j, k = 1, 2, 3, 4.) \quad (10)$$

R_n, Invariant Volume in n-Body Momentum Space

A useful invariant is $\int d^4p\,\delta(p^2 - m^2) = \int\frac{d^3\vec{p}}{2w} = \int\frac{p^2 d|\vec{p}|\,d\omega}{2w} = \frac{1}{2}\int|\vec{p}|\,dw\,d\omega$.

$R_2 = \pi|\vec{p}_1|/\sqrt{s}$, $R_3 = \pi^2\int dw_1dw_2 = (\pi^2/4s)\int dm_{12}^2dm_{23}^2$.

Recurrence Relation for Factoring R_n (see e.g., Hagedorn, p. 93*):

Write $N \to 1, 2, \cdots, k,\ k + 1, \cdots, n$ (R_n),

as $N \to K, k + 1, \cdots, n$ (R_{n-k+1}); $K \to 1, 2, \cdots, k$ (R_k); then $R_n = \int d(m_K^2)R_kR_{n-k+1}$,

or as $N \to K, L$; $L \to k + 1, \cdots, n$ (R_ℓ); $K \to 1, 2, \cdots, k$ (R_k); then $R_n = \int d(m_K^2)d(m_L^2)R_kR_\ell\frac{\pi p_{(KL)}}{\sqrt{s}}$

Cross Sections and Decay Rates†

For a system of n particles with overall four-momentum p and final momenta $q_1, \cdots, q_n$ $[q_i = (e_i, \vec{q}_i)]$, define Lorentz Invariant Phase Space

$$d\,\text{LIPS}(s; q_1, \cdots, q_n) = (2\pi)^4\delta^4(p - \sum_i q_i)\,\frac{1}{(2\pi)^{3n}}\prod_{i=1}^{n}\frac{d^3\vec{q}_i}{2e_i}. \quad (11)$$

Note that $R_n = (2\pi)^{3n-4}\int d\,\text{LIPS}$.

For $1 + 2 \to n$ particles or $1 \to n$ particles, in general $|i\rangle \to |f\rangle$,

$$\sigma_{if} = \frac{1}{4F}\int|T_{if}|^2\,d\,\text{LIPS}(s; q_1, \cdots, q_n), \quad (12)$$

or

$$\Gamma_{if} = \frac{1}{2m_1}\int|T_{if}|^2\,d\,\text{LIPS}(m_1^2; q_1, \cdots, q_n), \quad (13)$$

where T_{if} is an invariant matrix element. F is Møller's invariant flux factor, $F^2 = (p_1\cdot p_2)^2 - p_1^2p_2^2$. In every system where $\vec{p}_1$ and $\vec{p}_2$ are collinear, $F = w_1w_2|\vec{v}_1 - \vec{v}_2|$ $(\vec{v} = \vec{p}/w)$. If 1 is beam, 2, target $(\vec{p}_2 = 0)$, then $F = |\vec{P}_1|m_2 = |\vec{p}_1|\sqrt{s}$.

For elastic scattering in c.m., $\frac{d\,\text{LIPS}}{d\Omega} = \frac{1}{(4\pi)^2}\,\frac{|\vec{p}_1|}{\sqrt{s}}$, and (12) yields

$$\frac{d\sigma}{d\Omega} = \frac{|T|^2}{(8\pi)^2s} \quad \text{or} \quad \frac{d\sigma}{dt} = \frac{|T|^2}{64\pi|\vec{p}_1|^2s}. \quad (14)$$

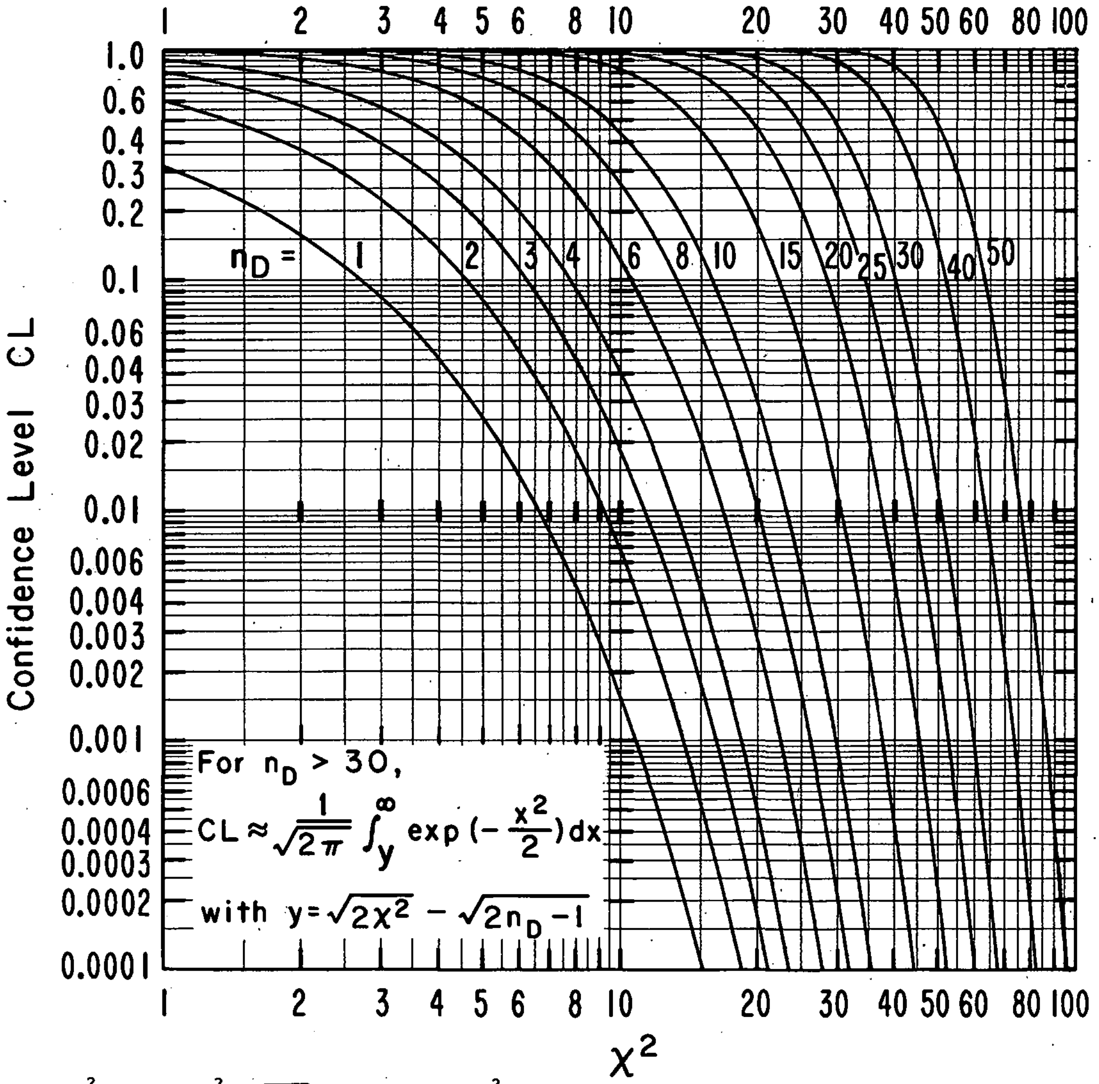
The normalization is such that the optical theorem reads

$$\text{Im}\,T|_{t=0} = 2|\vec{p}_1|\sqrt{s}\,\sigma_{\text{tot}}. \quad (15)$$

The choice of Eq. (11) implies a particular normalization of any spinors that may occur in T.† The advantage of this normalization is that it greatly simplifies the structure of T by putting factors such as $\frac{1}{(2\pi)^3}\,\frac{1}{2E}$ into the phase space where they really belong. In addition, the labels, i, f, refer to specific spin (helicity) states, so that the usual "average and sum" rule is implicit.

*R. Hagedorn, Relativistic Kinematics, W. A. Benjamin, New York, 1964.
†See, for example, Chaps. 1 and 2 of H. Pilkuhn, The Interactions of Hadrons, John Wiley & Sons, New York, 1967.

CONFIDENCE LEVEL VS. χ^2 FOR n_D DEGREES OF FREEDOM



For any n_D, $\langle\chi^2\rangle = n_D$, $\delta(\chi^2) = \sqrt{2n_D}$. For large n_D, χ^2 becomes normally distributed about n_D. Thus in the notation of the box in the figure,

$$y_1 = (\chi^2 - n_D)/\sqrt{2n_D} \text{ has unit s.d.}$$

A better approximation, due to Fisher,* is that χ, not χ^2, is normally distributed, specifically

$$y_2 = \sqrt{2\chi^2} - \sqrt{2n_D - 1} \text{ has unit s.d.}$$

One sees then that y_1 underestimates small C.L.'s. Thus for $n = 50$ and $\chi^2 = 80$, $y_1 = 3.0$ and C.L. = 0.13% vs. $y_2 = 2.7$, C.L. = 0.35%.

*R. A. Fisher, Statistical Methods for Research Workers, Oliver and Boyd, Edinburgh.

The Poisson distribution for x, when expected value is $\bar{x}$:

$$P(x, \bar{x}) = \bar{x}^x e^{-\bar{x}}/x!$$

Approximation for n! :

$$\sqrt{2\pi n}\,(n/e)^n < n! < \sqrt{2\pi n}\,(n/e)^n[1 + 1/(12n - 1)]$$

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The distribution

$$P_{2n+1}(x) = \frac{1}{2^n n!\,\sigma^{2n+2}}\, x^{2n+1} \exp\left[-\frac{x^2}{2\sigma^2}\right]$$

is normalized so that $\int_0^\infty P_{2n+1}(x)dx = 1$; the normalization is valid for $n > -1$ and not necessarily integral ($(\frac{1}{2})! = \sqrt{\pi}/2$). For $n = -1/2$ it reduces to the Gaussian distribution. Through a change of variables it yields the χ^2 distribution for n_D degrees of freedom:

$$P_{n_D}(\chi^2) = \frac{1}{2^{n_D/2}\left(\frac{n_D}{2} - 1\right)!}\,(\chi^2)^{n_D/2-1} \exp\left[-\chi^2/2\right].$$

Relation between standard deviation σ and mean deviation α:

$$2\sigma^2 = \pi\alpha^2;\ \sigma = 1.4826 \text{ probable error.}$$

Odds against exceeding one standard deviation = 2.15:1; two, 21:1; three, 370:1; four, 16,000:1; five, 1,700,000:1.

0 0 0 0 3 6 0 4 7 8 5

ATOMIC AND NUCLEAR PROPERTIES OF MATERIALS

Material	Z	A	Nominal[a] Cross Section σ barns	Nominal Collision Length $L_{Coll.}$[b] g cm^{-2}	Nominal Collision Length $L_{Coll.}$[b] cm	Absorption Length[m, n] λ, cm	dE/dx[c] min. MeV/(g/cm^2)	dE/dx[c] min. MeV/cm	Radiation Length L_{rad}[d] g cm^{-2}	Radiation Length cm	Density ρ g cm^{-3}
H_2	1	1.01	0.063	26.5	374[e]		4.13	0.292[e]	62.8	887[e]	0.0708[e]
D_2	1	2.01	0.100	33.4	202[e]		2.07	0.342[e]	126	764[e]	0.165[e]
He	2	4.00	0.16	42.0	336[e]		1.94	0.243[e]	93.1	745[e]	0.125[e]
Li	3	6.94	0.23	50.4	94.4		1.69	0.902	83.3	156	0.534
Be	4	9.01	0.28	55.0	29.8	39.5	1.60	2.96	66.0	35.7	1.848
C	6	12.01	0.33	60.4	f		1.78	f	43.3	f	≈1.55[f]
N_2	7	14.01	0.36	63.6	78.7[e]		1.81	1.46[e]	38.6	47.8[e]	0.808[e]
Ne	10	20.18	0.465	72.1	60.1[e]		1.73	2.08[e]	29.1[i]	24.3[e, i]	1.200[e, k]
Al	13	26.98	0.57	79.2	29.3	38.8	1.62	4.37	24.3	9.00	2.70
Fe	26	55.85	0.92	101.2	12.9	17.1	1.48	11.6	13.9	1.77	7.87
Cu	29	63.54	1.00	105.4	11.8	15.6	1.44	12.9	13.0	1.45	8.96
Sn	50	118.69	1.55	129.7	17.7		1.28	9.4	8.9	1.22	7.31
W	74	183.85	2.02	150.8	7.81		1.17	22.6	6.8	0.35	19.3
Pb	82	207.19	2.20	156.2	13.8	18.3	1.13	12.8	6.4	0.56	11.35
U	92	238.03	2.42	163.6	≈ 8.63		1.09	≈ 20.7	6.1	≈ 0.32	≈ 18.95
Air				64.6	53610[g]		1.81	0.0022[g]	37.2	30870[g]	0.001205[g]
Freon (CF_3Br)				87.1	≈ 58		1.52	≈ 2.3	16.7	≈ 11	≈ 1.5
H_2 (bubble chamber, 27° K)				26.5	442[h]		4.13	0.248[h]	62.8	1050[h]	≈ 0.060[h]
H-Ne mixture (bubble chamber)[j]				67.3	96.1		1.83	1.28	29.8[i]	42.6[i]	0.70
H_2O				57.2	57.2		2.03	2.03	36.4	36.4	1.00
Ilford Emulsion				103.0	27.0		1.44	5.49	11.2	2.94	3.815
LiF				63.8	24.2		1.69	4.46	39.8	15.1	2.64
Mylar ($C_5H_4O_2$)				59.1	42.8		1.91	2.64	40.4	29.3	1.38
NaI				119.0	32.4		1.32	4.84	9.5	2.59	3.67
Polyethylene (CH_2)				51.0	≈ 55		2.09	≈ 1.92	45.3	≈ 49	≈ 0.92
Polystyrene (CH)[ℓ] [≈Scintillator]				54.9	≈ 52	68.5	2.03	≈ 2.13	44.3	≈ 42	≈ 1.05
Propane (C_3H_8, bubble chamber)				48.9	119		2.28	0.94	45.9	112	0.41

WARNING: See notes a and b.

a. $\sigma = \sigma_{nominal} = \pi(\hbar/m_\pi c)^2 \times A^{2/3} = 62.8\ \text{mb} \times A^{2/3}$

b. $L_{coll} = A/(N\sigma_{natural}) = 26.5\ \text{g cm}^{-2} \times A^{1/3}$

NOTE: These quantities are calculated assuming a "nuclear radius" = $(\hbar/m_\pi c)\, A^{1/3} = (1.4f)\, A^{1/3}$. But attenuation of 25 GeV/c protons[m] and 20 GeV/c neutrons[n] is only 3/4 nominal.

c. From W. H. Barkas and M. J. Berger, Tables of Energy Losses and Ranges of Heavy Charged Particles, NASA SP-3013 (1964).
d. Mainly from O. I. Dovzhenko and A. A. Pomanskii, Soviet Physics JETP **18**, 187 (1964).
e. For liquid phase at 1 atm. and boiling temperature.
f. Density variable.
g. At 20° C.
h. May vary by about ±3% depending on operating conditions.
i. From F. R. Huson, Ionization Loss, Range, Straggling and Multiple Scattering, BNL 11386 (1967).
j. 53.7 atomic percent Ne.
k. Density of gas at STP = 0.900×10^{-3} g cm^{-3}, i.e., 0.75×10^{-3} times the density (1.200) of the boiling liquid.
ℓ. Typical scintillator; e.g., PILOT B has an atomic ratio H/C = 1.1.
m. G. Cocconi, Proc. 1960 Rochester Conf., p. 804, Fig. 6, find for attenuation, r (nuclear) = $1.23\ A^{1/3}$.
n. J. Engler et al., Nucl. Instr. and Meth. 106, 189 (1973) report λ(Fe) = (17.1±0.3) cm, λ(Scintillator) = (68.5±1.5) cm.

MULTIPLE COULOMB SCATTERING*

The rms projected angle θ due to multiple Coulomb scattering (only) of a particle of charge z (in units of electron charge), momentum p (in MeV/c), and velocity v (in units of c) is

$$\theta_{proj} = z\,\frac{15}{pv}\sqrt{\frac{L}{L_{rad}}}\,(1+\epsilon)\ \text{radians};$$

where L = length in scatterer.

For $L \geq 1/10\ L_{rad}$, ε is generally < 1/10. The distribution of θ is not truly Gaussian.†

The rms projected displacement y on traversing an absorber of thickness L is

$$y_{rms} = L\theta_{proj}/\sqrt{3}.$$

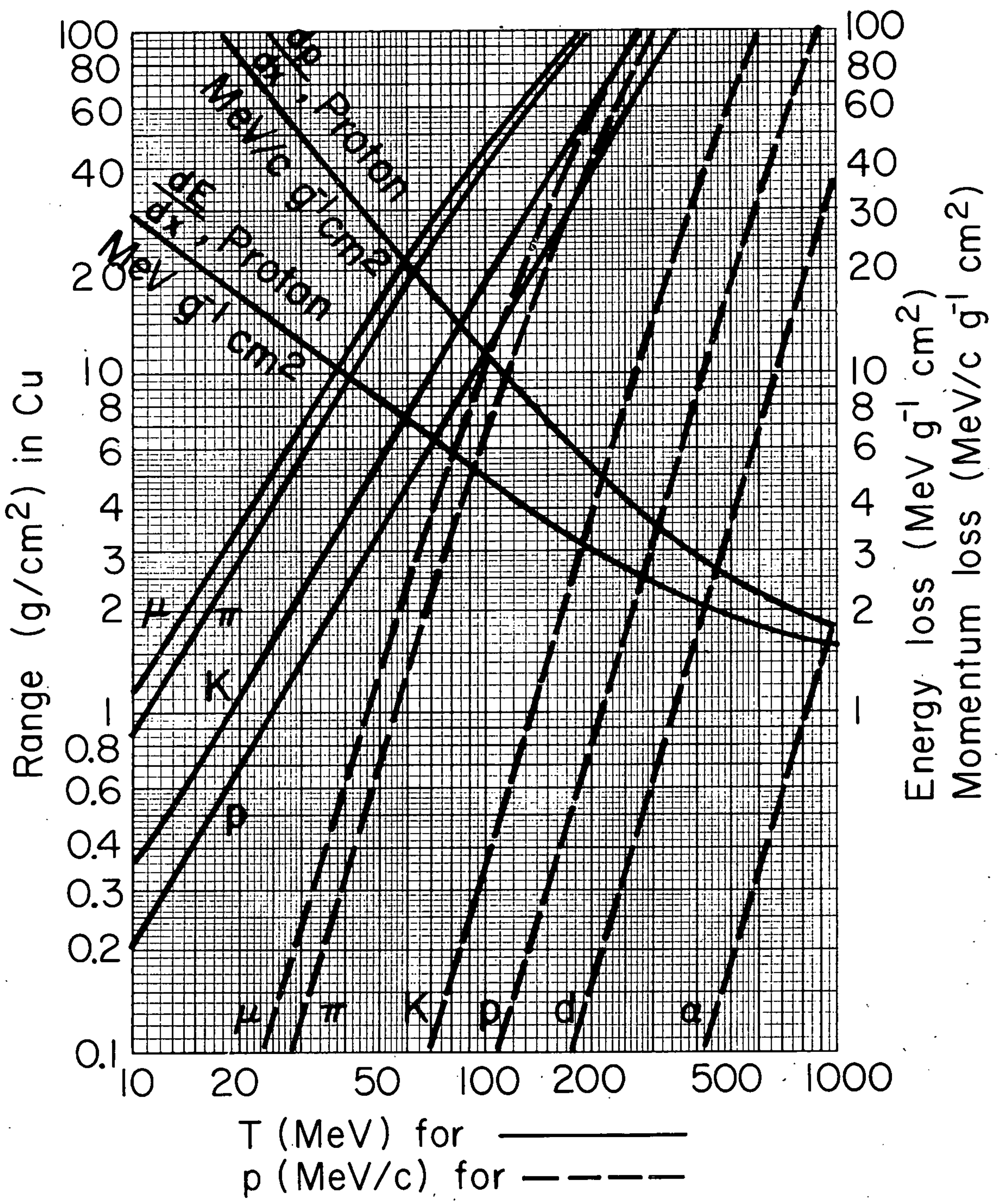
*Mainly from G. Z. Molière, Naturforsch. **3**(a), 78 (1948).

†See, for example, the experimental work of A. D. Hansen, L. H. Lanzl, E. M. Lyman, and M. B. Scott, Phys. Rev. **84**, 634 (1951).

RADIOACTIVITY AND RADIATION PROTECTION

Unit of activity = Curie:
  1 Ci = 3.7×10^{10} disintegrations/sec
Unit of exposure dose for x and γ radiation = Roentgen:
  1 R = 1 esu/cm^3 = 87.8 erg/g (5.49×10^7 MeV/g) of air
Unit of absorbed dose = rad:
  1 rad = 100 erg/g (6.25×10^7 MeV/g) in any material
Unit of dose equivalent (for protection) = rem:
  rems (Roentgen equivalents for man) = rads × QF,
where QF (quality factor) depends upon the type of radiation and other factors. For γ rays and HE protons, QF ≈ 1; for thermal neutrons, QF ≈ 3; for fast neutrons, QF ranges up to 10; and for α particles and heavy ions, QF ranges up to 20.
Maximum permissible occupational dose for the whole body:
  5 rem/year (or ≈ 100 millirem/week)
Fluxes (per cm^2) to liberate 1R in carbon:
  3×10^7 minimum ionizing singly charged particles
  0.9×10^9 protons of 1 MeV energy
(These fluxes are correct to within a factor of 2 for all materials.)
Natural background: 120 to 130 millirem/year
  cosmic radiation (charged particles + neutrons) ~25 mrem/yr
  cosmic radiation (γ rays) ~25 mrem/yr
  radiation from rocks and air (γ rays) ~73 mrem/yr
Cosmic ray background in counters: ~ 1/min/cm^2/ster

RANGE AND ENERGY LOSS IN COPPER

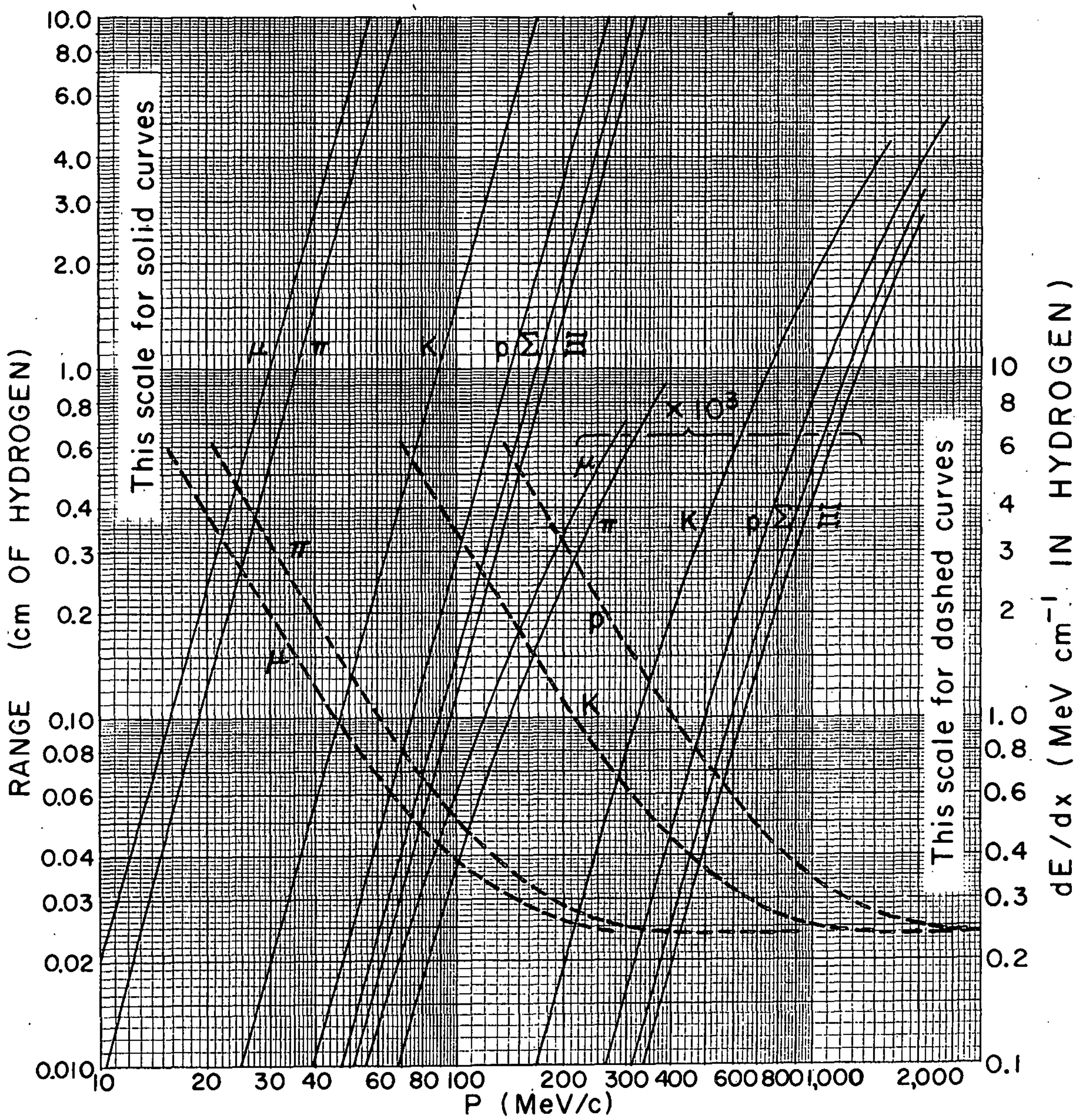


Range and energy/momentum loss in copper, based on a calculation assuming a nominal mean excitation potential of 310 eV. (Calculation by W. A. Aron, UCRL-1325, 1951). The abscissa is to be read as kinetic energy T for the solid curves and momentum p for the dashed curves.

See scaling law at bottom of next page.

0 0 0 0 3 6 0 4 7 8 6

RANGE AND ENERGY LOSS IN LIQUID HYDROGEN

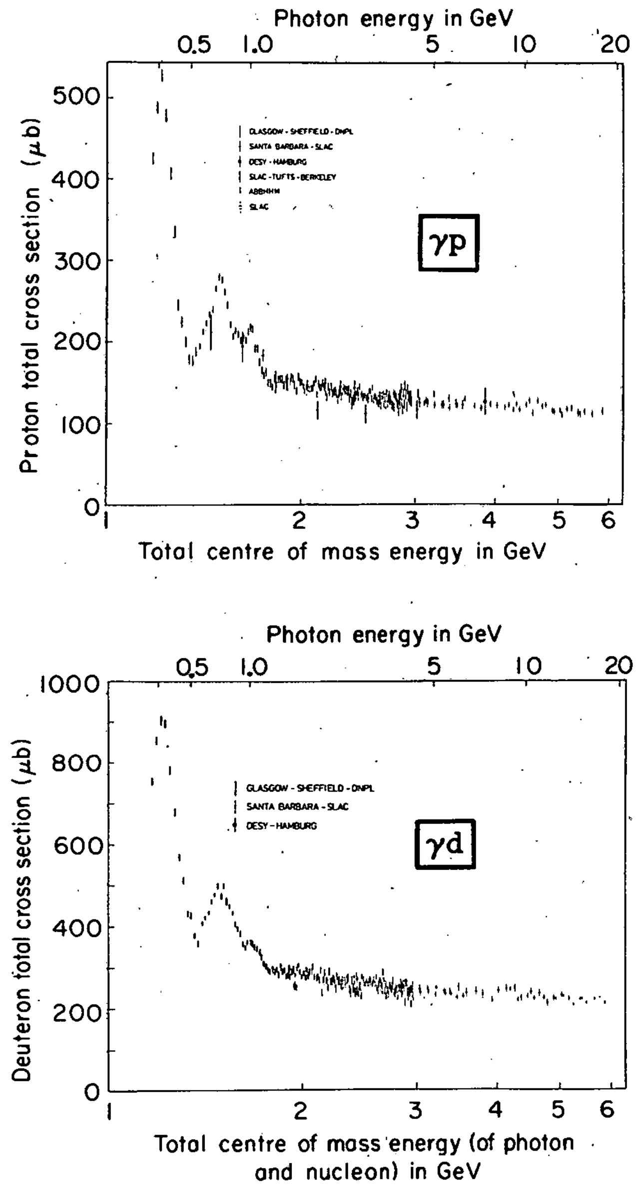


Range and energy loss in liquid hydrogen bubble chamber, determined by a μ^+ range of 1.103 ± 0.003 cm from the $\pi^+ \rightarrow \mu^+\nu$ decay. Liquid hydrogen conditions: $T = 27.6 \pm 0.1$°K; $P = 48 \pm 5$ psia; $\rho = (5.86 \pm 0.06) 10^{-2}$ g/cm^3. (Data by Clark and Diehl, UCRL-3789, 1957.) Bubble chamber physicists: note that the number of bubbles per cm is proportional to $1/\beta^2$, not to dE/dx.

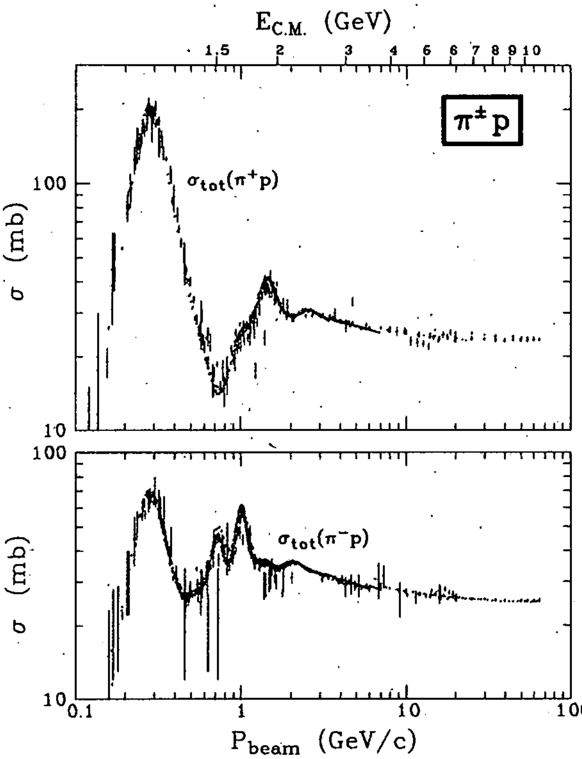
Scaling law for particles of other mass or charge: for a given medium, the range R_b of any beam particle with mass M_b, charge z_b, and momentum p_b is given in terms of the range R_a of any other particle with mass M_a, charge z_a, and momentum $p_a = p_b M_a / M_b$ (i.e., having the same velocity) by the expression

$$R_b(M_b, z_b, p_b) = \left[\frac{M_b/M_a}{z_b^2/z_a^2}\right] R_a(M_a, z_a, p_a = p_b M_a/M_b).$$

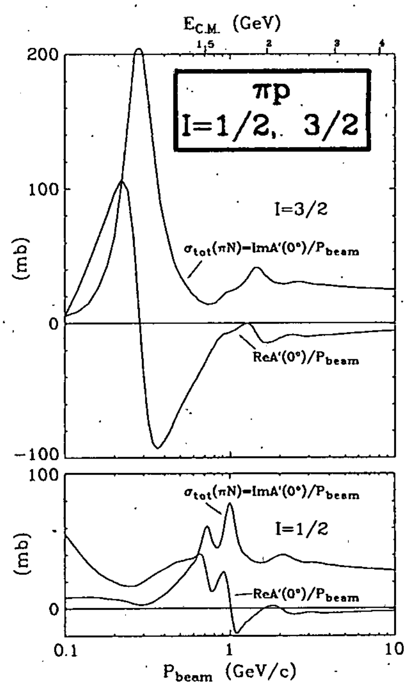
CROSS SECTION PLOTS



$\sigma_{tot}(\gamma p)$ and $\sigma_{tot}(\gamma d)$ as compiled by G. M. Lewis, Glasgow.

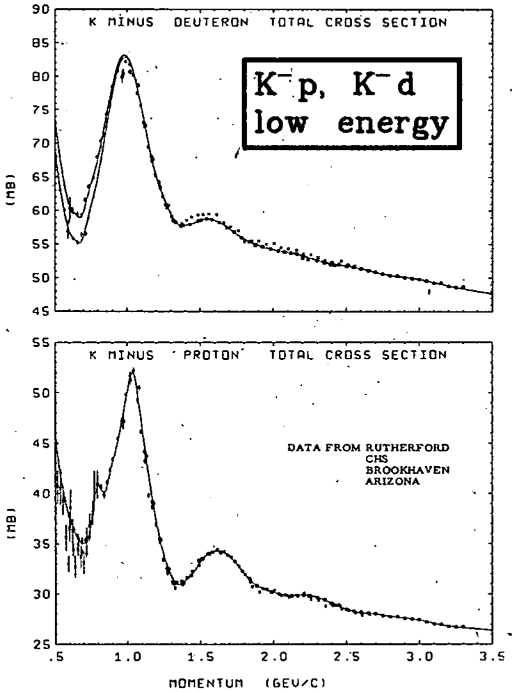


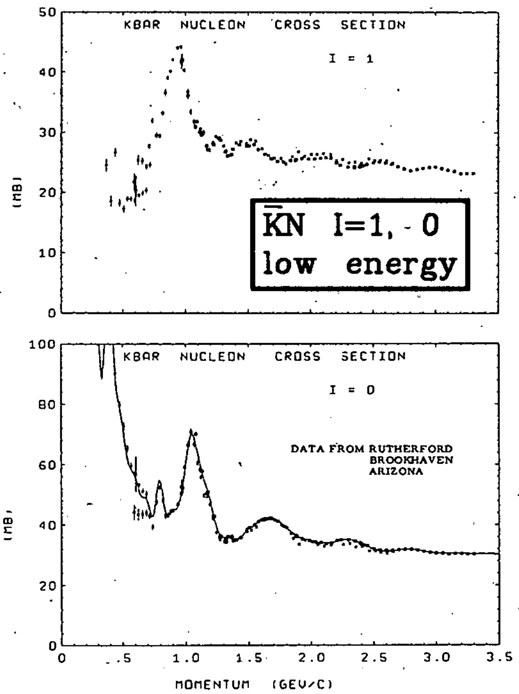
πN total cross section data from the compilation of C. Lovelace, et al. (see Sec. VI C of the text).



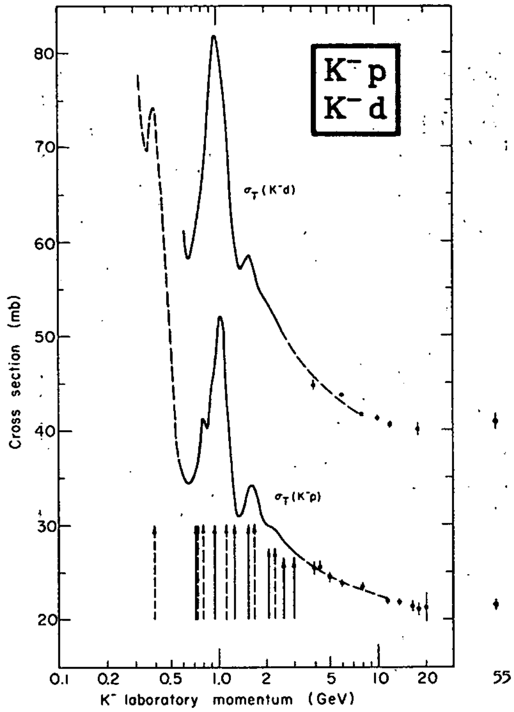
A smooth interpolation of the πN total cross sections for I=3/2 and I=1/2, and the corresponding real parts of the forward amplitudes as calculated from dispersion relations by G. Höhler and H. P. Jakob (private communication). The normalization of the curves for each value of I is such that the sum of their squares divided by 19.6 gives $d\sigma/dt$ at 0° in $mb/(GeV/c)^2$.

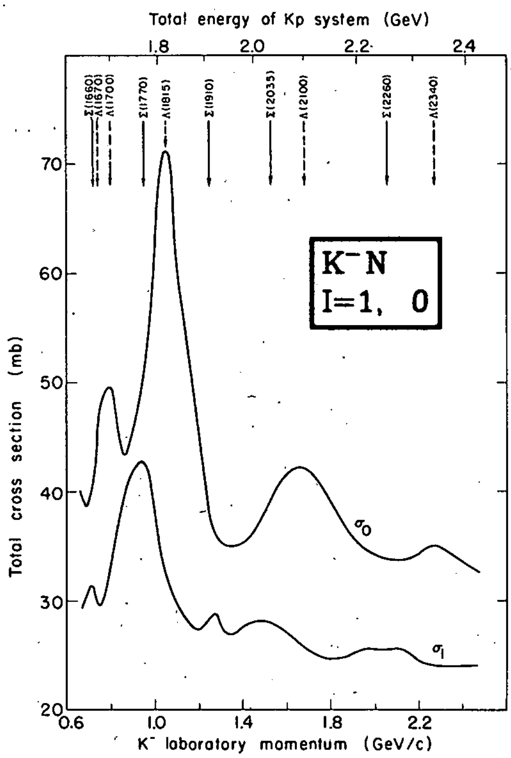
CROSS SECTION PLOTS





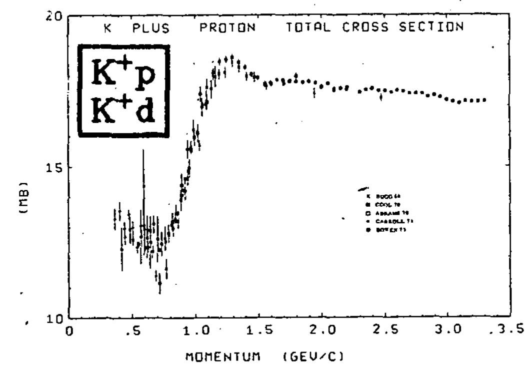
Compiled and unfolded by G. R. Lynch, Proc. 1970 Duke Baryon Conference.

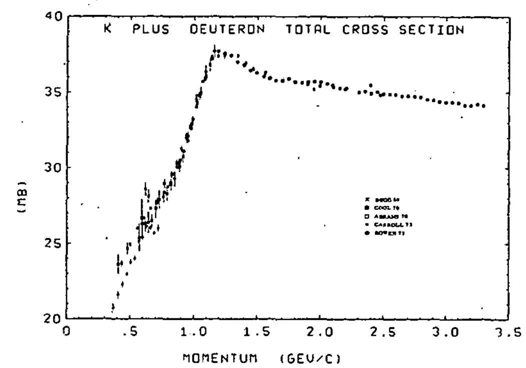




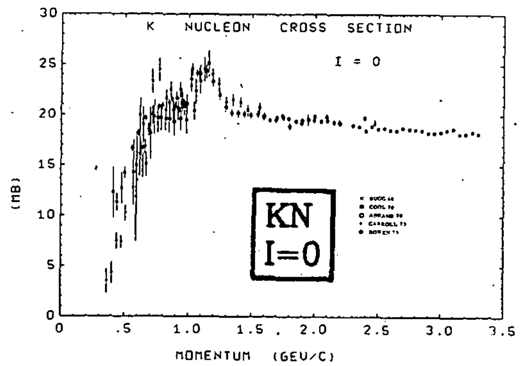
From A. Barbaro-Galtieri in Advances in Particle Physics, Vol. 2, edited by R. L. Cool and R. E. Marshak (Wiley & Sons, 1968). The points at 55 GeV/c are taken from IHEP-CERN Collab., Phys. Letters 30B, 500 (1969).

CROSS SECTION PLOTS

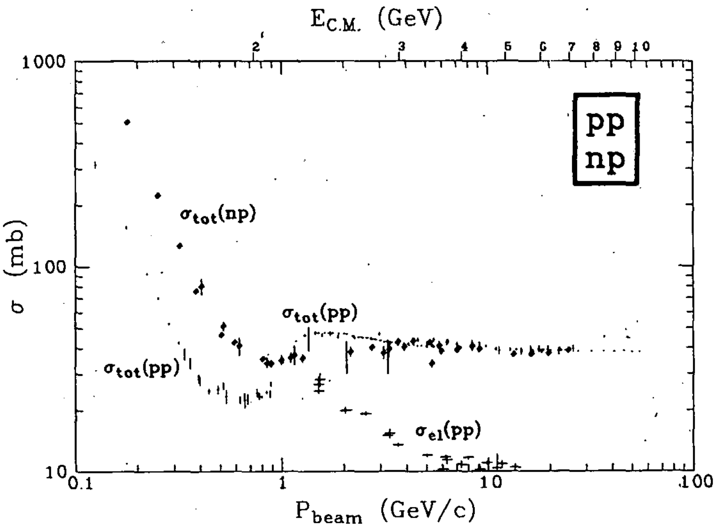




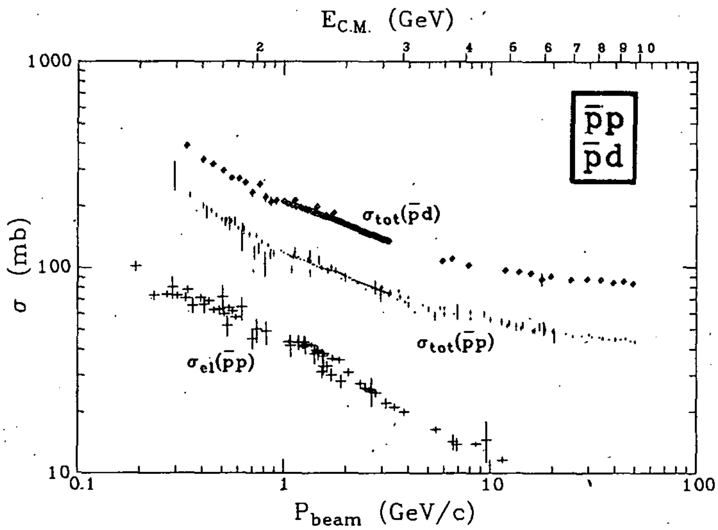
Compilation of recent K^+p and K^+d total cross-section measurements. References can be found in the Baryon Data Card Listings.



Total cross-section for isospin zero KN system. Unfolding of the BUGG 68 and BOWEN 70 and 73 data was done by G. R. Lynch (as in Proc. of 1970 Duke Conference). Tables of σ_0 were provided by the BNL authors. Lynch and BNL use the same method of unfolding; the BOWEN 73 unfolded distribution is obtained by a different method (see plot in Z^* mini-review in the Baryon Data Card Listings).



pp and np cross sections from Particle Data Group, "NN and ND Interactions -- A Compilation". UCRL-20 000 NN (August 1970); some points at higher energies added since original compilation.



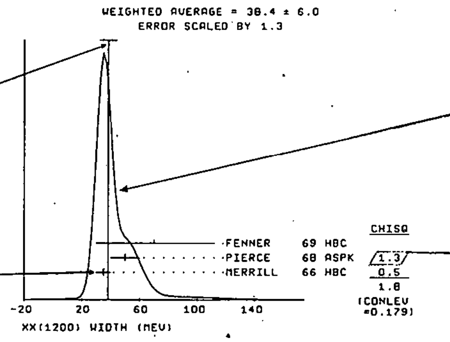
$\bar{p}p$ and $\bar{p}d$ cross sections from Particle Data Group, "A Compilation of $\overline{N}N$ and $\overline{N}D$ Reactions", LBL-58 (1972).

0 0 0 0 3 6 0 4 / 8 8

DATA CARD LISTINGS

Illustrative Key

```
XX(1200)   74 XX MESON (1200,JPG=  -)  I=1
              ORIGINALLY CALLED XXX
   ------>    OMITTED FROM TABLE
------ --------- --------- --------- --------- --------- --------- --------
              74  XX(1200) MASS (MEV)
M          1216.        11.        MERRILL    66 HBC     0 3.2 K-P       7/66
M   L  150 1192.       (16.)       LYNCH      67 HBC    +-  2.7 PI-P     6/67
M   L   LYNCH DATA HAS QUESTIONABLE BACKGROUND SUBTRACTION
M          1198.       10.    7.   PIERCE     68 ASPK  +   2.1 K-P      9/68
M         (1208.)                  FENNER     69 HBC    0 4.2 PI+P      9/69
M   S   80 1210.        8.         SMITH      70 MMS    -  3.5 PI-P     1/73*
M   S   SUPERSEDES EARLIER RESULT
M               . . . . . . . . .
M   AVG     1206.9       5.1       AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
------ --------- --------- --------- --------- --------- --------- --------
              74  XX(1200) WIDTH (MEV)
W          35.          5.         MERRILL    66 HBC    0 3.2 K-P       7/66
W          50.         10.         PIERCE     68 ASPK  +  2.1 K-P       9/68
W          70.         40.         FENNER     69 HBC    0 4.2 PI+P      9/69
W         (60.)     OR LESS        SMITH      70 MMS   -  3.5 PI-P      1/73*
W               . . . . . . . . .
W   AVG     38.4        6.0        AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.3)
                                   (SEE IDEOGRAM BELOW )
```

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------ --------- --------- --------- --------- --------- --------- --------
              74  XX(1200) PARTIAL DECAY MODES
                                                       DECAY MASSES
P1      XX(1200) INTO 3PI                              139+ 139+ 139
P2      XX(1200) INTO K KBAR                           493+ 493
------ --------- --------- --------- --------- --------- --------- --------
              74  XX(1200) BRANCHING RATIOS
R1      XX(1200) INTO 3PI/TOTAL                             (P1)
R1             .66        .02       MERRILL    66 HBC    0 3.2 K-P      7/66
R1   L        (.68)      (.03)      LYNCH      67 HBC   +-  2.7 PI-P    6/67
R1   L   LYNCH DATA HAS QUESTIONABLE BACKGROUND SUBTRACTION
R1              . . . . . . . . .
R1   FIT     0.675      0.012   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.3)
R2      XX(1200) INTO KKBAR/TOTAL                           (P2)
R2             .35        .05       PIERCE     68 ASPK  +   2.1 K-P     9/68
R2              . . . . . . . . .
R2   FIT     0.325      0.012   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.3)
R3      XX(1200) INTO KKBAR/3PI                          (P2)/(P1)
R3             .50        .03       FENNER     69 HBC    0 4.2 PI+P     9/69
R3             .41        .04       SMITH      70 MMS   -  3.5 PI-P     1/73*
R3              . . . . . . . . .
R3   AVG     0.468      0.043   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.8)
R3   FIT     0.480      0.026   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.3)
****** ********* ********* ********* ********* ********* ********* ********
                  REFERENCES FOR XX(1200)
MERRILL  66 PRL 16 143      A. MERRILL                    (SACLAY+CERN)
LYNCH    67 PR 155 610      B. LYNCH                             (BNL)
PIERCE   68 PL 27B 230      N. PIERCE                            (LRL)
FENNER   69 NC 61B 372      D. FENNER, B. BEANE            (NYSE+AMEX)
SMITH    70 PRL 24 14       J. SMITH                            (SLAC)
****** ********* ********* ********* ********* ********* ********* ********
****** ********* ********* ********* ********* ********* ********* ********
```

- Name of particle as it appears in table.
- Arrow indicates this particle omitted from table.
- Quantity tabulated below.
- Code for quantity tabulated (M=mass, W=width, etc.)
- Symbols used to key together data card and related comments.
- Number of events above background.
- Measured values (parentheses indicate value not used in average).
- ± Error in measured value (– field blank if error symmetric; parentheses on error only indicate data not used in average due to problems with error estimation).
- Average value (and error) of quantity measured.
- Vertical bar indicates average; width of horizontal bar on top is error (scaled) in average.
- Value and error for each experiment.
- Partial decay mode (labeled by P_i).
- Branching ratio (labeled by R_j).
- Value (and error) of quantity measured, as determined from constrained fit (using all measured branching ratios for this particle).
- References listed by year, then author.
- Abbreviated reference form used on data cards above.
- Journal, report, preprint, etc. (see abbreviations on next page).

- Particle name, and quantum numbers (if known).
- Particle code (for internal use only).
- General comments on particle.
- Abbreviated reference for this result; full reference given below.
- Measurement technique (see abbreviations on next page.)
- Charge(s) of particle detected.
- Reaction producing particle, or comments.
- Date this result punched (asterisk indicates result added or changed since previous edition).
- Scale factor > 1 indicates inconsistent data.
- Ideogram to display inconsistent data; curve is sum of Gaussians, one for each experiment (area of Gaussian = 1/error; width of Gaussian = ± error).
- Contribution of experiment to χ^2 (if no entry present, experiment not used in calculating χ^2 or scale factor because of large error).
- Branching ratio R_j in terms of partial decay mode fractions P_i above.
- Author(s)
- Institution(s) of author(s) (see abbreviations on next page).

Illustrative Key *(cont'd)*

Abbreviations

Journals

APAH	Acta Phys. Acad. Hungarica
ADVP	Advances in Physics
ANP	Annals of Physics
ARNS	Annual Reviews of Nuclear Science
BAPS	Bulletin of the American Physical Society
JETP	English Translation of Soviet Physics JETP
JETPL	Letters to Soviet Physics JETP
LNC	Letters to Nuovo Cimento
NC	Nuovo Cimento
NP	Nuclear Physics
PL	Physics Letters
PN	Particles and Nuclei
PPSL	Proceedings of the Physical Society of London
PR	Physical Review
PRL	Physical Review Letters
PRSL	Proceedings of the Royal Society of London
RMP	Reviews of Modern Physics
SJNP	Soviet Journal of Nuclear Physics
ZPHY	Zeitschrift für Physik

Measurement techniques

ASPK	Automatic spark chambers
CC	Cloud chamber
CNTR	Counters, electronics
DBC	Deuterium bubble chamber
DPWA	Energy-dependent partial wave analysis
EMUL	Emulsions
HBC	Hydrogen bubble chamber
HEBC	Helium bubble chamber
HLBC	Heavy liquid bubble chamber
IPWA	Energy-independent partial wave analysis
MMS	Missing mass spectrometer
MPWA	Model-dependent partial wave analysis
OSPK	Optical spark chambers
RVUE	Review of previous experimental data
STRC	Streamer chamber

Conferences

Conferences are referred to by the location in which they were held (e.g., DUBNA, BOULDER, LUND, etc.).

Institutions

AACH	TECHNISCHE UNIV. AACHEN	AACHEN, GERMANY
AERE	ATOMIC ENERGY RES. ESTAB.	HARWELL, BERKS., ENGLAND
AMST	UNIV. OF AMSTERDAM	AMSTERDAM, NETHERLANDS
ANKA	MIDDLE EAST TECHNICAL UNIV.	ANKARA, TURKEY
ANL	ARGONNE NAT. LAB.	ARGONNE, ILL., USA
ARIZ	UNIV. OF ARIZONA	TUCSON, ARIZ., USA
ATEN	NUCLEAR RES. CENTRE DEMOKRITOS	ATHENS, GREECE
BARI	UNIV. DEGLI STUDI DI BARI	BARI, ITALY
BELG	INST. INTERUNIV. DES SCI. NUC.	BRUXELLES, BELGIUM
BERG	FYSISK INSTITUTT	BERGEN, NORWAY
BERL	INST. HOCHENERGIEPHYS. DAW	ZEUTHEN/BERLIN, DDR
BERN	UNIV. BERN	BERN, SWITZERLAND
BGNA	UNIV. DI BOLOGNA	BOLOGNA, ITALY
BING	STATE UNIV. OF NEW YORK AT BINGHAMTON	BINGHAMTON, N. Y., USA
BIRM	BIRMINGHAM UNIV.	BIRMINGHAM, ENGLAND
BNL	BROOKHAVEN NATIONAL LAB.	UPTON, L.I., N. Y., USA
BOHR	NIELS BOHR INSTITUTE	COPENHAGEN, DENMARK
BONN	UNIV. BONN	BONN, GERMANY
BOST	BOSTON UNIV.	BOSTON, MASS., USA
BRAN	BRANDEIS UNIV.	WALTHAM, MASS., USA
BRIS	H. H. WILLS PHYS. LAB., U. OF BRISTOL	BRISTOL, ENGLAND
BROW	BROWN UNIV.	PROVIDENCE, R. I., USA
BRUX	UNIV. LIBRE DE BRUXELLES	BRUXELLES, BELGIUM
BUCH	BUCHAREST STATE UNIV.	BUCHAREST, ROMANIA
BUDA	CENTRAL RESEARCH INSTITUTE OF PHYSICS	BUDAPEST, HUNGARY
BUFF	STATE UNIV. OF NEW YORK AT BUFFALO	BUFFALO, N. Y., USA
CAEN	LAB. DE PHYS. CORPUSCULAIRE	CAEN, FRANCE
CARL	CARLTON UNIV.	OTTAWA, CANADA
CARN	CARNEGIE-MELLON UNIV.	PITTSBURGH, PA., USA
CASE	CASE WESTERN RESERVE UNIV.	CLEVELAND, OHIO, USA
CAVE	CAVENDISH LAB., CAMBRIDGE UNIV.	CAMBRIDGE, ENGLAND
CDEF	COLLEGE DE FRANCE	PARIS, FRANCE
CEA	CAMBRIDGE ELECTRON ACCEL.	CAMBRIDGE, MASS., USA
CERN	EUROPEAN ORG. FOR NUC. RES.	GENEVA, SWITZERLAND
CHIC	UNIV. OF CHICAGO	CHICAGO, ILL., USA
CINC	UNIV. OF CINCINNATI	CINCINNATI, OHIO, USA
CIT	CALIF. INSTITUTE OF TECHNOLOGY	PASADENA, CALIF., USA
CNRC	CANADIAN NATIONAL RESEARCH COUNCIL	OTTAWA, CANADA
COLO	UNIV. OF COLORADO	BOULDER, COLO., USA
COLU	COLUMBIA UNIV.	NEW YORK, N. Y., USA
CORN	CORNELL UNIV.	ITHACA, N. Y., USA
CRAC	INST. FOR NUCLEAR RESEARCH	CRACOW, POLAND
CUNY	CITY UNIV. OF NEW YORK	NEW YORK, N. Y., USA
CURI	LABORATOIRE JOLIOT-CURIE	PARIS, FRANCE
DARE	DARESBURY NUC. PHYS. LAB.	DARESBURY, ENGLAND
DART	DARTMOUTH COLLEGE	HANOVER, N. H., USA
DESY	DEUTSCHES ELEKTRONEN-SYNCH.	HAMBURG, GERMANY
DUKE	DUKE UNIV.	DURHAM, N. C., USA
DURH	UNIV. OF DURHAM	DURHAM, ENGLAND
DUUC	UNIVERSITY COLLEGE	DUBLIN, IRELAND
EDIN	UNIV. OF EDINBURGH	EDINBURGH, SCOTLAND
EFI	ENRICO FERMI INST. FOR NUCL. STUDIES	CHICAGO, ILL., USA
EPOL	ECOLE POLYTECHNIQUE	PARIS, FRANCE
ETHZ	SWISS FEDERAL INST. OF TECHNOLOGY	ZURICH, SWITZERLAND
FIRZ	UNIV. DI FIRENZE	FIRENZE, ITALY
FISK	FISK UNIV.	NASHVILLE, TENN., USA
FLOR	UNIV. OF FLORIDA	GAINSVILLE, FLA., USA
FRAS	LAB. NAZIONALI DEL SINCROTRONE	FRASCATI, ITALY
FSU	FLORIDA STATE UNIV.	TALLAHASSEE, FLA., USA
GENO	UNIV. DI GENOVA	GENOVA, ITALY
GEVA	UNIV. DE GENEVE	GENEVA, SWITZERLAND
GLAS	UNIV. OF GLASGOW	GLASGOW, SCOTLAND
GRAZ	UNIV. GRAZ	GRAZ, AUSTRIA
HAIF	TECHNION - ISRAEL INST. OF TECHNOLOGY	HAIFA, ISRAEL
HAMB	UNIV. HAMBURG	HAMBURG, GERMANY
HARV	HARVARD UNIV.	CAMBRIDGE, MASS., USA
HAWA	UNIV. OF HAWAII	HONOLULU, HAWAII, USA
HEID	UNIV. HEIDELBERG	HEIDELBERG, GERMANY
HELS	HELSINGIN YLIOPISTO	HELSINKI, FINLAND
IIT	ILLINOIS INST. OF TECH.	CHICAGO, ILL., USA
ILL	UNIV. OF ILLINOIS	URBANA, ILL., USA
ILLC	UNIV. OF ILLINOIS AT CHICAGO	CHICAGO, ILL., USA
IND	UNIV. OF INDIANA	BLOOMINGTON, IND., USA
IOWA	UNIV. OF IOWA	IOWA CITY, IOWA, USA
IPN	INST. DE PHYS. NUCLEAIRE	ORSAY, FRANCE
IPNP	INSTITUT DE PHYSIQUE NUCLEAIRE	PARIS, FRANCE
IRAD	INSTITUTE DU RADIUM	PARIS, FRANCE
ISU	IOWA STATE UNIV.	AMES, IOWA, USA
ITEP	INST. FOR TEOR. AND EXP. PHYS.	MOSCOW, USSR
IUPU	INDIANA U. - PURDUE U. AT INDIANAPOLIS	INDIANAPOLIS, IND., USA
JAGL	JAGELLONIAN UNIV.	CRACOW, POLAND
JHU	JOHNS HOPKINS UNIV.	BALTIMORE, MD., USA
JINR	JOINT INST. FOR NUCL. RESEARCH	DUBNA, USSR
KANS	UNIV. OF KANSAS	LAWRENCE, KANSAS, USA
KARL	TECHNISCHE UNIV. KARLSRUHE	KARLSRUHE, GERMANY
KNTY	UNIV. OF KENTUCKY	LEXINGTON, KY., USA
LANC	LANCASTER UNIV.	LANCASTER, ENGLAND
LASL	U. C. LOS ALAMOS SCIENTIFIC LAB.	LOS ALAMOS, N. M., USA
LAUS	UNIV. OF LAUSANNE	LAUSANNE, SWITZERLAND
LBL	U. C. LAWRENCE BERKELEY LAB.	BERKELEY, CALIF., USA
LEBD	LEBEDEV PHYSICS INST.	MOSCOW, USSR
LEHI	LEHIGH UNIV.	BETHLEHEM, PA., USA
LEID	INST. LORENTZ	LEIDEN, NETHERLANDS
LINZ	LINZ INSTITUT FUR PHYSIK, KEPLER HOCH.	LINZ, AUSTRIA
LIVP	LIVERPOOL UNIV.	LIVERPOOL, ENGLAND
LOIC	IMPERIAL COL. OF SCI. AND TECH.	LONDON, ENGLAND
LOQM	QUEEN MARY COLLEGE	LONDON, ENGLAND
LOUC	UNIVERSITY COLLEGE	LONDON, ENGLAND
LOWC	WESTFIELD COLLEGE	LONDON, ENGLAND
LPNP	LAB. DE PHYS. NUCL. ET HAUTES ENERGIES	PARIS, FRANCE
LRL	U. C. LAWRENCE BERKELEY LAB.	BERKELEY, CALIF., USA
LSU	LOUISIANA STATE UNIV.	BATON ROUGE, LA., USA
LUND	UNIV. I LUND	LUND, SWEDEN
MADR	JUNTA DE ENERGIA NUCLEAR	MADRID, SPAIN
MANH	MANHATTAN COLLEGE	NEW YORK, N. Y., USA
MANZ	UNIV. MAINZ	MAINZ, GERMANY
MASA	UNIV. OF MASSACHUSETTS	AMHERST, MASS., USA
MASB	UNIV. OF MASSACHUSETTS	BOSTON, MASS., USA
MCGI	MCGILL UNIV.	MONTREAL, CANADA
MCHS	UNIV. MANCHESTER	MANCHESTER, ENGLAND
MICH	UNIV. OF MICHIGAN	ANN ARBOR, MICH., USA
MILA	UNIV. DI MILANO	MILANO, ITALY
MINN	UNIV. OF MINNESOTA	MINNEAPOLIS, MINN., USA
MIOH	MIAMI UNIV.	OXFORD, OHIO, USA
MIT	MASSACHUSETTS INST. OF TECHNOLOGY	CAMBRIDGE, MASS., USA
MODE	ISTITUTO DI FISICA DELLA UNIVERSITA	MODENA, ITALY
MPIM	MAX-PLANCK-INST. FUR PHYS.-ASTROPHYS.	MUNICH, GERMANY
MSNA	INS. DI FISICA DELL UNIV.	MESSINA, ITALY
MSU	MICHIGAN STATE UNIV.	EAST LANSING, MICH., USA
NAGO	NAGOYA UNIV.	NAGOYA, JAPAN
NAL	NATIONAL ACCELERATOR LAB.	BATAVIA, ILL., USA
NAPL	UNIV. DI NAPOLI	NAPOLI, ITALY
NDAM	UNIV. OF NOTRE DAME	NOTRE DAME, IND., USA
NEAS	NORTHEASTERN UNIV.	BOSTON, MASS., USA
NEVI	NEVIS LAB.	IRVINGTON-ON-HUDSON, N.Y., USA
NIJM	R. K. UNIV. NIJMEGEN	NIJMEGEN, NETHERLANDS
NORD	NORDISK INS. FOR TEOR. ATOMFYS.	COPENHAGEN, DENMARK
NOVO	INST. OF NUCL. PHYS.	NOVOSIBIRSK, USSR
NRL	NAVAL RESEARCH LABORATORY	WASHINGTON, D.C., USA
NWES	NORTHWESTERN UNIV.	EVANSTON, ILL., USA
NYU	NEW YORK UNIV.	NEW YORK, N. Y., USA
OHIO	OHIO UNIV.	ATHENS, OHIO, USA
OREG	UNIV. OF OREGON	EUGENE, ORE., USA
ORNL	OAK RIDGE NATIONAL LAB.	OAK RIDGE, TENN., USA
ORSA	UNIV. DE PARIS, FAC. DES SCI.	ORSAY, FRANCE
OSLO	OSLO UNIV.	OSLO, NORWAY
OSU	OHIO STATE UNIV.	COLUMBUS, OHIO, USA
OXF	OXFORD UNIV.	OXFORD, ENGLAND
PADO	UNIV. OF PADOVA	PADOVA, ITALY
PATR	UNIV. OF PATRAS	PATRAS, GREECE
PENN	UNIV. OF PENNSYLVANIA	PHILADELPHIA, PA., USA
PISA	UNIV. DI PISA	PISA, ITALY
PITT	UNIV. OF PITTSBURGH	PITTSBURGH, PA., USA
PPA	PRINCETON-PENN. PROTON ACCEL.	PRINCETON, N. J., USA
PRAG	INSTITUTE OF PHYSICS, CSAV	PRAGUE, CZECHOSLOVAKIA
PRIN	PRINCETON UNIV.	PRINCETON, N. J., USA
PURD	PURDUE UNIV.	LAFAYETTE, IND., USA
REHO	WEIZMANN INST. OF SCI.	REHOVOTH, ISRAEL
RHEL	RUTHERFORD HIGH ENERGY LAB.	CHILTON, DID., BERKS., ENGLAND
RISO	RESEARCH ESTAB. RISO	ROSKILDE, DENMARK
ROCH	UNIV. OF ROCHESTER	ROCHESTER, N. Y., USA
ROMA	UNIV. DEGLI STUDI DI ROMA	ROME, ITALY
RUTG	RUTGERS UNIV.	NEW BRUNSWICK, N. J., USA
SACL	CNTR. D'ETUDES NUC. SACLAY	GIF-SUR-YVETTE, FRANCE
SEAT	SEATTLE PACIFIC COLLEGE	SEATTLE, WASH., USA
SERP	INST. OF HIGH EN. PHYS.	SERPUKOV, USSR
SETO	SETON HALL UNIV.	SOUTH ORANGE, N. J., USA
SHMP	UNIV. OF SOUTHAMPTON	SOUTHAMPTON, ENGLAND
SLAC	STANFORD LINEAR ACCEL. CENTER	STANFORD, CALIF., USA
SOFI	BULGARIAN ACAD. OF SCI.	SOFIA, BULGARIA
STAN	STANFORD UNIV.	STANFORD, CALIF., USA
STEV	STEVENS INST. OF TECH.	HOBOKEN, N. J., USA
STLO	ST. LOUIS UNIV.	ST. LOUIS, MO., USA
STOH	STOCKHOLM UNIV.	STOCKHOLM, SWEDEN
STON	STATE UNIV. OF NEW YORK AT STONYBROOK	STONYBROOK, L.I., N. Y., USA
STRB	CENTRE DES RES. NUCLEAIRES	STRASBOURG, FRANCE
SUSS	SUSSEX UNIV.	SUSSEX, ENGLAND
SYRA	SYRACUSE UNIV.	SYRACUSE, N. Y., USA
TELA	UNIV. OF TEL-AVIV	TEL-AVIV, ISRAEL
TENN	UNIV. OF TENNESSEE	KNOXVILLE, TENN., USA
TNTO	UNIV. OF TORONTO	TORONTO, CANADA
TOHO	TOHOKU UNIV.	SENDAI, JAPAN
TOKY	UNIV. OF TOKYO	TOKYO, JAPAN
TORI	UNIV. DI TORINO	TORINO, ITALY
TRST	UNIV. OF TRIESTE	TRIESTE, ITALY
TUFT	TUFTS UNIV.	MEDFORD, MASS., USA
UCB	UNIV. OF CALIF. AT BERKELEY	BERKELEY, CALIF., USA
UCD	UNIV. OF CALIF. AT DAVIS	DAVIS, CALIF., USA
UCI	UNIV. OF CALIF. AT IRVINE	IRVINE, CALIF., USA
UCLA	UNIV. OF CALIF. AT LOS ANGELES	LOS ANGELES, CALIF., USA
UCND	UNION CARBIDE NUCLEAR DIVISION	OAK RIDGE, TENN., USA
UCR	UNIV. OF CALIF. AT RIVERSIDE	RIVERSIDE, CALIF., USA
UCSB	UNIV. OF CALIF. AT SANTA BARBARA	SANTA BARBARA, CALIF., USA
UCSC	UNIV. OF CALIF. AT SANTA CRUZ	SANTA CRUZ, CALIF., USA
UCSD	UNIV. OF CALIF. AT SAN DIEGO	LA JOLLA, CALIF., USA
UMD	UNIV. OF MARYLAND	COLLEGE PARK, MD., USA
UPNJ	UPSALA COLLEGE	EAST ORANGE, N. J., USA
UTAH	UNIV. OF UTAH	SALT LAKE CITY, UTAH, USA
VAND	VANDERBILT UNIV.	NASHVILLE, TENN., USA
VIEN	INST. FOR HIGH EN. PHYS., A. A. S.	VIENNA, AUSTRIA
VIRG	UNIV. OF VIRGINIA	CHARLOTTESVILLE, VA., USA
VPI	VIRGINIA POLYTECHNIC INST.	BLACKSBURG, VA., USA
WARS	UNIV. OF WARSAW	WARSAW, POLAND
WASH	UNIV. OF WASHINGTON	SEATTLE, WASH., USA
WIEN	UNIV. WIEN	WIEN, AUSTRIA
WILL	COLLEGE OF WILLIAM AND MARY	WILLIAMSBURG, VA., USA
WISC	UNIV. OF WISCONSIN	MADISON, WISC., USA
WOOD	WOODSTOCK COLLEGE	WOODSTOCK, MD., USA
WUSL	WASHINGTON UNIV.	ST. LOUIS, MO., USA
WYOM	UNIV. OF WYOMING	LARAMIE, WYOMING, USA
YALE	YALE UNIV.	NEW HAVEN, CONN., USA
ZEEM	ZEEMAN LAB., UNIV. OF AMSTERDAM	AMSTERDAM, NETHERLANDS

0 0 0 0 3 6 0 4 7 8 9

Data Card Listings

For notation, see key at front of Listings.

Stable Particles

γ, ν_e, ν_μ, e, μ

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CODE EVENTS QUANTITY  ERROR+  ERROR-  REFERENCE YR TECN SIGN COMMENTS  DATE
    ABOVE                                                           PUNCHED
  BACKGROUND

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γ

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                      0  GAMMA (0,J=1)
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                      0  GAMMA MASS (IN UNITS OF 10**-21 MEV)

M   P        (6.)    OR LESS           PATEL     65          SATELLITE DATA  10/69
M            6.      OR LESS           GINTSBURG 64          SATELLITE DATA  10/69
M            2.3     OR LESS           GOLDHABER 68          SATELLITE DATA  10/69
M   F        (0.06)  OR LESS           FRANKEN   71          LOW FREQ RES CIR  3/72
M            10.     OR LESS           WILLIAMS  71 CNTR     TESTS GAUSS LAW   3/71
M   F   VALIDITY QUESTIONABLE ACCORDING TO AUTHORS AND KROLL 71.                3/72
M   P   SEE CRITICISM IN GOLDHABER 71                                           3/72

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REFERENCES FOR GAMMA


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GINTSBUR 64 SOV. ASTR.AJ7 536 M. A. GINTSBURG           (ACAD SCI,USSR)
PATEL    65 PL    14 105      V. L. PATEL                        (DURHAM)
GOLDHABE 68 PRL   21  567     A. GOLDHABER,M. NIETO         (STONY BROOK)
FRANKEN  71 PRL 26 115        P A FRANKEN, G W AMPULSKI            (MICH)
WILLIAMS 71 PRL 26 721        +FALLER,HILL                     (WESLEYAN)
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PAPERS NOT REFERRED TO IN DATA CARDS


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GOLDHABE 71 RMP 43 277        A S GOLDHABER, M M NIETO  (STON+BOHR+UCSB)
KROLL    71 PRL 26 1395       N M KROLL                            (SLAC)
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ν_e

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                      1  E-NEUTRINO (0,J=1/2)
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                      1  E-NEUTRINO MASS (KEV)

M            (0.25)  OR LESS           LANGER    52 CNTR
M            (0.15)  OR LESS           HAMILTON  53 CNTR
M            (0.55)   (0.28)           FRIEDMAN  58 CNTR
M             0.06   OR LESS  CL=.90   BERGKVIS  69 CNTR     EL.STATIC.MAG.SP 11/69

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REFERENCES FOR E-NEUTRINO


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LANGER   52 PR   88  689      L M LANGER,R J D MOFFAT              (INDIANA)
HAMILTON 53 PR   92 1521      D HAMILTON,W P ALFORD,L GROSS     (PRINCETON)
FRIEDMAN 58 PR 109  2214      LEWIS FRIEDMAN,LINCOLN G SMITH          (BNL)
BERGKVIS 69 CERN 69-7 91      KARL-ERIK BERGKVIST          (UNIV STOCKHOLM)
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ν_μ

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                      2  MU-NEUTRINO (0,J=1/2)
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                      2  MU-NEUTRINO MASS (MEV)

M             3.5    OR LESS           BARKAS    56 EMUL
M             4.0    OR LESS           DUDZIAK   59 CNTR
M             3.6    OR LESS           FEINBERG  63 RVUE                         7/66
M             3.0    OR LESS           ALLCOCK   65 RVUE                         7/66
M             2.5    OR LESS           BARDON    65 ASPK
M             2.8    OR LESS  CL=.90   SHAFER    65 CNTR                         5/71
M             1.6    OR LESS  CL=.90   BOOTH     67 CNTR                         3/68
M             2.2    OR LESS  CL=.90   HYMAN     67 HEBC     O. K- HE           11/67
M            (0.46)   (0.64)   (0.46)  FRANK     68 CNTR     PRELIMINARY         9/68
M   B        (1.2)   OR LESS  CL=.90   BACKENSTO 71 CNTR     M**2=-1.28+-1.24  10/71
M   S         1.15   OR LESS  CL=.90   SHRUM     71 CNTR     M**2=-1.55+-1.14  12/71
M   B         1.15   OR LESS  CL=.90   BACKENSTO 73 CNTR     M**2=-0.29+-0.90   1/73*
M   B   BACKENSTOSS 73 REPLACES BACKENSTOSS 71 AND USES THEIR NEW PI- MASS.     1/73*
M   B   WE CALCULATE UPPER LIMIT FROM M**2.                                     1/73*
M   S   SHRUM 71 USES SHAFER 67 PI- MASS VALUE AND CRANE 71 MU MASS VALUE.      1/73*

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REFERENCES FOR MU-NEUTRINO


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BARKAS   56 PR 101  778       W H BARKAS,W BIRNBAUM,F M SMITH         (LRL)
DUDZIAK  59 PR 114  336       W F DUDZIAK,R SAGANE,J VEDDER           (LRL)
FEINBERG 63 ARNS 13 431       G FEINBERG, L M LEDERMAN           (COLUMBIA)
ALLCOCK  65 PPSL  85  875     G R ALLCOCK                       (LIVERPOOL)
BARDON   65 PRL  14 449       BARDON,NORTON,PEOPLES +   (COLU+STONY BROOK)

SHAFER   65 PRL  14 923       R E SHAFER,CROWE,JENKINS                (LRL)
BOOTH    67 PL 26B  39        BOOTH,JOHNSON,WILLIAMS,WORMALD  (LIVERPOOL)
HYMAN    67 PL 25B 376        +LOKEN,PEWITT,MCKENZIE+    (ANL+CARN+NWES)
FRANK    68  VIENNA ABS.  365 FRANK,GAMET,LAKIN         (SHMP+LIVP+STAN)
BACKENST 71 PL 36B 403        BACKENSTOSS,DANIEL,KOCH+  (CERN,KARL,HEID)
SHRUM    71 PL 37B 114        E V SHRUM,K O H ZIOCK,     (UNIV OF VIRGINIA)
BACKENST 73 SUBMITTED TO PL B BACKENSTOSS,DANIEL,KOCH+ (CERN,KARL,MUNICH)
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e

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                      3  ELECTRON (0.5,J=1/2)
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                      3  ELECTRON MASS (MEV)

M          (.5110061(.00002)           COHEN     65 RVUE
M           .5110041 .0000016          TAYLOR    69 RVUE     USING NEW E/H      7/70

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                      3  ELECTRON MEAN LIFE (UNITS 10**21 YR)

T             2.0    OR MORE           MOE       65 CNTR                         6/66

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                      3  ELECTRON MAGNETIC MOMENT(E/2ME)

MM         (1.0011609)   +-(24)*10**-7 SCHUPP    61 CNTR -
MM         (1.001159622) +-(27)*10**-9 WILKINSON 63 CNTR -                       8/66
MM         (1.001168)    +-(22)*10**-6 RICH      66 CNTR +  POSITRON             8/66
MM R       (1.001159557) +-(30)*10**-9 RICH      68 CNTR -                       6/68
MM         (1.0011596389)+-(31)*10**-10TAYLOR    69 RVUE                         2/71
MM         (1.001159644) +-(7)* 10**-9 WESLEY    70 CNTR                         6/70
MM          1.0011596577 +-(35)*10**-10WESLEY    71 CNTR -                       2/72
MM         (1.0011603)   +-(12)*10**-7 GILLELAND 72 CNTR +                       2/72
MM R    RICH 68 IS REEVALUATION OF WILKINSON 63.

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REFERENCES FOR ELECTRON


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SCHUPP   61 PR   121   1      A A SCHUPP,R W PIDD,H R CRANE          (MICH)
WILKINSO 63 PR 130 852        D T WILKINSON,H R CRANE                (MICH)
COHEN    65 RMP 37 537        COHEN,DUMOND  (N.A.AVIATION SCI.CENTER+CIT)
MOE      65 PR 140 B 992      M K MOE,F REINES     (CASE INST TECHNOLOGY)
RICH     66 PRL  17  271      A RICH, H R CRANE                      (MICH)
RICH     68 PRL 20 967        A RICH                                 (MICH)
TAYLOR   69 RMP 41 375        +PARKER,LANGENBERG            (PRIN+UCI+PENN)
WESLEY   70 PRL 24 1320       J C WESLEY,A.RICH                      (MICH)
WESLEY   71 PR A4 1341        J C WESLEY,A RICH                      (MICH)
GILLELAN 72 PR A5 38          J GILLELAND,A RICH                     (MICH)
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μ

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                      4  MUON (106,J=1/2)
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                      4  MUON MASS (MEV)

M          (105.659)  (0.002)          FEINBERG  63 RVUE
M          (105.6599) (0.0014)         TAYLOR    69 RVUE     USING NEW E/H       7/70
M   C       105.6597   0.0005          CRANE     71 CNTR                         1/73*
M   D       105.6594   0.0004          CROWE     72 CNTR                         2/72
M   C   CRANE 71 GIVES MU/ME=206.76878(85).  WE USE ME=.5110041(16)MEV.          1/73*
M   D   CROWE 72 GIVES MU/ME=206.7682(5) AND USES ME=.5110041(16)MEV.            1/73*
M             . . . . . . . . .
M   AVG     105.65952  0.00031  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
M   FIT     105.6595    .0003 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)   1/73*

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                      4  MUON MEAN LIFE (UNITS 10**-6)

T             2.198    0.001    0.001 FARLEY     62 CNTR
T             2.203    0.004          LUNDY      62 CNTR     CONLEV=.98         11/67
T             2.202    0.003    0.003 ECKHAUSE   63 CNTR
T             2.197    0.005    0.002 MEYER      63 CNTR +
T             2.198    0.002    0.002 MEYER      63 CNTR -                       7/66
T             2.20026  0.00081        WILLIAMS   72 CNTR +                       2/72
T             . . . . . . . . .
T   AVG       2.19936  0.00061  0.00061 AVERAGE (ERROR INCL. SCALE FACTOR OF 1.1)

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                      4  MU+/MU- MEAN LIFE RATIO

DT            1.000    0.001           MEYER     63 CNTR  MEAN LIFE MU+/MU-     7/66

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                      4  MUON ANOMALOUS MAGN. MOMENT (10**-6*E/(2*MU MASS))

MM         (1162.0)    (5.0)           CHARPAK   62 CNTR +
MM  B      (1165.75)   (0.71)          BAILEY    68 CNTR +  STOR. RINGS          5/69
MM  B      (1166.25)   (0.24)          BAILEY    68 CNTR  - STOR. RINGS          5/69
MM  B       ERRORS STATISTICAL. VALUES COMBINED TO GIVE MU+- VALUE BELOW         5/69
MM          1166.16     0.31           BAILEY    68 CNTR +- STOR. RINGS          5/69

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                      4  MUON TO PROTON MAGNETIC MOMENT RATIO

MMR     THIS RATIO IS USED TO OBTAIN PRECISE VALUES OF THE MUON MASS.            3/72
MMR     SEE CROWE 72.                                                            3/72
MMR        3.1865    .0022             COFFIN    58 CNTR +  SPIN RESONANCE       2/72
MMR        3.1830    .0011             LUNDY     58 CNTR +  PRECESSION STROB     2/72
MMR        3.176     .013              LUNDY     58 CNTR -  PRECESSION STROB     2/72
MMR        3.1834    .0002             GARWIN    60 CNTR +  PRECESSION PHASE     2/72
MMR        3.18336   .00007            BINGHAM   63 CNTR +  PRECESSION STROB     2/72
MMR        3.1808    .0004             BINGHAM   63 CNTR -  PRECESSION STROB     2/72
MMR        3.18338   .00004            HUTCHINS  63 CNTR +  PRECESSION PHASE     2/72
MMR D     (3.183351)(.000016)          EHRLICH   69 CNTR    HFS SPLITTING        2/72
MMR C     (3.183314)(.000034)          THOMPSON  69 CNTR    HFS SPLITTING        2/72
MMR        3.183330  .000044           HUTCHINS  70 CNTR +  PRECESSION PHASE     2/72
MMR H     (3.183347)(.000009)          HAGUE     70 CNTR +  PRECESSION PHASE     2/72
MMR  C     3.183336  .000013           CRANE     71 CNTR    HFS SPLITTING        2/72
MMR  D     3.183349  .000015           DEVOE     71 CNTR    HFS SPLITTING        1/73*
MMR F     (3.183326)(.000013)          FAVART    71 CNTR    HFS SPLITTING        2/72
MMR  H     3.1833467 .0000082          CROWE     72 CNTR +  PRECESSION PHASE     2/72
MMR C   CRANE 71 SUPERSEDES THOMPSON 69. THIS IS NOT A DIRECT MEASUREMENT.       1/73*
MMR H   CROWE 72 SUPERSEDES HAGUE 70.
MMR F   FAVART 71 ASSUMES A ZERO VALUE FOR THE PROTON POLARIZABILITY.            1/73*
MMR  D  DEVOE 71 SUPERCEDES EHRLICH 69.  THIS IS NOT A DIRECT MEASUREMENT.       1/73*
MMR  D  WE GIVE A NEW VALUE WHICH CONTAINS A THEORETICAL CORRECTION OF           1/73*
MMR  D  -7.8+-2.3 PPM, AS DISCUSSED IN FOOTNOTE 35A OF CROWE 72.                 1/73*
MMR         . . . . . . . . . . .
MMR AVG    3.1833447 .0000061  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

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Stable Particles

μ, π±

Data Card Listings

For notation, see key at front of Listings.

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                    4  MUON PARTIAL DECAY MODES

                                                           DECAY MASSES
P1      MUON INTO E (E-NEU) (MU-NEU)                       .5+   0+   0
P2      MUON INTO E 2GAMMA                                 .5+   0+   0
P3      MUON INTO 3ELECTRONS                               .5+  .5+  .5
P4      MUON INTO E GAMMA                                  .5+   0

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                    4  MUON BRANCHING RATIOS

R1      MUON INTO E+2GAMMA (IN UNITS OF 10**-5)          (P2)/(P1)
R1            (1.6)  OR LESS  CL=.90   FRANKEL1  63 OSPK

R2      MUON INTO 3E (IN UNITS OF 10**-7)                (P3)/(P1)
R2 F          5.0    OR LESS  CL=.90   PARKER    62 CNTR
R2 F          1.3    OR LESS  CL=.90   ALIKHANOV 62 OSPK
R2 F          1.5    OR LESS  CL=.90   FRANKEL2  63 CNTR
R2 F          1.2    OR LESS  CL=.90   BABAEV    63 OSPK
R2 K          0.062  OR LESS  CL=.90   KORENCH2  71 OSPK                 2/72
R2 K     KORENCHENKO2 71 ASSUMES A CONSTANT MATRIX ELEMENT.                2/72
R2 F     FOUR ABOVE EXPERIMENTS EVALUATED UPPER LIMITS ASSUMING A SECOND
R2       ORDER V-A NEUTRINO LOOP DIAGRAM. LIMITS NOT SIGNIFICANTLY CHANGED B
R2       ASSUMING A CONSTANT MATRIX ELEMENT.

R3      MUON INTO E+GAMMA (IN UNITS OF 10**-8)           (P4)/(P1)
R3            4.3    OR LESS  CL=.90   FRANKEL1  63 OSPK
R3            2.2    OR LESS  CL=.90   PARKER    64 OSPK
R3            2.9    OR LESS  CL=.90   KORENCH1  71 OSPK +              10/71

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                    4  MUON DECAY PARAMETERS

         RELATED TEXT SECTION IV E


RHO     RHO PARAMETER                 (V-A THEORY PREDICTS RHO=0.75)
RHO C        (0.741)  (0.027)         DUDZIAK   59 CNTR +  20-53 MEV E+     10/69
RHO  P9213    0.745    0.025          PLANO     60 HBC  +  WHOLE SPECTRUM   10/69
RHO  P   TWO PARAMETER FIT TO RHO AND ETA.
RHO C 2276   (0.751)  (0.034)         BLOCK     62 HEBC -  WHOLE SPECTRUM   10/69
RHO D        (0.64)   (0.04)          BARLOW    64 CNTR -  WHOLE SPECTRUM   10/69
RHO D        (0.661)  (0.016)         BARLOW    64 CNTR +  WHOLE SPECTRUM   10/69
RHO D        (0.867)  (0.035)         PONTECORV 64 CC   -                   10/69
RHO D    RESULTS IN DOUBT.                                                   10/69
RHO C 800K   (0.7503) (0.0026)        PEOPLES   66 ASPK +  20-53 MEV E+     10/69
RHO C 280K   (0.760)  (0.009)         SHERWOOD  67 ASPK +  25-53 MEV E+     10/69
RHO C 170K   (0.762)  (0.008)         FRYBERGER 68 ASPK +  25-53 MEV E+     10/69
RHO C    ETA CONSTRAINED =0. THESE VALUES INCORPORATED INTO A TWO PARAMETER
RHO C    FIT TO RHO AND ETA BY DERENZO 69.
RHO           0.7518   0.0026         DERENZO   69 RVUE                     10/69
RHO          . . . . . . . . . .
RHO AVG       0.7517   0.0026  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

ETA     ETA PARAMETER                 (V-A THEORY PREDICTS ETA=0)
ETA P 9213   (-2.0)   (0.9)           PLANO     60 HBC  +  WHOLE SPECTRUM   10/69
ETA P    TWO PARAMETER FIT TO RHO AND ETA- PLANO 60 DISCOUNTS VALUE FOR ETA  10/69
ETA C 800K   (0.05)   (0.5)           PEOPLES   66 ASPK +  20-53 MEV E+     10/69
ETA C 280K   (-0.7)   (0.6)           SHERWOOD  67 ASPK +  25-53 MEV E+     10/69
ETA C 170K   (-0.7)   (0.5)           FRYBERGER 68 ASPK +  25-53 MEV E+     10/69
ETA C    RHO CONSTRAINED =0.75.
ETA   6346   -0.12     0.21           DERENZO   69 HBC  +  1.6-6.8 MEV E+   10/69

XSI     XSI PARAMETER                 (V-A THEORY PREDICTS XSI=1)
XSI     9K    0.97     0.05           BARDON    59 CNTR    BROMOFORM TARGET 10/69
XSI   8354    0.93     0.06           PLANO     60 HBC  +  8.8 KGAUSS       10/69
XSI A        (0.903)  (0.027)         ALI-ZADE  61 EMUL +  27 KGAUSS        10/69
XSI A    DEPOLARIZATION BY MEDIUM NOT KNOWN SUFFICIENTLY WELL.
XSI G  66K   (0.975)  (0.030)         GUREVICH  64 EMUL    140 KGAUSS       10/69
XSI           0.975    0.014          GUREVICH  67 EMUL                     10/69
XSI G    GUREVICH 67 SUPERSEDES GUREVICH 64                                  10/69
XSI          . . . . . . . . . .
XSI AVG       0.972    0.013   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

DEL     DELTA PARAMETER               (V-A THEORY PREDICTS DELTA=0.75)
DEL  8354     0.78     0.05           PLANO     60 HBC  +  WHOLE SPECTRUM   10/69
DEL           0.782    0.031          KRUGER    61                          10/69
DEL   490K    0.752    0.009          FRYBERGER 68 ASPK +  25-53 MEV E+     10/69
DEL      VOSSLER 69 HAS MEASURED THE ASYMMETRY BELOW 10 MEV                  11/69
DEL          . . . . . . . . . .
DEL AVG       0.7551   0.0085  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

HEL     HELICITY OF DECAY ELECTRON.
HEL     (V-A THEORY PREDICTS HELICITY=+-1 FOR E+-, RESPECTIVELY)
HEL     WE HAVE FLIPPED THE SIGN FOR E- SO OUR PROGRAMS CAN AVERAGE
HEL D        (0.28)   (0.16)          DICK      63 CNTR +  ANNIHILATION     10/69
HEL D    IN DOUBT- POSITRONS POSSIBLY DEPOLARIZED IN BE MODERATOR.
HEL           1.05     0.30           BUHLER    63 CNTR +  ANNIHILATION     10/69
HEL           0.94     0.38           BLOOM     64 CNTR +  BREMS TRANSMISS  10/69
HEL           1.04     0.18           DUCLOS    64 CNTR +  BHABHA SCATT     10/69
HEL    29K    0.89     0.28           SCHWARTZ  67 OSPK -  MOLLER SCATT     10/69
HEL          . . . . . . . . . .
HEL AVG       1.00     0.13    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

GS      SCALAR COUPLING CONSTANT IN MUON DECAY  (IN UNITS OF GV)
GS           (0.33) OR LESS           DERENZO   69 RVUE                     10/69

GAV     AXIAL VECTOR COUPLING CONSTANT IN MUON DECAY (IN UNITS OF GV)
GAV           0.86     0.33      0.11 DERENZO   69 RVUE                     10/69

FAV     PHASE BETWEEN VECTOR AND AXIAL VECTOR COUPLINGS  (DEGREES)
FAV          180.      15.            DERENZO   69 RVUE                     10/69

GT      TENSOR COUPLING CONSTANT IN MUON DECAY    (IN UNITS OF GV)
GT           (0.28) OR LESS           DERENZO   69 RVUE                     10/69

GP      PSEUDOSCALAR COUPLING CONSTANT IN MUON DECAY  (IN UNITS OF GV)
GP           (0.33) OR LESS           DERENZO   69 RVUE                     10/69

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                              REFERENCES FOR MUON

COFFIN    58 PR 109 973           +GARWIN,PENMAN,LEDERMAN,SACHS     (COLUMBIA)
LUNDY     58 PRL 1 38             +SENS,SWANSON,TELEGDI,YOVANOVITCH (CHICAGO)
BARDON    59 PRL   2   56         M BARDON, D BERLEY, L LEDERMAN    (COLUMBIA)
DUDZIAK   59 PR  114  336         W DUDZIAK,R SAGANE, J VEDDER           (LRL)
GARWIN    60 PR 118 271           GARWIN,HUTCHINSON,PENMAN,SHAPIRO (COLUMBIA)
PLANO     60 PR  119 1400         R J PLANO                         (COLUMBIA)
ALI-ZADE  61 JETP  13  313        ALI-ZADE,GUREVICH,NIKOLSKI            (USSR)
KRUGER    61 UCRL-9322 (UNPUB)    H KRUGER                               (LRL)

ALIKHANO  62 CERN CONF 423        A I ALIKHANOV,A BABAEV +       (ITEP MOSCOW)
BLOCK     62 NC    23  1114       BLOCK,FIORINI,KIKUCHI+(DUKE,BOLOGNA,MILANO)
CHARPAK   62 PL     1  16         G CHARPAK,F J M FARLEY,R L GARWIN +  (CERN)
FARLEY    62 CERN CONF 415        FARLEY,MASSAM,MULLER,ZICHICHI         (CERN)
LUNDY     62 PR 125 1686          RICHARD A LUNDY                        (EFI)
PARKER    62 NC   23  485         S PARKER,S PENMAN                      (EFI)

BABAEV    63 JETP 16 1397         BABAEV,BALATS,KAFTANOV,LANDSBERG +    (ITEP)
BINGHAM   63 NC 27 1352           G.MCD.BINGHAM                          (LRL)
BUHLER    63 PL    7  368         +CABIBBO,FIDECARO,MASSAM,MULLER+      (CERN)
DICK      63 PL    7  150         DICK,FEUVRAIS,SPIGHEL                 (CERN)
ECKHAUSE  63 PR 132  422          M ECKHAUSE,T A FILIPPAS +        (CARNEGIE)
FEINBERG  63 ARNS 13 431          GERALD FEINBERG, L M LEDERMAN    (COLUMBIA)
FRANKEL1  63 NC   27  894         S FRANKEL,W FRATI,J HALPERN +         (PENN)
FRANKEL2  63 PR 130  351          S FRANKEL,W FRATI,J HALPERN +         (PENN)
HUTCHINS  63 PR 131 1351          HUTCHINSON,MENES,PATLACH,SHAPIRO (COLUMBIA)
MEYER     63 PR  132  2693        S L MEYER,ANDERSON,BLESER,LEDERMAN+   (COLU)

BARLOW    64 PPS   84  239        +BOOTH,CARROL,COURT,DAVIES,EDWARDS+   (LIVP)
BLOOM     64 PL    8   87         +DICK,FEUVRAIS,HENRY,MACQ,SPIGHEL     (CERN)
DUCLOS    64 PL    9   62         +HEINTZE,DE RUJULA,SOERGEL            (CERN)
GUREVICH  64 PL   11  185         GUREVICH,MAKARIYNA+       (KURCHATOV,MOSCOW)
PONTECOR  64 DUBNA CONF           PONTECORVO,SULYAEV                  (MOSCOW)
PARKER    64 PR 133B 768          S PARKER,H L ANDERSON,C REY            (EFI)

PEOPLES   66 NEVIS-147 (UNPUB)    J PEOPLES                         (COLUMBIA)
GUREVICH  67  IAE 1297            GUREVICH,MAKARIYNA,MISHAKOVA+    (KURCHATOV)
SCHWARTZ  67 PR   162 1306        D M SCHWARTZ                           (EFI)
SHERWOOD  67 PR   156 1475        B A SHERWOOD                           (EFI)
BAILEY    68 PL    28B  287       +BARTL,VON BOCHMANN,BROWN,FARLEY+     (CERN)
     ALSO 72 NC 9A 369            +BARTL,VON BOCHMANN,BROWN,FARLEY+     (CERN)
FRYBERGE  68 PR   166 1379        D FRYBERGER                            (EFI)

DERENZO   69 PR   181 1854        S DERENZO                              (EFI)
EHRLICH   69 PRL 23 513           +HOFER,MAGNON,STOWELL,SWANSON+     (CHICAGO)
TAYLOR    69 RMP 41 375           +PARKER,LANGENBERG           (PRIN+UCI+PENN)
THOMPSON  69 PRL 22 163           +AMATO,CRANE,HUGHES,MOBLEY+           (YALE)
HAGUE     70 PRL 25 628           +ROTHBERG,SCHENCK,WILLIAMS+       (WASH+LRL)
HUTCHINS  70 PRL 24 1254          HUTCHINSON,LARSON,SCHOEN,SOBER,+       (PPA)

CRANE     71 PRL 27 474           +CASPERSON,CRANE,EGAN,HUGHES+         (YALE)
DEVOE     71 PRL 25 1779(ER)      +MCINTGRE,MAGNON,STOWELL,SWANSON+  (CHICAGO)
     ALSO 71 PRL 26 213           DEVOE,MCINTGRE,MAGNON,STOWELL+     (CHICAGO)
FAVART    71 PRL 27 1336          +MCINTYRE,STOWELL,TELEGDI,DEVOE+   (CHICAGO)
KORENCH1  71 SJNP 13 190          KORENCHENKO,KOSTIN,MICELMACHER+       (JINR)
KORENCH2  71 SJNP 13 728          KORENCHENKO,KOSTIN,MICELMACHER+       (JINR)
CROWE     72 PR D5 2145           +HAGUE,ROTHBERG,SCHENCK+          (LBL+WASH)
WILLIAMS  72 PR D6 737            R W WILLIAMS,D L WILLIAMS       (WASHINGTON)

                              PAPERS NOT REFERRED TO IN DATA CARDS

FISHER    59 PRL   3  349         FISHER,LEONTIC,LUNDBY,MEUNIER,STROOT (CERN)
ASTBURY   60 ROCH CONF 60 542     ASTBURY,HATTERSLEY,HUSSAIN +   (LIVERPOOL)
DEVONS    60 PRL   5  330         DEVONS,GIDAL,LEDERMAN,SHAPIRO    (COLUMBIA)
LATHROP   60 NC    17 109         J LATHROP,R A LUNDY,V L TELEGDI +      (EFI)
LATHROP   60 NC    17 114         J LATHROP,R A LUNDY,S PENMAN +         (EFI)
REITER    60 PRL   5   22         REITER,ROMANOWSKI,SUTTON +        (CARNEGIE)
TELEGDI   60 ROCH CONF 60 713     V L TELEGDI                           (CERN)
CHARPAK   61 PRL    6 128         CHARPAK,FARLEY,GARWIN,MULLER,SENS +   (CERN)
HUTCHINS  61 PRL    7 129         D P HUTCHINSON,J MENES +          (COLUMBIA)
SHAPIRO   62 PR 125 1022          G SHAPIRO,L M LEDERMAN            (COLUMBIA)
FAIRLEY   66 NC 45A 281           FAIRLEY,BAILEY,BROWN,GIESCH +         (CERN)
VOSSLER   69 NC 63A 423           C VOSSLER                              (EFI)
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                    8  CHARGED PION (140,JPG=0--) I=1

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                    8  CHARGED PION MASS (MEV)

M            139.37     0.20          CROWE     54 CNTR -
M            139.68     0.15          BARKAS    56 EMUL +
M    S      (139.577)  (0.013)        SHAFER    67 CNTR - MESONIC ATOMS     6/68
M    B      (139.549)  (0.008)        BACKENSTO 71 CNTR - MESONIC ATOMS    10/71
M    S       139.566    0.013         SHAFER    72 CNTR - MESONIC ATOMS    1/73*
M    B       139.569    0.008         BACKENSTO 73 CNTR - MESONIC ATOMS    1/73*
M    S  SHAFER 72 UPDATES SHAFER67 WITH NEW ALPHA AND NEW CALIB. LINE ENER. 1/73*
M    B  BACKENSTOSS 73 CORRECTS BACKENSTOSS 71 WITH NEW VACUUM POL. CALC.   1/73*
M           . . . . . . . . . .
M    AVG     139.5682   0.0068  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
M    FIT     139.5688   0.0064 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0) 1/73*

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                    8  (PI+) - (MU+) MASS DIFFERENCE (MEV)

D             34.00     0.076         BARKAS    56 EMUL
D             33.89     0.076         BARKAS    56 EMUL
D       145   33.881    0.035         HYMAN     67 HEBC  + K-HE             2/71
D             33.925    0.025         BOOTH     70 CNTR  + MAGNETIC SPECT.  2/71
D           . . . . . . . . . .
D    AVG      33.915    0.019   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
D    FIT      33.909    0.006  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0) 1/73*

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                    8  ((PI+) - (PI-))/AVG., MASS DIFFERENCE (PERCENT)

DM             0.02     0.05          AYRES     71 CNTR                     3/71

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Data Card Listings

For notation, see key at front of Listings.

Stable Particles

$\pi^{\pm}$, π^{0}

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                    8  CHARGED PION MEAN LIFE (UNITS 10**-9)

T              25.6      0.5      0.5  CROWE      57 RVUE
T              25.6      0.8      0.8  ANDERSON   60 CNTR
T       8000   25.46     0.32     0.32 ASHKIN     60 CNTR +
T              26.02     0.04          ECKHAUSE   65 CNTR +          9/66
T              25.6      0.3           BARDON     66 CNTR            6/66
T              25.9      0.3           DUNAITSEV  66 CNTR            6/68
T    N        (26.40)   (0.08)         KINSEY     66 CNTR +          6/66
T    N   SYSTEMATIC ERRORS IN CALIBR.IN THIS EXP.DISCUSSED BY NORDBERG 67  8/67
T              26.67     0.24          LOBKOWICZ  66 CNTR            9/66
T              26.04     0.05          NORDBERG   67 CNTR +          8/67
T              26.02     0.04          AYRES      71 CNTR +-         3/71
T              . . . . . . . . .
T    AVG       26.024    0.024    0.024  AVERAGE (ERROR INCL. SCALE FACTOR OF 1.0)
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          8  ((PI+) - (PI-))/AVG., MEAN LIFE DIFFERENCE (PERCENT)

DT   N   THIS QUANTITY IS A MEASURE OF CPT INVARIANCE IN W.I.

DT             0.23      0.40          LOBKOWICZ  66 CNTR    SEE NOTE L   9/66
DT   L   ABOVE IS THE MOST CONSERVATIVE VALUE QUOTED BY AUTHORS        9/66
DT             0.4       0.7           BARDON     66 CNTR            7/66
DT            -0.14      0.29          PETRUKHIN  68 CNTR            8/68
DT             0.055     0.071         AYRES      71 CNTR            3/71
DT             . . . . . . . . .
DT   AVG       0.053     0.068   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
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                8  CHARGED PION PARTIAL DECAY MODES

                                                  DECAY MASSES
P1       CHAR. PION INTO MU (MU-NEU)              105+   0
P2       CHAR. PION INTO E ( E-NEU)                .5+   0
P3       CHAR. PION INTO MU (MU-NEU) GAMMA        105+   0+    0
P4       CHAR. PION INTO PIO E (E-NEU)            134+   .5+   0
P5       CHAR. PION INTO E NEU GAMMA               .5+   0+    0
P6       CHAR. PION INTO E NEU E+ E-               .5+   0+   .5+   .5
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                8  CHARGED PION BRANCHING RATIOS

R1       CHAR. PION INTO MU NEU GAMMA (UNITS 10**-4)        (P3)/(P1)
R1        26    1.24      0.25           CASTAGNOL 58 EMUL    E(MU).LT.3.38 MV

R2       CHAR. PION INTO E NEU (UNITS 10**-4)               (P2)/(P1)
R2              1.21      0.07           ANDERSON  60 CNTR
R2              1.247     0.028          DI CAPUA  64 CNTR
R2              . . . . . . . . .
R2   AVG        1.242     0.026   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

R3       CHAR. PION INTO PIO E NEU (UNITS 10**-8)           (P4)/(P1)
R3   D    52   (1.15)    (.22)            DEPOMMI1  63 CNTR +              2/72
R3   D    36    0.97      0.20            BARTLETT  64 OSPK +
R3   D    38    1.07      0.21            BACASTOW  65 OSPK +
R3   D          1.10      0.26            BERTRAM   65 OSPK +              6/66
R3   D    43    1.1       0.2             DUNAITSEV 65 CNTR +              7/66
R3       332    1.00      0.08      0.10  DEPOMMIER 68 CNTR +              3/68
R3              . . . . . . . . .
R3   AVG        1.023     0.069   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
     D   DEPOMMIER 68 STATES THAT THE RESULT OF DEPOMMIER 63 IS AT LEAST   2/72
     D   10 PERCENT TOO LARGE BECAUSE OF A SYSTEMATIC ERROR IN THE PIO     2/72
     D   DETECTION EFFICIENCY.  THIS MAY BE TRUE OF ALL THE PREVIOUS       2/72
     D   MEASUREMENTS ACCORDING TO DEPOMMIER 68 AND V.SOERGEL, PRIVATE     2/72
     D   COMMUNICATION, 1972.

R4       CHAR. PION INTO E NEU GAMMA (UNITS 10**-8)         (P5)/(P1)
R4       143    3.0       0.5             DEPOMMI2  63 CNTR    GAM KE 50-90 MEV  6/66

R5       CHAR. PION INTO E NEU E+ E- (UNITS 10**-8)         (P6)/(P1)
R5              3.4    OR LESS  CL=.90   KORENCHEN 71 OSPK +                10/71

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                    REFERENCES FOR CHARGED PION

CROWE    54 PR  96  470        K M CROWE,R H PHILLIPS                  (LRL)
BARKAS   56 PR 101  778        W H BARKAS,W BIRNBAUM,F M SMITH         (LRL)
CROWE    57 NC   5  541        K M CROWE                      (STANFORD HEPL)
CASTAGNO 58 PR 112 1779        C CASTAGNOLI,M MUCHNIK                 (ROMA)

ANDERSON 60 PR 119 2050        H L ANDERSON,T FUJII,R H MILLER +       (EFI)
ASHKIN   60 NC  16  490        ASHKIN,FAZZINI,FIDECARO,LIPMAN +       (CERN)
DEPOMMI1 63 PL 5 61            DEPOMMIER,HEINTZE,RUBBIA,SOERGEL       (CERN)
DEPOMMI2 63 PL 7 285           P DEPOMMIER,HEINTZE,RUBBIA,SOERGEL     (CERN)
BARTLETT 64 PR 136B 1452       BARTLETT,DEVONS,MEYER,ROSEN        (COLUMBIA)
DI CAPUA 64 PR 133B 1333       DI CAPUA,GARLAND,PONDROM,STRELZOFF     (COLU)

BACASTOW 65 PR 139 B407        +GHESQUIERE,WIEGAND,LARSEN         (LRL+SLAC)
BERTRAM  65 PR 139 B 617       BERTRAM,MEYER,CARRIGAN+      (MICH+CARNEGIE)
DUNAITSE 65 JETP 20 58         DUNAITSEV,PETRUKHIN,PROKOSHKIN +      (DUBNA)
ECKHAUSE 65 PL 19 348          ECKHAUSE,HARRIS,SHULER+  (WILLIAM AND MARY)

BARDON   66 PRL 16 775         BARDON,DORE,DORFAN,KRIEGER +       (COLUMBIA)
DUNAITSE 66 PL 23 283          +KUTYIN,PROKOSHKIN,RASUVAEV,SIMONOV (DUBNA)
KINSEY   66 PR 144    1132     KINSEY,LOBKOWICZ,NORDBERG  (ROCHESTER UNIV)
LOBKOWIC 66 PRL  17  548       LOBKOWICZ,MELISSINOS,NAGASHIMA+  (ROCH+BNL)

HYMAN    67 PL 25B 376         +LOKEN,PEWITT,DERRICK +      (ANL+CARN+NWES)
NORDBERG 67 PL 24B  594        NORDBERG,LOBKOWICZ,BURMAN  (ROCHESTER UNIV)
SHAFER   67 PR 163 1451        ROBERT E. SHAFER                        (LRL)
    ALSO 65 PRL 14 923         SHAFER,CROWE,JENKINS                    (LRL)

DEPOMMIE 68 NP B4 189          DEPOMMIER,DUCLOS,HEINTZE,KLEINKNECHT+(CERN)
PETRUKHI 68 JINR-P1-3862       PETRUKHIN,RYKALIN,KHAZINS,CISEK       (DUBNA)
AYRES    71 PR 3D 1051         +CORMACK,GREENBERG,KENNEY +        (LRL,UCSB)
    ALSO 67 PR  157  1288      AYRES,CALDWELL,GREENBERG,KENNEY,KURZ+ (LRL)
    ALSO 68 PRL 21 261         AYRES,CORMACK,GREENBERG,KENNEY+    (LRL,UCSB)
    ALSO 69 UCRL-18369         DAVID S AYRES (THESIS)                  (LRL)
    ALSO 69 PRL 23 1267        GREENBERG,AYRES,CORMACK,KENNEY+    (LRL,UCSB)
BOOTH    70 PL 32B 723         +JOHNSON,WILLIAMS,WORMALD              (LIVP)
BACKENST 71 PL 36B 403         BACKENSTOSS,DANIEL,KOCH+    (CERN,KARL,HEID)
    ALSO 70 THESIS             C. VON DER MALSBURG              (HEIDELBERG)
KORENCHE 71 SJNP 13 189        KORENCHENKO,KOSTIN,MICELMACHER+        (JINR)
BACKENST 73 SUBMITTED TO PL B  BACKENSTOSS,DANIEL,KOCH+ (CERN,KARL,MUNICH)
    ALSO 73 SUBMITTED TO NP    L. TAUSCHER
SHAFER   72 PRIVATE COMM.      R. SHAFER, 1972
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                    PAPERS NOT REFERRED TO IN DATA CARDS

MERRISON 62 ADVP 11 1          A W MERRISON                      (LIVERPOOL)
SHAPIRO  62 PR 125 1022        G SHAPIRO,L M LEDERMAN             (COLUMBIA)
CZIRR    63 PR 130  341        JOHN B CZIRR                            (LRL)

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π^0

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                9  NEUTRAL PION (135,JPG=0--) I=1
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                9  (PI+-) - (PIO) MASS DIFFERENCE (MEV)

D             (5.37)    (1.0)            PANOFSKY  51 CNTR -
D              4.50      0.31            CHINOWSKY 54 CNTR -
D              4.62      0.05            HADDOCK   59 CNTR -
D              4.60      0.04            HILLMAN   59 CNTR
D              4.55      0.07            CASSELS   59 CNTR
D              4.69      0.07            SAMIOS    60 HBC               2/72
D              4.6056    0.0055          CZIRR     63 CNTR
D              4.59      0.03            PETRUKHIN 63 CNTR -
D              4.6034    0.0052          VASILEVSK 66 CNTR -            9/66
D              . . . . . . . . .
D    AVG       4.6043    0.0037  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
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                9  NEUTRAL PION MEAN LIFE (UNITS 10**-16)

T    N    76  (1.9)     (0.5)     (0.5)  GLASSER   61 EMUL
T    N    45  (2.3)     (1.1)     (1.0)  TIETGE    62 EMUL
T    N    88  (2.8)     (0.9)     (0.9)  KOLLER    63 EMUL    SEE STAMER 66
T              1.05      0.18      0.18  VON DARDE 63 CNTR
T    N    75  (1.7)     (0.5)            SHWE      64 EMUL
T              0.730     0.105           BELLETTIN 65 CNTR              6/66
T    N    67  (1.6)     (0.6)     (0.5)  EVANS     65 EMUL              6/66
T    K   232   1.0       0.5             STAMER    66 EMUL              8/67
T              0.56      0.06            BELLETTIN 70 CNTR   PRIM.EFF. ON NUC  7/70
T              0.9       0.068           KRYSHKIN  70 CNTR   PRIMAKOFF EFFECT 12/70
T    N   OLD EMULSION-MEASUREMENTS NOT USED BECAUSE OF POSSIBLE SYSTEMATIC
T    N   SHIFT TO LARGER MEAN LIFE VALUES.
T    K   INCLUDES EVENTS OF KOLLER 63.                                  8/67
T              . . . . . . . . .
T    AVG       0.839     0.103     0.092  AVERAGE (ERROR INCL. SCALE FACTOR OF 2.1)
                         (SEE IDEOGRAM BELOW )
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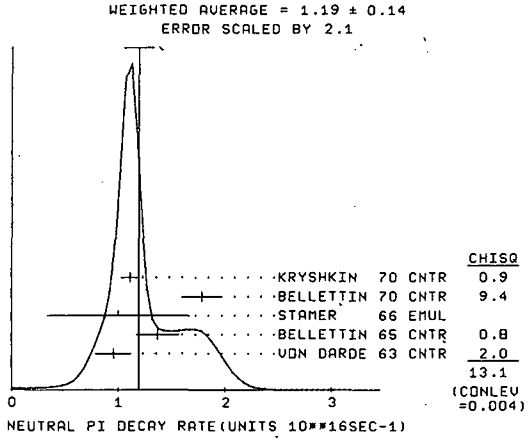


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                9  NEUTRAL PION PARTIAL DECAY MODES

                                                  DECAY MASSES
P1       PIO INTO 2GAMMA                           0+    0
P2       PIO INTO E+ E- GAMMA                     .5+   .5+    0
P3       PIO INTO 4ELECTRONS                      .5+   .5+   .5+   .5
P4       PIO INTO 3 GAMMA                          0+    0+    0
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                9  NEUTRAL PION BRANCHING RATIOS

R1       PIO INTO (GAMMA E+ E-)/(2GAMMA) (PERCENT)          (P2)/(P1)
R1            (1.196)   THEORET. CALC.   JOSEPH    60      QUANTUM ELECT.   9/66
R1        27   1.17      0.15            BUDAGOV   60 HBC
R1      3071   1.166     0.047           SAMIOS    61 HBC   PI-P TO PIO N
R1   S   SAMIOS VALUE USES PANOFSKY RATIO = 1.62
R1             . . . . . . . . .
R1   AVG       1.166     0.045   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

R2       PIO INTO (3 GAMMA)/(2 GAMMA) (UNITS 10**-6)        (P4)/(P1)
R2         0   5.0    OR LESS  CL=.90    DUCLOS    65 CNTR                6/66
R2             5.0    OR LESS  CL=.90    KUTIN     65 CNTR                3/68

R3       PIO INTO (E+E+E-E-)/(2 GAMMA) (UNITS 10**-5)       (P3)/(P1)
R3            (3.47)   THEORETICAL CAL. KROLL     55       QUANTUM ELECT.   9/66
R3       146   3.18      0.30            SAMIOS    62 HBC   SEE NOTE N BELOW 6/66
R3   N   ABOVE VALUE USES PANOFSKY RATIO = 1.62

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Stable Particles

π^0, $K^\pm$

REFERENCES FOR NEUTRAL PION


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PANOFSKY 51 PR    81  565      W K H PANOFSKY,R L AANODT,J HADLEY       (LRL)
CHINOWSK 54 PR    93  586      W CHINOWSKY,J STEINBERGER           (COLUMBIA)
KROLL    55 PR 98 1355         N KROLL ,W WADA                 (COLUMBIA+NRL)
CASSELS  59 PPS   74   92      CASSELS,JONES,MURPHY,O.NEILL       (LIVERPOOL)
HADDOCK  59 PRL    3  478      HADDOCK,ABASHIAN,CROWE,CZIRR             (LRL)
HILLMAN  59 NC    14  887      HILLMAN,MIDDELKOOP,YAMAGATA,ZAVATTINI(CERN)

BUDAGOV  60 JETP 11  755       BUDAGOV,VIKTOR,DZHELEPOV,ERMOLOV +     (JINR)
JOSEPH   60 NC 16 997          D W JOSEPH                               (EFI)
SAMIOS   60 NC 18 154          N P SAMIOS                          (COLUMBIA)
GLASSER  61 PR  123 1014       R G GLASSER,N SEEMAN,B STILLER           (NRL)
SAMIOS   61 PR  121  275       N P SAMIOS                      (COLUMBIA+BNL)
SAMIOS   62 PR 126 1844        SAMIOS,PLANO,PRODELL +          (COLUMBIA+BNL)
TIETGE   62 PR  127 1324       J TIETGE,W PUESCHEL           (MAX PLANCK INST)

CZIRR    63 PR  130  341       JOHN B CZIRR                             (LRL)
KOLLER   63 NC   27 1405       E L KOLLER,S TAYLOR,T HUETTER       (STEVENS)
    ALSO 66 STAMER
PETRUKHI 63 SIENA CONF 208     V I PETRUKHIN,YU D PROKOSHKIN           (JINR)
VON DARD 63 PL     4   51      VON DARDEL,DEKKERS,MERMOD,VAN PUTTEN+(CERN)

SHWE     64 PR  1368 1839      H SHWE,F M SMITH,W H BARKAS              (LRL)
BELLETTI 65 NC 40 A 1139       BELLETTINI,BEMPORAD,BRACCINI+(PISA+FIRENZE)
DUCLOS   65 PL 19 253          DUCLOS,FREYTAG,HEINTZE +  (CERN+HEIDELBERG)
EVANS    65 PR 139 B 982       D A EVANS                             (OXFORD)
KUTIN    65 JETP LETT 2 243    KUTIN,PETRUKHIN,PROKOSHKIN               (JINR)

STAMER   66 PR 151  1108       STAMER,TAYLOR,KOLLER,HUETTER+       (STEVENS)
VASILEVS 66 PL  23  281        VASILEVSKY,VISHNYAKOV,DUNAITSEV +     (DUBNA)
BELLETTI 70 NC 66A 243         BELLETTINI,BEMPORAD,LUBELSMEY+   (PISA+BONN)
KRYSHKIN 70 JETP 30 1037       +STERLIGOV,USOV        (TOMSK POLYTECH.INST.)
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$K^\pm$

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                 10  CHARGED K (494,JP=0-) I=1/2
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                 10  CHARGED K MASS (MEV)

M             493.9      0.2            COHEN     57 RVUE +
M             493.7      0.3            BARKAS    63 EMUL  -
M             493.78     0.17           GREINER   65 EMUL +   VIA TAU DECAY    7/66
M             493.87     0.19           KUNSELMAN 71 CNTR  - KAONIC ATOMS     10/71
M             493.691    0.040          BACKENSTO 73 CNTR-- KAONIC ATOMS       1/73*
M             . . . . . . . . . .
M    AVG      493.709    0.037   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
M    FIT      493.715    0.037  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)  1/73*
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                 10  (K+) - (K-) MASS DIFFERENCE (MEV)

DM F  1.5M   -0.032     0.090           FORD      72 ASPK +-                   4/72*
DM F     FORD 72 USES M(PI+)-M(PI-) = +28+-70 KEV.                            1/73*
------ --------- --------- --------- --------- --------- --------- --------

                 10  CHARGED K MEAN LIFE (UNITS 10**-8)

T          CHAR. K MEAN LIFE
T    O          (0.95)    (0.36)    (0.25) ILOFF      56 EMUL
T    O   52     (1.60)    (0.3)     (0.3)  EISENBERG  58 EMUL
T                1.21      0.06      0.06  BURROWES   59 CNTR
T    O   33     (1.38)    (0.24)    (0.24) FREDEN     60 EMUL
T    O          (1.25)    (0.22)    (0.17) BARKAS     61 EMUL
T    O   51     (1.27)    (0.36)    (0.23) BHOWMIK    61 EMUL
T       293      1.31      0.08      0.08  NORDIN     61 HBC   -
T               (1.24)    (0.07)           NORDIN     61 RVUE  -
T                1.231     0.011     0.011 BOYARSKI   62 CNTR +
T                1.2443    0.0038          FITCH      65 CNTR +  K AT REST        6/66
T                1.221     0.011           FORD       67 CNTR +-                 8/67
T                1.2272    0.0036          LOBKOWICZ  69 CNTR +  K IN FLIGHT     9/66
T        3M      1.2380    0.0016          OTT        71 CNTR  +  STOPPING  K    2/71
T    O  OLD EXPERIMENTS WITH LARGE ERRORS EXCLUDED FROM AVERAGING                 2/71
T             . . . . . . . . . .
T    AVG         1.2370    0.0032    0.0032 AVERAGE (ERROR INCL. SCALE FACTOR OF 2.4)
T    FIT         1.2371    0.0026 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.9)
                           (SEE IDEOGRAM BELOW )
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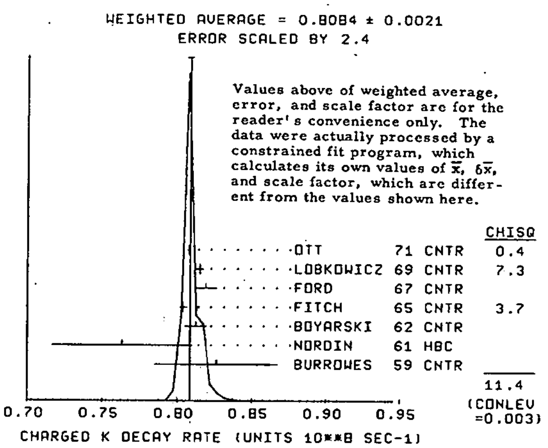


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                 10 '((K+) - (K-))/AVG., MEAN LIFE DIFFERENCE (PERCENT)

DT   N   THIS QUANTITY IS A MEASURE OF CPT INVARIANCE IN W.I.

DT             0.47      0.30             FORD       67 CNTR                      8/67
DT             0.090     0.078            LOBKOWICZ  69 CNTR                     12/70
DT             . . . . . . . . . .
DT   AVG       0.114     0.093    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.2)
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                 10  CHARGED K PARTIAL DECAY MODES

                                                                DECAY MASSES
P1      CHAR. K INTO MU NEU                   K MU2            105+   0
P2      CHAR. K INTO PI PIO                   K PI2            139+ 134
P3      CHAR. K INTO PI PI+ PI-               TAU              139+ 139+ 139
P4      CHAR. K INTO PI 2PIO                  TAU PRIME        139+ 134+ 134
P5      CHAR. K INTO MU PIO NEU               K MU3            105+ 134+   0
P6      CHAR. K INTO E PIO NEU                K E3              .5+ 134+   0
P7      K+ INTO PI+ PI- E+ NEU                K E+ 4           139+ 139+  .5+   0
P8      K+ INTO PI+ PI+ E- NEU                K E- 4           139+ 139+  .5+   0
P9      K+ INTO PI+ PI- MU+ NEU               K+MU+ 4          139+ 139+ 105+   0
P10     K+ INTO PI+ PI+ MU- NEU               K+MU- 4          139+ 139+ 105+   0
P11     CHAR. K INTO E NEU                    K E2              .5+   0
P12     CHAR. K INTO MU NEU GAMMA             K MU RAD         105+   0+   0
P13     CHAR. K INTO PI PIO GAMMA             K PI RAD         139+ 134+   0
P14     CHAR. K INTO PI PI+ PI- GAMMA         TAU RAD          139+ 139+ 139+   0
P15     CHAR. K INTO PI E+ E-                 PI E E           139+  .5+  .5
P16     CHAR. K INTO PI MU+ MU-               PI MU MU         139+ 105+ 105
P17     CHAR. K INTO PI GAMMA GAMMA           PI GAM GAM       139+   0+   0
P18     CHAR. K INTO PI E NEUTRINO GAMMA      PI E NEU GAM     139+  .5+   0+   0
P19     K- INTO PI+ E- E-                     PI+E-E-          139+  .5+  .5
P20     CHAR. K INTO PI NEU NEU               PI NEU NEU       139+   0+   0
P21     CHAR. K INTO E NEU GAMMA              K E2 RAD          .5+   0+   0
P22     CHAR. K INTO PI GAMMA                 K PI GAM         139+   0
P23     CHAR. K INTO PI 3GAMMA                PI 3GAM          139+   0+   0+   0
P24     CHAR. K INTO PIO PIO E NEU            K E4 2PIO        134+ 134+  .5+   0
P25     K+ INTO PI- E+ MU+                    PI-E+MU+         139+  .5+ 105
P26     K+ INTO PI+ E+ MU-                    PI+E+MU-         139+  .5+ 105
P27     CHAR. K INTO MU NEU NEU NEUBAR        MU 3NEU          105+   0+   0+   0
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                   CHARGED K CONSTRAINED FIT
          OVERALL FIT OF MEAN LIFE, WIDTHS AND BRANCHING
          RATIOS USES 52 DATA POINTS TO DETERMINE SIX
          QUANTITIES.  OVERALL FIT HAS  CHISQ=82.2.  MAIN
          CONTRIBUTION (16.3) COMES FROM R19 OF HAIDT
          71 (WE SEE NO REASON TO REJECT THIS EXPERIMENT
          AT THIS TIME)
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FITTED PARTIAL DECAY MODE BRANCHING FRACTIONS

The matrix below is derived from the error matrix for the fitted partial decay mode branching fractions, P_i, as follows: The diagonal elements are $P_i \pm \delta P_i$, where $\delta P_i = \sqrt{\langle \delta P_i \delta P_i \rangle}$, while the off-diagonal elements are the normalized correlation coefficients $\langle \delta P_i \delta P_j \rangle / (\delta P_i \cdot \delta P_j)$. For the definitions of the individual P_i, see the listings above; only those P_i appearing in the matrix are assumed in the fit to be nonzero and are thus constrained to add to 1.

	P 1	P 2	P 3	P 4	P 5	P 6
P 1	.6352+-.0019					
P 2	-.7953	.2106+-.0018				
P 3	-.1750	-.0694	.0559+-.0003			
P 4	-.1814	-.0728	.1456	.0173+-.0005		
P 5	-.2968	-.1830	.0439	-.0155	.0324+-.0010	
P 6	-.2852	-.1793	.1199	-.0085	.4265	.0485+-.0006

FITTED PARTIAL DECAY MODE RATES

The matrix below is the branching fraction matrix above, transformed into rate space; i.e., $G_i \equiv \Gamma_i = \Gamma_{total} P_i$, in appropriate units. In analogy to the matrix above, the diagonal elements are $G_i \pm \delta G_i$, where $\delta G_i = \sqrt{\langle \delta G_i \delta G_i \rangle}$, while the off-diagonal elements are the normalized correlation coefficients $\langle \delta G_i \delta G_j \rangle / (\delta G_i \cdot \delta G_j)$. Note that, because of the error in Γ_{total}, the errors and correlations here are not directly derivable from those above.

	G 1	G 2	G 3	G 4	G 5	G 6
G 1	.5135+-.0019					
G 2	-.4575	.1702+-.0015				
G 3	-.1104	-.0435	.0452+-.0002			
G 4	-.1284	-.0607	.1396	.0140+-.0004		
G 5	-.2040	-.1598	.0464	-.0142	.0262+-.0008	
G 6	-.1399	-.1299	.1207	-.0059	.4297	.0392+-.0005

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                 10  CHARGED K DECAY RATES

W1      CHAR. K INTO MU NEU (UNITS 10**6 SEC-1)          (G1)
W1           51.2      0.8              FORD       67 CNTR +-                     8/67
W1           . . . . . . . . . .
W1   FIT     51.35     0.19    FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.2)

W2      CHAR. K INTO PI PI+ PI- (UNITS 10**6 SEC-1)      (G3)
W2   F      (4.496)   (0.030)           FORD       67 CNTR +- SEE NOTE F         8/67
W2   F 3.2M (4.529)   (0.032)           FORD       70 ASPK    SEE NOTE F        11/70
W2           4.511     0.024            FORD       70 ASPK    SEE NOTE F        11/70
W2   F   THE LAST IS THE COMBINED RESULT OF FORD 67 AND FORD 70
W2           . . . . . . . . . .
W2   FIT     4.520     0.023   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)

W3      CHAR. K INTO (TAU) - (TAU PRIME) (UNITS 10**6 SEC-1)
W3                                                            (G3-G4)
W3       USED FOR DELTA I = 1/2 TEST.
W3           . . . . . . . . . .
W3   FIT     3.117     0.043   FROM FIT
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Data Card Listings

Stable Particles

For notation, see key at front of Listings.

$K^{\pm}$

W4 CHAR. K INTO (MU PIO NEU) + (E PIO NEU) (UNITS 10**6 SEC-1) (G5+G6)
W4 USED FOR DELTA I = 1/2 TEST.
W4 . . . .
W4 FIT 6.542 0.083 FROM FIT

10 ((K+) - (K-))/AVG., DECAY RATE DIFFERENCE (PERCENT)

D1 DIFFERENCE IN K MU2 RATES ((G1+)-(G1-))/G1 (PERCENT)
D1 -0.54 0.41 FORD 67 CNTR 8/67

D2 DIFFERENCE IN TAU RATES ((G3+)-(G3-))/G3 (PERCENT)
D2 -0.50 0.90 FLETCHER 67 OSPK 8/67
D2 F (-0.04) (0.21) FORD 67 CNTR SEE NOTE F 8/67
D2 F 3.2M (0.10) (0.14) FORD 70 ASPK SEE NOTE F 11/70
D2 0.08 0.12 FORD 70 ASPK SEE NOTE F 11/70
D2 F THE LAST IS THE COMBINED RESULT OF FORD 67 AND FORD 70
D2 . . . .
D2 AVG 0.07 0.12 AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

D3 DIFFERENCE IN TAU PRIME RATES ((G4+)-(G4-))/AVERAGE (PERCENT)
D3 1802 -1.1 1.8 HERZO 69 OSPK 5/70

D4 DIFFERENCE IN K PI2 RATES ((G2+)-(G2-))/AVERAGE (PERCENT)
D4 0.8 1.2 HERZO 69 OSPK 5/70

D5 DIFFERENCE IN K PI RAD RATES ((G13+)-(G13-))/AVERAGE (PERCENT)
D5 24 0.0 24.0 EDWARDS 72 OSPK PI+ KE 58-90 MEV 8/72*

10 CHARGED K BRANCHING RATIOS

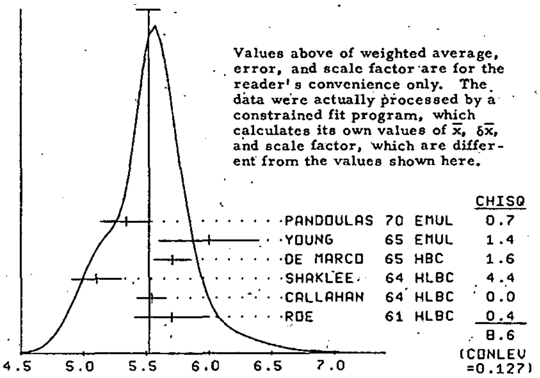
R O OLD DATA EXCLUDED

R1 CHAR. K INTO (MU NEU)/TOTAL (UNITS 10**-2) (P1)
R1 O (58.5) (3.0) BIRGE 56 EMUL +
R1 O (56.9) (2.6) ALEXANDER 57 EMUL +
R1 O OLD EXPERIMENTS NOT INCLUDED IN AVERAGING 1/71
R1 62K 63.24 0.44 CHIANG 72 OSPK + 1.84 GEV/C K+ 9/72*
R1 . . . .
R1 FIT 63.52 0.19 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R2 CHAR. K INTO (PI PIO)/TOTAL (UNITS 10**-2) (P2)
R2 O (27.7) (2.7) BIRGE 56 EMUL +
R2 O (23.2) (2.2) ALEXANDER 57 EMUL +
R2 O EARLIER EXPERIMENTS NOT AVERAGED
R2 (21.0) (0.6) CALLAHAN 65 HLBC SEE R17
R2 (21.6) (0.6) TRILLING 65 RVUE 6/66
R2 16K 21.18 0.28 CHIANG 72 OSPK + 1.84 GEV/C K+ 9/72*
R2 . . . .
R2 FIT 21.06 0.18 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)

R3 CHAR. K INTO (PI PI+ PI-)/TOTAL (UNITS 10**-2) (P3)
R3 O (5.6) (0.4) BIRGE 56 EMUL +
R3 O (6.8) (0.4) ALEXANDER 57 EMUL +
R3 O (5.2) (0.3) TAYLOR 59 EMUL +
R3 O EARLIER EXPERIMENTS NOT AVERAGED
R3 5.7 0.3 ROE 61 HLBC + 9/66
R3 2332 5.54 0.12 CALLAHAN 64 HLBC +
R3 540 5.1 0.2 SHAKLEE 64 HLBC + 9/66
R3 5.71 0.15 DE MARCO 65 HBC 6/66
R3 44 6.0 0.4 YOUNG 65 EMUL + 6/66
R3 P 693 5.34 0.21 PANDOULAS 70 EMUL + 10/70
R3 C 2330 (5.56) (0.20) CHIANG 72 OSPK + 1.84 GEV/C K+ 9/72*
R3 C THIS VALUE IS NOT INDEPENDENT OF CHIANG 72 R1,R2,R4,R5, AND R6 9/72*
R3 P INCLUDES EVENTS OF TAYLOR 59.
R3 . . . .
R3 AVG 5.521 0.098 AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.3)
R3 FIT 5.591 0.030 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)
(SEE IDEOGRAM BELOW)

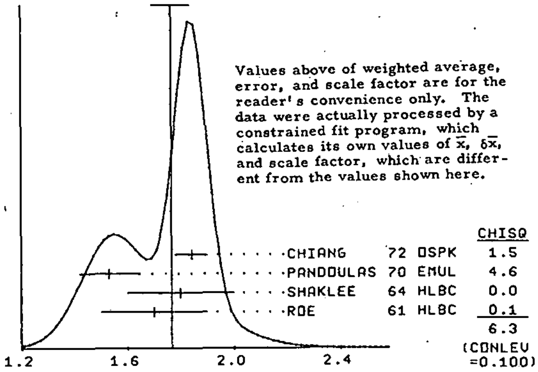
WEIGHTED AVERAGE = 5.521 ± 0.098
ERROR SCALED BY 1.3



CHAR.K TO (PI PI+ PI-)/TOTAL (UN 10**-2)

R4 CHAR. K INTO (PI 2PIO)/TOTAL (UNITS 10**-2) (P4)
R4 O (2.1) (0.5) BIRGE 56 EMUL +
R4 O (2.2) (0.4) ALEXANDER 57 EMUL +
R4 O (1.5) (0.2) TAYLOR 59 EMUL +
R4 O EARLIER EXPERIMENTS NOT AVERAGED
R4 1.7 0.2 ROE 61 HLBC + 11/67
R4 108 1.8 0.2 SHAKLEE 64 HLBC + 11/67
R4 P 198 1.53 0.11 PANDOULAS 70 EMUL + 10/70
R4 1307 1.84 0.06 CHIANG 72 OSPK + 1.84 GEV/C K+ 9/72*
R4 P INCLUDES EVENTS OF TAYLOR 59.
R4 . . . .
R4 AVG 1.767 0.071 AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.4)
R4 FIT 1.735 0.049 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.4)
(SEE IDEOGRAM BELOW)

WEIGHTED AVERAGE = 1.767 ± 0.071
ERROR SCALED BY 1.4



CHAR. K INTO (PI 2PIO)/TOTAL (UN 10**-2)

R5 CHAR. K INTO (MU PIO NEU)/TOTAL (UNITS 10**-2) (P5)
R5 O (2.8) (1.0) BIRGE 56 EMUL +
R5 O (5.9) (1.3) ALEXANDER 57 EMUL +
R5 O (2.8) (0.4) TAYLOR 59 EMUL +
R5 O EARLIER EXPERIMENTS NOT AVERAGED
R5 2345 3.33 0.16 CHIANG 72 OSPK + 1.84 GEV/C K+ 9/72*
R5 . . . .
R5 FIT 3.24 0.10 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.9)

R6 CHAR. K INTO (E PIO NEU)/TOTAL (UNITS 10**-2) (P6)
R6 O (3.2) (1.3) BIRGE 56 EMUL +
R6 O (5.1) (1.3) ALEXANDER 57 EMUL +
R6 O EARLIER EXPERIMENTS NOT AVERAGED
R6 5.0 0.5 ROE 61 HLBC + 11/67
R6 429 4.7 0.3 SHAKLEE 64 HLBC + 11/67
R6 3516 4.86 0.10 CHIANG 72 OSPK + 1.84 GEV/C K+ 9/72*
R6 . . . .
R6 AVG 4.849 0.093 AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R6 FIT 4.851 0.055 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)

R7 CHAR. K INTO (PI2 + MU3)/TOTAL (UNITS 10**-2) (P2+P5) 11/67
R7 WE COMBINE THESE TWO MODES FOR EXPTS MEASURING THEM IN XENON BC
R7 BECAUSE OF DIFFICULTIES OF SEPARATING THEM THERE
R7 23.4 1.1 ROE 61 HLBC + 11/67
R7 886 25.4 0.9 SHAKLEE 64 HLBC + 11/67
R7 . . . .
R7 AVG 24.60 0.98 AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.4)
R7 FIT 24.30 0.19 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)

R8 K+ INTO (PI+ PI+ E- NEU)/TOTAL (UNITS 10**-7) (P8)
R8 20. OR LESS CL=.95 BIRGE 65 FBC + 8/66
R8 0 6.9 OR LESS CL=.95 ELY 69 HLBC + 10/69
R8 0 9.0 OR LESS CL=.95 SCHWEINBE 71 HLBC + 9/71

R9 K+ INTO (PI+ PI- MU+ NEU)/TOTAL (UNITS 10**-5) (P9)
R9 1 0.77 0.54 0.50 CLINE 65 FBC + 8/66

R10 K+ INTO (PI+ PI+ MU- NEU)/TOTAL (UNITS 10**-6) (P10)
R10 0 3.0 OR LESS CL=.95 BIRGE 65 FBC + 8/66

R11 CHAR. K INTO (E NEU)/TOTAL (UNITS 10**-5) (P11)
R11 160.0 OR LESS CL=.95 BORREANI 64 HBC + 11/67
R11 4 2.1 1.8 -1.3 BOWEN 67 OSPK + 8/67
R11 BOWEN RESULT SHOULD BE CORRECTED TO 1.9(+1.7,-1.2) BECAUSE OF
R11 K+ TO E+ NEU GAMMA DECAYS BEFORE COMPARING WITH BOTTERILL 67 R28

R12 CHAR. K INTO (PI GAMMA GAMMA)/TOTAL (UNITS 10**-4)
R12 (P17)
R12 ALL VALUES GIVEN HERE ASSUME A PHASE SPACE PION ENERGY SPECTRUM 2/72
R12 1.1 OR LESS CL=.95 CHEN 68 OSPK + T(PI) 60-90 MEV 5/68
R12 0.5 OR LESS CL=.90 KLEMS 71 OSPK + T(PI)GT 117 MEV 8/71
R12 0 0.35 OR LESS CL=.90 LJUNG 72 HLBC + 6-102,114-127MEV 2/72

R13 CHAR. K INTO (PI PIO GAMMA)/TOTAL (UNITS 10**-4) (P13)
R13 18 2.2 0.7 CLINE 64 FBC + PI+ KE 55-80 MEV 8/66
R13 0 1.9 OR LESS CL=.90 EMMERSON 69 OSPK PI+ KE 55-80-MEV 10/69
R13 A2100 2.71 0.19 ABRAMS 72 ASPK + PI+ KE 55-90 MEV 1/73*
R13 24 2.4 0.8 EDWARDS 72 OSPK PI+ KE 58-90 MEV 8/72*
R13 A ABRAMS 72 OBSERVES DIRECT EMISSION BR. RATIO OF (1.56+-0.35)*10**-5 1/73*
R13 A +-0.5*10**-5 ADDNL. SYST. ERROR AND INNER BREMSSTRAHLUNG BR. RATIO 1/73*
R13 A OF (2.55+-0.18)*10**-4. WE QUOTE THE SUM OF THESE BR. RATIOS. 1/73*
R13 . . . .
R13 AVG 2.66 0.18 AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

R14 CHAR. K INTO (PI PI+ PI- GAMMA)/TOTAL (UNITS 10**-4)
R14 (P14)
R14 1.0 0.4 STAMER 65 EMUL + EGAM GT 11MEV 8/66

R15 CHAR. K INTO (PI E+ E-)/TOTAL (UNITS 10**-6) (P15)
R15 1 2.45 OR LESS CL=.90 CAMERINI 64 FBC + 8/66
R15 4.4 OR LESS CL=.90 BISI 67 DBC + 11/67
R15 0.4 OR LESS CLINE 67 FBC + 11/67
R15 32.0 OR LESS CL=.90 BEIER 72 OSPK +- 9/72*

R16 CHAR. K INTO (PI MU+ MU-)/TOTAL (UNITS 10**-6) (P16)
R16 3.0 OR LESS CL=.90 CAMERINI 65 FBC + 8/66
R16 2.4 OR LESS CL=.90 BISI 67 DBC + 11/67

R17 CHAR. K INTO (E PIO NEU)/(MU2+PI2) (UNITS 10**-2)(P6)/(P1+P2)
R17 134 3.24 0.34 YOUNG 65 EMUL + 8/66
R17 1045 3.96 0.15 CALLAHAN 66 FBC + 9/66
R17 . . . .
R17 AVG 3.84 0.27 AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.9)
R17 FIT 3.767 0.040 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)

Stable Particles

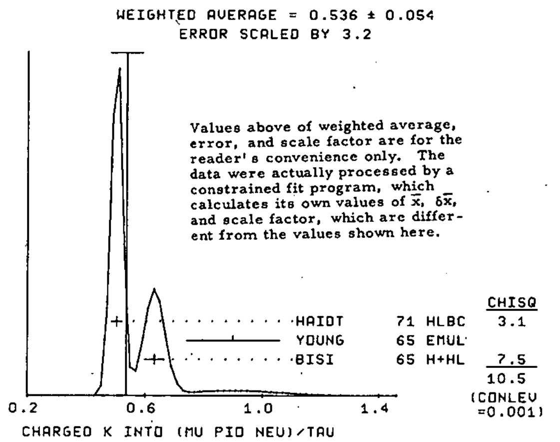
$K^{\pm}$

Data Card Listings

For notation, see key at front of Listings.

```
R18     CHAR. K INTO (PI 2PIO)/TAU                            (P4)/(P3)
R18    2027     0.303     0.009            BISI        65 H+HL +                  8/66
R18      17     0.393     0.099            YOUNG       65 EMUL +                  8/66
R18             . . . . . . . . .
R18 AVG         0.3037    0.0090  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R18 FIT         0.3103    0.0087 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.4)

R19     CHAR. K INTO (MU PIO NEU)/TAU                         (P5)/(P3)
R19    2175     0.632     0.035            BISI        65 H+HL +                  8/66
R19      38     0.90      0.16             YOUNG       65 EMUL +                  8/66
R19 H 1505     (0.510)   (0.017)           EICHTEN     68 HLBC +                 11/68
R19  H1505      0.503     0.019            HAIDT       71 HLBC +                 12/70
R19  H  HAIDT 71 IS A REANALYSIS OF EICHTEN 68.
R19             . . . . . . . . .
R19 AVG         0.536     0.054   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 3.2)
R19 FIT         0.580     0.018   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.9)
                                  (SEE IDEOGRAM BELOW )
```

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R20     CHAR. K INTO (E PIO NEU)/TAU                          (P6)/(P3)
R20     230     0.90      0.06             BORREANI    64 HBC  +                  8/66
R20      37     0.90      0.16             YOUNG       65 EMUL +                  8/66
R20     854     0.94      0.09             BELLOTT2    67 HLBC                   11/67
R20 H 4385     (0.846)   (0.021)           EICHTEN     68 HLBC +                 11/68
R20  H4385      0.850     0.019            HAIDT       71 HLBC +                 12/70
R20  H  HAIDT 71 IS A REANALYSIS OF EICHTEN 68.
R20             . . . . . . . . .
R20 AVG         0.858     0.018   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R20 FIT         0.868     0.010  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)

R21     K+ INTO (PI+ PI- E+ NEU)/TAU (UNITS 10**-4)           (P7)/(P3)
R21      69     6.7       1.5              BIRGE       65 FBC  +                  8/66
R21     269     5.83      0.63             ELY         69 HLBC +                 11/68
R21     500     7.36      0.68             BOURQUIN    71 ASPK                   12/71
R21     106     7.0       0.9              SCHWEINBE  71 HLBC +                   9/71
R21             . . . . . . . . .
R21 AVG         6.64      0.40    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

R22     K+ INTO (PI+ PI- MU+ NEU)/TAU (UNITS 10**-4)          (P9)/(P3)
R22       1    (2.5)   APPROX              GREINER     64 EMUL +                  8/66
R22       7     2.57      1.55             BISI        67 DBC  +                 11/67

R23     CHAR. K INTO (E PIO NEU)/(MU2+PI2) (UNITS 10**-2)(P6)/(P1+P2)
R23    1679     5.89      0.21             CESTER      66 OSPK +                  8/67
R23    5110     6.16      0.22             ESCHSTRUT  68 OSPK +                   3/68
R23             . . . . . . . . .
R23 AVG         6.02      0.15    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R23 FIT         5.736     0.064  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R24     CHAR. K INTO (PI PIO)/(MU NEU)                        (P2)/(P1)
R24             0.3253    0.0065           AUERBACH    67 OSPK +                  8/67
R24    1600     0.305     0.018            ZELLER      69 ASPK +                 10/69
R24             . . . . . . . . .
R24 AVG         0.3230    0.0065  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.1)
R24 FIT         0.3316    0.0037 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R25     CHAR. K INTO (E PIO NEU)/(MU NEU)                     (P6)/(P1)
R25     472     0.0797    0.0054           AUERBACH    67 OSPK +                  8/67
R25      THE VALUE .0785+-.0025 GIVEN IN THE ABOVE REF IS AN AVERAGE OF
R25      AUERBACH 67 R25 AND CESTER 66 R23.
R25     960     .0775     .0033            BOTTERI1    68 ASPK +                  5/68
R25     561     0.069     0.006            GARLAND     68 OSPK +                  4/68
R25     350     0.069     0.006            ZELLER      69 ASPK +                 10/69
R25             . . . . . . . . .
R25 AVG         0.0753    0.0025  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.1)
R25 FIT         0.07638   0.00085 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R26     CHAR. K INTO (MU PIO NEU)/(MU NEU)                    (P5)/(P1)
R26     310     0.0602    0.0046           AUERBACH    67 OSPK +                  8/67
R26     424     0.055     0.004            GARLAND     68 OSPK +                  4/68
R26     240     0.054     0.009            ZELLER      69 ASPK +                 10/69
R26             . . . . . . . . .
R26 AVG         0.0569    0.0029  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R26 FIT         0.0510    0.0016 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.9)

R27     CHAR. K INTO (MU NEU)/TAU                             (P1)/(P3)
R27 R   427    (10.38)   (0.82)            YOUNG       65 EMUL +                  9/66
R27 R    DELETED FROM OVERALL FIT BECAUSE YOUNG 65 CONSTRAINS HIS RESULTS.
R27 R    TO ADD UP TO 1.  ONLY YOUNG MEASURED MU2 DIRECTLY.
R27             . . . . . . . . .
R27 FIT        11.361     0.075  FROM FIT

R28     CHAR. K INTO (E NEU)/(MU NEU) (UNITS 10**-5)          (P11)/(P1)
R28      10     1.9       0.7       0.5    BOTTERILL 67 ASPK +                   11/67
R28       8     1.8       0.8       0.6    MACEK       69 ASPK +                  4/69
R28     113     2.42      0.42             CLARK       72 OSPK +                  1/73*
R28             . . . . . . . . .
R28 AVG         2.16      0.31    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

R29     CHAR. K INTO (MU PIO NEU)/(E PIO NEU)                 (P5)/(P6)
R29  C1509      0.703     0.056            CALLAHA1    66 HLBC                    6/68
R29   5601      0.667     0.017            BOTTERI2    68 ASPK +                  6/68
R29 A 1398     (0.604)   (0.022)           EICHTEN     68 HLBC                   10/68
R29 AH         (0.596)   (0.025)           HAIDT       71 HLBC +                 12/70
R29  D3480      0.698     0.025            CHIANG      72 OSPK +  1.84 GEV/C K+   9/72*
R29                          COMMENTS
R29  D  THIS VALUE IS STATISTICALLY INDEPENDENT OF CHIANG 72 R5 AND R6.           9/72*
R29  H  HAIDT 71 IS A REANALYSIS OF EICHTEN 68.
R29 A   ONLY INDIVIDUAL RATIOS INCLUDED IN FIT (SEE R19 AND R20).                11/68
R29  C  FROM THIS EXPERIMENT WE USE ONLY THE MU3/E3 RATIO AND DO NOT
R29  C  INCLUDE IN THE FIT THE RATIOS MU3/TAU AND E3/TAU, SINCE THEY SHOW
R29  C  LARGE DISAGREEMENTS WITH THE REST OF THE DATA.
R29             . . . . . . . . .
R29 AVG         0.678     0.014   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R29 FIT         0.668     0.024  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 2.2)

R30     CHAR. K INTO (PI E NEU GAMMA)/(PI E NEU)              (P18)/(P6)
R30 R          (0.012)   (0.008)           BELLOTT1    67 HLBC +  EGAM GT 30MEV  11/67
R30  R  13      0.0076    0.0028           ROMANO      71 HLBC    EGAM GT 10MEV  10/71
R30 R   WE USE LOWEST E(GAMMA) CUT.SEE ROMANO 71 FOR DEPENDENCE ON THIS CUT       2/72

R31     K- INTO (PI+ E- E-)/TOTAL (UNITS 10**-5)              (P19)
R31      TEST OF LEPTON NUMBER CONSERVATION.
R31            (1.5)  OR LESS              CHANG       68 HBC  -                  3/68

R32     CHAR. K INTO (PI NEU NEU)/TOTAL (UNITS 10**-6)        (P20)
R32         (100.0)  OR LESS  CL=.90       CAMERINI    69 HLBC +  TEST NEUTR.CURR. 5/70
R32  K          1.4   OR LESS  CL=.90      KLEMS       71 OSPK +  T(PI) GT 117 MEV 8/71
R32  K  ASSUMES PI+ SPECTRUM SAME AS PIO SPECTRUM IN KE3 DECAY

R33     CHAR. K INTO (E NEU GAMMA)/TOTAL UNITS 10**-5)        (P21)
R33  M         (7.1)  OR LESS              MACEK       70 OSPK +  P(E) 234 TO 247  12/70
R33  M  ABOVE IS MEASUREMENT OF STRUCTURE-DEPENDENT DECAY ONLY.

R34     CHAR. K INTO (PI GAMMA)/TOTAL (UNITS 10**-6)          (P22)
R34             4.0   OR LESS  CL=.90      KLEMS       71 OSPK +                  8/71

R35     CHAR. K INTO (TAU)/(TAU PRIME)                        (P3/P4)
R35      USED FOR DELTA I=1/2 TEST.
R35             . . . . . . . . .
R35 FIT         3.223     0.090   FROM FIT

R36     CHAR. K INTO (PI 3GAMMA)/TOTAL (UNITS 10**-4)         (P23)
R36             3.0   OR LESS  CL=.90      KLEMS       71 OSPK +  T(PI) GT 117MEV  8/71

R37     K+ INTO (PI+ PI+ E- NEU)/(PI+ PI- E+ NEU)             (P8)/(P7)         2/72
R37       0     0.013 OR LESS  CL=.95      BOURQUIN    71 ASPK                   12/71

R38     CHAR. K INTO (PIO PIO E NEU)/KE3 (UNITS 10**-4)       (P24)/(P6)
R38       0    37.0   OR LESS  CL=.90      ROMANO      71 HLBC +                 12/71
R38       2     3.8       5.1       1.3    CLINE       72 HLBC +                  2/72

R39     K+ INTO (PI- E+ MU+)/TOTAL (UNITS 10**-8)             (P25)
R39     K- INTO (PI+ E- MU-)/TOTAL IS ALSO INCLUDED HERE
R39             2.8   OR LESS  CL=.90      BEIER       72 OSPK +-                 9/72*

R40     K+ INTO (PI+ E+ MU-)/TOTAL (UNITS 10**-8)             (P26)
R40     K- INTO (PI- E- MU+)/TOTAL IS ALSO INCLUDED HERE
R40             1.4   OR LESS  CL=.90      BEIER       72 OSPK +-                 9/72*

R41     CHAR. K INTO (MU 3NEU)/TOTAL (UNITS 10**-6)           (P27)
R41             7.0   OR LESS  CL=.90      CABLE       72 CNTR +                 10/72*
```

Note on Slope Parameter for $K\to 3\pi$ Decays

As was discussed in Section IV F. 1 of the text, for the 3π decays of the K mesons we list the slope parameter "g" which is defined, as in that section, by

$$|M|^2 \propto 1 + g\,\frac{(s_3-s_0)}{m_{\pi^+}^2} + h\left(\frac{s_3-s_0}{m_{\pi^+}^2}\right)^2 + j\,\frac{(s_2-s_1)}{m_{\pi^+}^2} \quad (1)$$

where

$$s_i = (\underline{p}_K - \underline{p}_i)^2 = (m_K - m_i)^2 - 2\,m_K T_i \quad (2)$$

$$s_0 = \tfrac{1}{3}\sum s_i = \tfrac{1}{3}(m_K^2 + m_1^2 + m_2^2 + m_3^2) \quad (3)$$

$\underline{p}_K, \underline{p}_i$ are the four-vectors for the K and the i^{th} pion, and the index 3 refers to the odd pion. (4)

We refer to the three possible charged decays as τ, τ', τ^0

Data Card Listings

For notation, see key at front of Listings.

Stable Particles

$K^\pm$

$\tau^\pm$	$K^\pm \to \pi^+\pi^-\pi^\pm$
$\tau'^\pm$	$K^\pm \to \pi^0\pi^0\pi^\pm$
τ^0	$K_2^0 \to \pi^+\pi^-\pi^0$

where the odd pion is the third one.

There is no strong evidence so far that a second order term in (s_3-s_0) is needed in Eq. (1), nor that the term in (s_2-s_1) is present. A value of $j \neq 0$ indicates CP violation as would a value of g for τ^+ different from that for τ^-. The CP violation tests in τ decays are listed as $\frac{(g^+-g^-)}{(g^++g^-)}$ for charged K and as $\sigma^\pm$ for neutral K (see Sec. IV F. 3b in the text).

As for the coefficient h, most of the experimenters have fitted their data with a second order term, which turned out to be consistent with zero. We use the value of g obtained when the second order term was dropped from the fit. HEUSSE 70 have studied the $K_L^0 \to \pi^0\pi^0\pi^0$ decay where only a second order term could explain deviation from uniformity of the Dalitz plot. They also get results consistent with a zero coefficient. ALBROW 70 have studied $K_L^0 \to \pi^+\pi^-\pi^0$ and found that the fit to the Dalitz plot improves if second and third order terms are added (CL goes from 24% to 48%), but the fit with no higher orders is a perfectly acceptable one (CL = 24%). FORD 72 have studied $K^\pm \to \pi^\pm\pi^\mp\pi^\pm$ and find that the χ^2/DF goes from 1.38 to 1.20 when the second order and the CP violation terms are added. However, the authors state that since their Coulomb correction is larger than the experimental errors and is not well known, it is difficult to interpret these results.

In the literature other definitions of slope parameters have appeared. We have converted to the definition of g in Eq. (1) whatever experimental quantity has been reported. We give the conversion to the definition (1) for two of the most widely used parametrizations and tabulate the conversion factors for the reader's convenience.

(a) For analysis of charged K's the expression often used is:

$$|M|^2 = 1 + a_y Y$$

with

$$Y = \frac{3T_3 - Q}{Q}, \quad Q = m_K - \sum m_i .$$

The relevant formulae are:

$$Y = -\frac{3}{2}\,\frac{s_3-s_0}{m_K Q} + \Delta, \text{ with } \Delta = \frac{m_{12}-m_3}{Q}\left(2 - \frac{m_3+m_{12}}{m_K}\right)$$

and

$$\boxed{g = \frac{-c_y a_y}{1+a_y\Delta}}, \quad \text{with } c_y = \frac{3}{2}\,\frac{m_{\pi^+}^2}{m_K Q} .$$

(b) For the analysis of K^0 decay the expression often used is:

$$|M|^2 = 1 + 2a_t \frac{m_K}{m_{\pi^+}^2}(2T_3 - T_{3\,max})$$

with

$$T_{3\,max} = \frac{m_K^2 + m_3^2 - 4m_{12}^2}{2m_K} - m_3 .$$

The relevant transformations are

$$T_3 = -\frac{s_3-s_0}{2m_K} + \frac{Q}{3}(1+\Delta)$$

and

$$\boxed{g = \frac{-2a_t}{1+a_t c_t}}, \quad \text{with } c_t = \frac{2m_K}{m_{\pi^+}^2}\left[\frac{2}{3}Q(1+\Delta) - T_{3\,max}\right] .$$

For the reader's convenience we give a table of numerical values for Q, $T_{3\,max}$, Δ, c_y and c_t, obtained using the masses from our August 1970 edition. The g values quoted in these Data Card Listings would not be changed if the current mass values were used.

	Q	$T_{3\,max}$	Δ	c_y	c_t
$\tau^\pm$	74.96	48.15	0	0.7894	0.0924
$\tau'^\pm$	84.24	53.27	-0.0789	0.7025	-0.0778
τ^0	83.54	53.92	0.0798	0.7028	0.3176

Some K^0 authors use the above form of matrix element:

$$|M|^2 = 1 + 2a_u \frac{m_K}{m_{\pi^+}^2}(2T_3 - T_{3\,max}) ,$$

but define

$$T_{3\,max} = \frac{2}{3}Q .$$

The relevant transformation is then

Stable Particles
$K^{\pm}$

Data Card Listings
For notation, see key at front of Listings.

$$g = \frac{-2a_u}{1 + a_u c_u}, \text{ with } c_u = \frac{2m_K}{m_{\pi^+}^2} \Delta = 0.2272.$$

Older K^0 analyses were done using

$$|M|^2 = 1 + a_v \frac{T_3}{m_K}.$$

The relevant transformation is then

$$g = \frac{-c_v a_v}{1 + d_v a_v}$$

with

$$c_v = \frac{m_{\pi^+}^2}{2m_K^2} = 0.0393$$

and $d_v = \frac{Q}{3m_K}(1 + \Delta) = 0.0604.$

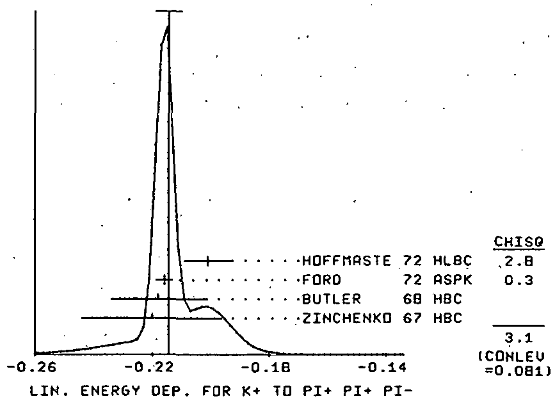
```
               10  CHARGED K ENERGY DEPENDENCE OF DALITZ PLOT

        RELATED TEXT SECTION IV F.1, APPENDIX I, AND MINI-REVIEW ABOVE

      MATRIX ELEMENT SQUARED =  1 + G (S3-S0)/(MPI+**2)

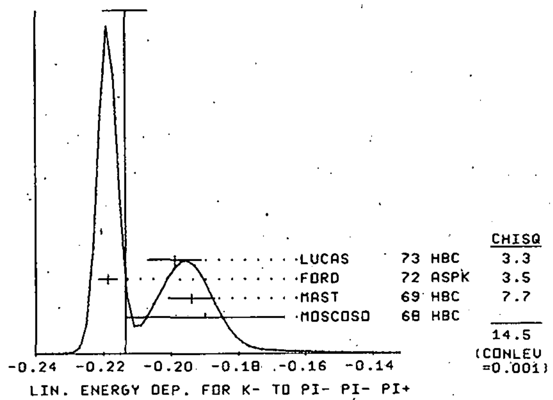
GT+  LINEAR ENERGY DEPENDENCE (G) FOR TAU DECAYS  K+ INTO PI+ PI+ PI-
GT+      THESE EXPTS FIT M**2=1+AY*Y. WE LIST G IN THE MAIN LISTING AND
GT+      GIVE AY AT RIGHT. G=-1.5*AY*(MPI**2)/(MK*Q). SEE NOTE ABOVE.
GT+Z  5428   -0.22     0.024            ZINCHENKO 67 HBC  +  AY=0.28+-.03      10/69
GT+   9994   -0.218    0.016            BUTLER    68 HBC  +  AY=0.277+-.020    10/69
GT+ G17898  (-0.196)  (0.012)           GRAUMAN   70 HLBC +  AY=0.228+-.030     8/70
GT+Q  750K   -0.2158   0.0028           FORD      72 ASPK +  AY=0.2734+-.0035   4/72*
GT+  39819   -0.201    0.008            HOFFMASTE 72 HLBC +  INCLUDES GRAUMAN   1/71
GT+ Q    THIS VALUE OF AY IS FROM A QUADRATIC FIT WITH Y**2 COEF=.030+-.010.   4/72*
GT+ Q    A LINEAR FIT IS QUOTED ONLY FOR THEIR COMBINED K+ AND K- SAMPLE.      4/72*
GT+ Q    IT GIVES AY=0.2737+-.0032 .  THE QUADRATIC FIT TO THE COMBINED        4/72*
GT+ Q    SAMPLE GIVES AY=0.2752+-.0033 AND Y**2 COEFF=0.025+-.010 .            4/72*
GT+ Q    (CHISQ/DF)=1.38 FOR LINEAR FIT AND 1.20 FOR QUADRATIC FIT.            1/73*
GT+ G    EMULS. DATA ADDED - ALL EVENTS INCLUDED BY HOFFMASTER 72              1/71
GT+ Z    ALSO INCLUDES DBC EVENTS.
GT+          . . . . . . . . .
GT+ AVG       -0.2144   0.0045  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.7)
                                (SEE IDEOGRAM BELOW )
```

WEIGHTED AVERAGE = -0.2144 ± 0.0045
ERROR SCALED BY 1.7




```
GT-  LINEAR ENERGY DEPENDENCE (G) FOR TAU DECAYS  K- INTO PI- PI- PI+
GT-      FOR DEFINITION OF AY SEE NOTE UNDER S10GT+.
GT- F 1347  (-0.220)  (0.035)           FERRO-LUZ 61 HBC  - AY=0.28+-.045      10/69
GT-M  5778   -0.190    0.023            MOSCOSO   68 HBC  - AY=0.242+-.029     10/69
GT-  50919   -0.194    0.007            MAST      69 HBC  - AY=0.247+-.009     10/69
GT-Q  750K   -0.2187   0.0028           FORD      72 ASPK - AY=0.2770+-.0035    4/72*
GT-    84K   -0.199    0.008            LUCAS     73 HBC  - AY=0.252+-.011     10/72*
GT- Q    THIS VALUE OF AY IS FROM A QUADRATIC FIT WITH Y**2 COEF=.020+-.010.   4/72*
GT- Q    SEE ALSO THE NOTE Q IN THE GT+ SECTION ABOVE.                         4/72*
GT- F    NO RADIATIVE CORRECTIONS INCLUDED.
GT- M    ALSO INCLUDES DBC EVENTS.
GT-          . . . . . . . . . .
GT- AVG       -0.2135   0.0066  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 2.7)
                                (SEE IDEOGRAM BELOW )
```

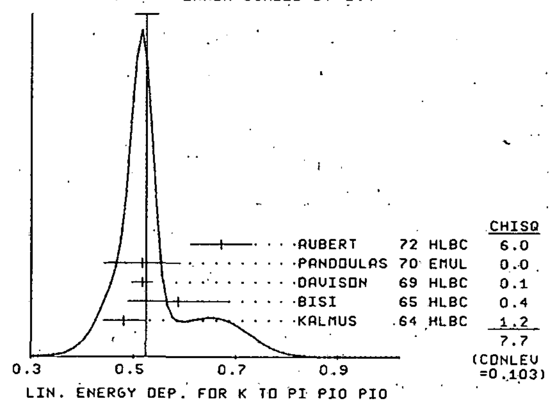
WEIGHTED AVERAGE = -0.2135 ± 0.0066
ERROR SCALED BY 2.7




```
DG   ((GT+)-(GT-))/((GT+)+(GT-)) IN PERCENT
DG        A NON-ZERO VALUE FOR THIS QUANTITY INDICATES CP VIOLATION
DG    3.2M   -0.70     0.53             FORD      70 ASPK                      11/70

GTP  LINEAR ENERGY DEPENDENCE (G) FOR TAU PRIME DECAY CHA.K INTO PI PIOPIO
GTP   1792    0.48     0.04             KALMUS    64 HLBC +                    10/69
GTP   1874    0.586    0.098            BISI      65 HLBC +  ALSO HBC          10/69
GTP   4048    0.516    0.020            DAVISON   69 HLBC +  ALSO EMUL         10/69
GTP    198    0.516    0.074            PANDOULAS 70 EMUL +                    10/70
GTP  A1365    0.67     0.06             AUBERT    72 HLBC                       1/73*
GTP  A  WE GIVE LINEAR TERM OF HIGHER ORDER FIT. EQ.I OF APP.II,AUBERT 72.      1/73*
GTP          . . . . . . . . .
GTP AVG        0.523    0.023   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.4)
                                (SEE IDEOGRAM BELOW )
```

WEIGHTED AVERAGE = 0.523 ± 0.023
ERROR SCALED BY 1.4



Note on K^+ and K^0 Form Factors

The definitions of the parameters λ_+, λ_-, and ξ can be found in Section IV F.2 of the text. Many approximations are usually made to extract these or related parameters from the experimental data.

1) Scalar and tensor currents: there is no evidence for scalar or tensor currents, so pure vector current is usually assumed.

2) Im ξ so far is consistent with 0, and this is usually assumed in most of the experiments.

3) Radiative corrections are not serious; they change λ_+ by about 0.005 (GINSBERG 67 and 70).

Data Card Listings

For notation, see key at front of Listings.

Stable Particles

$K^{\pm}$

4) Older $K_{\mu 3}$ experiments have determined ξ assuming $\lambda_+ = \lambda_0 = 0$.

5) Momentum transfer dependence of ξ: many $K_{\mu 3}$ experiments have determined ξ assuming a linear q^2 dependence for f_+, as in Eq. (27) of the main text. Some of these assume $\lambda_- = 0$ since there is no strong evidence for a non-zero λ_-. Others allow $\lambda_- \neq 0$ or equivalently $\Lambda \neq 0$ where

$$\xi(q^2) = \xi(0) + \Lambda \frac{q^2}{m_\pi^2} \quad .$$

Instead of λ_- or Λ, HAIDT 71 (K^+) gives $\xi(q^2)$ where q^2 is chosen to minimize the correlation with $\xi(0)$.

6) Most K_{e3} experiments have assumed a linear q^2 dependence for f_+.

Since it is now clear that $\lambda_+ \neq 0$, assumption-4 values of ξ are parenthesized. Assumption-5 values of ξ and λ_+ are encoded and any corresponding non-zero values of λ_- or Λ are given in footnotes. No attempt is made to average these ξ or λ_+ values because they are highly correlated.[1, 2] As in the past, we keep the values of ξ as obtained in the μ polarization measurements (ξ_B) separated from the values obtained from branching ratios and spectra (ξ_A).

Assumption-6 values of λ_+ (for K_{e3}) are encoded and averaged. There is some indication from CHIEN 71 (K^0_L) that a quadratic q^2 term may be required in f_+ for K_{e3}. Chounet, Gaillard, and Gaillard[2] further suggest that the large values of λ_+ in $K^0_{\mu 3}$ (compared with K^0_{e3}) could be explained by the presence of a second order term.

See references 1 and 2 for excellent reviews of $K_{\ell 3}$ form factors and for a thorough treatment of the problems of correlations, higher order terms, and alternative parametrizations.

References

1. M. K. Gaillard and L. M. Chounet, $K_{\ell 3}$ Form Factors, CERN 70-14 (May 1970), and Phys. Letters 32B, 505 (1970).

2. L. M. Chounet, J. M. Gaillard, and M. K. Gaillard, Physics Reports 4C, 199 (1972).

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                   10  CHARGED K FORM FACTORS                                8/67

        RELATED TEXT SECTION IV F.2 AND MINI-REVIEW ABOVE

           F+ AND F- ARE FORM FACTORS FOR THE VECTOR MATRIX ELEMENT
           FS AND FT REFER TO THE SCALAR AND TENSOR TERM

XIA      XIA = F-/F+ (DETERMINED FROM SPECTRA AND KMU3/KE3)   -------------
XIA       SOME OF THE OLDER EXPERIMENTS HAVE EVALUATED XI ASSUMING THAT IT IS
XIA       INDEPENDENT OF THE MOMENTUM TRANSFER (T), I.E., THEY SET L+=L-=0.
XIA       OTHERS HAVE ASSUMED A VALUE FOR L+ AND USED L-=0. ONLY RECENTLY
XIA       BOTH L+,L- AND XI(0) (OR THREE RELATED PARAMETERS) HAVE BEEN INCLU-
XIA       DED IN THE FITS . SEE HAIDT 71. (OR CHIEN 70 FOR KOL) .
XIA L   76  (+1.8)    (1.6)           BROWN     62 XEBC +  MU+,PIO SPECTRA   8/67
XIA L   87  (+0.7)    (0.5)           GIACOMELL 64 EMUL +  MU+ SPECTRUM      8/67
XIA L       (-0.1)    (0.7)           JENSEN    64 XEBC +  MU+,PIO SPECTRN   8/67
XIA L       (-0.17)   (0.75)   (0.99) SHAKLEE   64 XEBC +  KMU3/KE3          8/67
XIA L       (+0.6)    (0.5)           BISI 1    65 HBC  +  KMU3/KE3          8/67
XIA        BTWN +0.2 AND +1.4         CUTTS     65 OSPK +  MU+ SPECTRUM      8/67
XIA L 1509  (+0.4)    (0.4)           CALLAHA1  66 FRBC +  KMU3/KE3          8/67
XIA   2648    0.0      1.1      0.9   CALLAHA1  66 FRBC +  MU+ SPECTRUM      8/67
XIA    444   +0.72     0.80           CALLAHA1  66 FRBC +  P+O SPEC,FIX MU   8/67
XIA L       (+0.75)   (0.50)          AUERBACH  67 OSPK +  KMU3/KE3          8/67
XIA E 1398  (-0.60)   (0.20)          EICHTEN   68 HLBC +  KMU3/KE3 T=4.    10/68
XIA B 5601  (-0.08)   (0.15)          BOTTERIL2 68 ASPK +  KM3/KE3, L+=.023  6/68
XIA L   78  (-0.5)    (0.9)           EISLER    68 HLBC +  PIO SPECT, L+-=0  6/68
XIA L  976  (+1.0)    (0.6)           GARLAND   68 OSPK +  KMU3/KE3, L+-=0   4/68
XIA          0.91      0.82           ZELLER    69 ASPK +  KM3/KE3, L+=0.23 10/69
XIA  B      -0.35      0.22           BOTTERIL  70 OSPK    KM3/KE3, L+=.045 10/69
XIA  H3240  -0.80      0.50           HAIDT     71 HLBC +  D.P. L+=.055,T=7  2/72
XIA   3240  -0.50      1.5            HAIDT     71 HLBC +  O.P. L+=.055,T=0  2/71
XIA   1505  -0.72      0.21           HAIDT     71 HLBC +  KM3/KE3 NOTE K    2/71
XIA   4025  -0.62      0.28           ANKENBRAN 72 ASPK +  PIO  L+=.024 T=0  6/72*
XIA   3480  -0.09      0.28           CHIANG    72 OSPK +  D.P. L+-=.029T=0  9/72*
XIA L   L+ AND  L-  ASSUMED TO BE ZERO.
XIA E   EICHTEN 68 REPLACED BY HAIDT 71.
XIA  E  T=4  ASSUMES  L+=.023+-.008 - INSENSITIVE TO L-.
XIA  B  T=0  BOTTERIL 70 IS REEVALUATION OF BOTTERIL2 68 WITH DIFF. L+.     10/69
XIA  H  HAIDT 71 T=6.8 VALUE CORRECTED USING FIGURE 188.                     2/72
XIA  H  VALUES AT T=0 AND AT T=6.8 ARE UNCORRELATED.                         2/72
XIA  K  T=3.9 HAIDT 71 KM3/KE3 VALUE ASSUMES L+=.029 - INDEPENDENT OF L-.    1/73*
XIA          . . . . . . . . . .
XIA AVERAGE MEANINGLESS (SCALE FACTOR = 1.2)

XIB     XIB = F-/F+ (DETERMINED FROM MU POLARIZATION IN KMU3)   ------------
XIB      THE MU POLARIZATION IS A MEASURE OF XI(T). NO ASSUMPTIONS ON L+-
XIB      NECESSARY, T SHOULD BE SPECIFIED.
XIB   2100   +1.2      2.4      1.8   BORREANI  65 HLBC +  POLARIZATION      8/67
XIB    397   -1.4      1.8            CALLAHA1  66 FRBC +  TOTAL POLA-.      8/67
XIB   2950   -0.7      0.9      3.3   CALLAHA1  66 FRBC +  LONG. POLAR.      8/67
XIB   3133   -0.95     0.3            CUTTS     68 OSPK +  TOTAL POL. T=3    6/68
XIB  H6000   -0.6      1.1            HAIDT     71 HLBC +  TOTAL POL. T=0    2/72
XIB  H6000   -1.0      0.3            HAIDT     71 HLBC +  TOTAL POL. T=4.9  2/72
XIB  H  HAIDT 71 VALUES AT T=0 AND T=4.9 ARE UNCORRELATED.
XIB          . . . . . . . . . .
XIB AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

IXI          IMAGINARY PART OF XI (TEST OF T REVERSAL)   ------------------
IXI            0.1       0.4      0.3   BETTELS   68 HLBC    POLARIZATION     10/69

FS      FS/F+  RATIO OF SCALAR TO F+ COUPLINGS FOR KE3 DECAY(ABS. VALUE)----
FS             .18  OR LESS  CL=.90   BELLOTT2  67 HLBC                     10/69
FS             .30  OR LESS  CL=.95   KALMUS    67 HLBC +                   10/69
FS            0.23  OR LESS  CL=.90   BOTTERIL1 68 ASPK                      8/66
FS    2707    0.14     0.03     0.04  STEINER   71 HLBC +  L+,FS,FT,PHI FIT  2/72
FS    4017    0.13  OR LESS  CL=.90   CHIANG    72 OSPK +                    9/72*

FT      FT/F+  RATIO OF TENSOR TO F+ COUPLINGS FOR KE3 DECAY(ABS. VALUE)----
FT             .58  OR LESS  CL=.90   BELLOTT2  67 HLBC                     10/69
FT            1.1   OR LESS  CL=.95   KALMUS    67 HLBC +                   10/69
FT            0.58  OR LESS  CL=.90   BOTTERIL1 68 ASPK                      8/66
FT    2707    0.24     0.16     0.14  STEINER   71 HLBC +  L+,FS,FT,PHI FIT  2/72
FT    4017    0.75  OR LESS  CL=.90   CHIANG    72 OSPK +                    9/72*

L+E      LAMBDA +  (LINEAR ENERGY DEPENDENCE OF F+ IN KE3 DECAY)   --------
L+E      FOR RAD. CORR. TO THE DALITZ PLOT, SEE GINSBERG 67.
L+E    217   +0.036    .045           BROWN     62 XEBC +  PIO SPEC,NO R.C.
L+E    407   -0.010    .029           JENSEN    64 XEBC +  PIO SPEC,NO R.C.  8/67
L+E    230   -0.04     .05            BORREANI  64 HBC  +  E+ SPEC,NO R.C.   8/67
L+E    854    0.045    0.017   0.018  BELLOTT2  67 FBC  +  DLTZ PLT, R.C.   11/67
L+E   1393   +0.016    .016           IMLAY     67 OSPK + DLTZ PLT,NO R.C.   8/67
L+E    515   +0.028    .013     .014  KALMUS    67 FBC  + E,PI SPEC,NO R.C.  8/67
L+E    960    (.08)    (.04)          BOTTERIL1 68 ASPK + E SPEC  USES R.C.  6/68
L+E     90   -0.02     0.08     0.12  EISLER    68 HLBC + PIO SPEC,NO R.C.   6/68
L+E   1458    .045     .015           BOTTERIL  70 OSPK    PIO SPECTRUM RC  10/69
L+E   2707    0.027    0.010          STEINER   71 HLBC DLTZ PLT,USES R.C.  11/71
L+E   4017    0.029    0.011          CHIANG    72 OSPK +  DLTZ PLOT,NO RC   9/72*
L+E          . . . . . . . . . .
L+E AVG       0.0282   0.0052  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

L+M     LAMBDA +  (LINEAR ENERGY DEPENDENCE OF F+ IN KMU3 DECAY)
L+M      FOR RAD. CORR. TO DALITZ PLOT OF KMU3  SEE GINSBERG 70
L+M   3240    0.055    0.025          HAIDT     71 HLBC    KMU3 DAL. PLOT    2/71
L+M   4025    0.024    0.022          ANKENBRAN 72 ASPK +  PIO SPEC XI=-.62  6/72*
L+M          . . . . . . . . . .
L+M AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

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REFERENCES FOR CHARGED K


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BIRGE    56 NC   4   834       BIRGE,PERKINS,PETERSON,STORK,WHITEHEA (LRL)
ILOFF    56 PR 102   927       ILOFF,GOLDHABER,LANNUTTI,GILBERT +    (LRL)
ALEXANDE 57 NC   6   478       ALEXANDER,JOHNSTON,OCEALLAIGH (DUBLIN INST)
COHEN    57 FUND.CONS.PHYS.    +CROWE,DUMOND       (ATOMICS INTER.+LRL+CIT)
EISENBER 58 NC   8  663        EISENBERG,KOCH,LOHRMANN,NIKOLIC +    (BERN)
BURROWES 59 PRL  2  117        BURROWES,CALDWELL,FRISCH,HILL +       (MIT)
TAYLOR   59 PR 114  359        S TAYLOR,HARRIS,OREAR,LEE,BAUMEL (COLUMBIA)

FREDEN   60 PR 118  564        S C FREDEN,F C GILBERT,R S WHITE      (LRL)
BARKAS   61 PR 124 1209        BARKAS,DYER,MASON,NORRIS,NICKOLS,SMIT (LRL)
BHOWMIK  61 NC  20  857        B BHOWMIK,P C JAIN,P C MATHUR  (DELHI UNIV)
FERRO-LU 61 NC   22  1087      FERRO-LUZZI,MILLER,MURRAY,ROSENFELD+  (LRL)
NORDIN   61 PR 123 2166        PAUL NORDIN JR                        (LRL)
ROE      61 PRL  7  346        ROE,SINCLAIR,BROWN,GLASER +      (MICH+LRL)
BOYARSKI 62 PR 128 2398        BOYARSKI,LOH,NIEMELA,RITSON           (MIT)
BROWN    62 PRL  8  450        BROWN,KADYK,TRILLING,ROE+        (LRL,MICH)
BARKAS   63 PRL 11   26        W H BARKAS,J N DYER,H H HECKMAN       (LRL)

BORREANI 64 PL    12 123       G BORREANI,G RINAUDO,A WERBROUCK    (TURIN)
CALLAHAN 64 PR  136 B 1463     A CALLAHAN,R MARCH,R STARK      (WISCONSIN)
CAMERINI 64 PRL  13 318        CAMERINI,CLINE,FRY,POWELL   (WISCONSIN+LRL)
CLINE    64 PRL  13 101        D CLINE, W F FRY                (WISCONSIN)
GIACOMEL 64 NC 34  1134        GIACOMELLI,MONTI,QUARENI+  (BOLOGNA,MUNICH)
GREINER  64 PRL  13 284        D GREINER, W OSBORNE, W BARKAS        (LRL)
JENSEN   64 PR  136 B1431      JENSEN,SHAKLEE,ROE,SINCLAIR          (MICH)
KALMUS   64 PRL   13   99      +KERNAN,PU,POWELL,DOWD           (LRL,WISC)
SHAKLEE  64 PR  136 B 1423     SHAKLEE,JENSEN,ROE,SINCLAIR          (MICH)

BIRGE    65 PR 139 B 1600      BIRGE,ELY,GIDAL,CAMERINI,CLINE + (LRL+WISC)
BISI     65 NC   35  768       BISI,BORREANI,CESTER,FERRARO +     (TORINO)
BISI 1   65 PR 139 B 1068      BISI,MARZARI-CHIESA,RINAUDO        (TORINO)
BORREANI 65 PR 140 B1686       BORREANI,GIDAL,RINAUDO,CAFORIO+ (BARI,TORI)
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Stable Particles
$K^{\pm}$, K^0, K^0_S

Data Card Listings
For notation, see key at front of Listings.

```
CALLAHAN 65 PRL  15  129      A CALLAHAN,D CLINE                     (WISCONSIN)
CAMERINI 65 NC 37 1795        +CLINE,GIDAL,KALMUS,KERNAN              (WISC+LRL)
CLINE    65 PL   15  293      A CLINE,W F FRY                        (WISCONSIN)

DE MARCO 65 PR 140 B 1430     DE MARCO,GROSSO,RINAUDO           (TORINO+CERN)
FITCH    65 PR 140 B 1088     FITCH,QUARLES,WILKINS(PRINCETON+MT HOLYOKE)
GREINER  65 ARNS  15   67     QUOTED BY BARKAS                           (LRL)
STAMER   65 PR  138 B 440     STAMER,HUETTER,KOLLER,TAYLOR,GRAUMAN (STEV)
TRILLING 65 UCRL 16473        GEORGE H TRILLING                          (LRL)
    UPDATED FROM 1965 ARGONNE CONF., PAGE 5.
YOUNG    65 UCRL 16362        POH-SHIEN YOUNG (THESIS;BERKELEY)          (LRL)
    ALSO 67 PR 156 1464       P-S YOUNG,W.Z.OSBORNE,W.H.BARKAS           (LRL)

CALLAHA1 66 PR 150 1153       CALLAHAN,CAMERINI+(WISC,LRL,RIVERSIDE,BARI)
CALLAHAN 66 NC  44A 90        A C CALLAHAN                         (WISCONSIN)
CESTER   66 PL 21 343         CESTER,ESCHSTRUTH,ONEILL+   (PRINCETON-PENN)
    ALSO 67 AUERBACH, FOOTNOTE 1.

AUERBACH 67 PR 155  1505      +DOBBS,MANN,MCFARLANE,WHITE+       (PENN,PRIN)
BELLOTT1 67 HEIDELBERG CONF   BELLOTTI,PULLIA                          (MILAN)
BELLOTT2 67 NC 52A  1287      BELLOTTI,FIORINI,PULLIA                  (MILAN)
    ALSO 66 PL   20   690     BELLOTTI,F+ORINI,PULL+A+                 (MILAN)
BISI     67 PL 25B  572       BISI,CESTER,CHIESA,VIGONE               (TORINO)
BOTTERIL 67 PRL  19   982     BOTTERILL,BROWN,CORBETT,CULLIGAN + (OXFORD)
    ALSO 68 BOTTERIL
BOWEN    67 PR 154 1314       BOWEN,MANN,MCFARLANE,HUGHES+(PENN-PRINCETO)

CLINE    67 HEIDELBERG CONF   CLINE,HAGGERTY,SINGLETON,FRY+     (WISCONSIN)
FLETCHER 67 PRL   19   98     FLETCHER,BEIER,EDWRADS,+              (ILLINOIS)
FORD     67 PRL 18 1214       +LEMONICK,NAUENBERG,PIROUE           (PRINCETON)
IMLAY    67 PR 160  1203      IMLAY,ESCHSTRUTH,FRANKLIN+           (PRINCETON)
KALMUS   67 PR  159  1187     KALMUS,KERNAN  /                           (LRL)
ZINCHENK 67 RUTGERS(THESIS)   ZINCHENKO                              (RUTGERS)

BETTELS  68 NC 56A 1106       AACHEN-BARI-BERGEN-CERN-EP-NIJMEGEN-ORSAY+
BOTTERIL 68 PR 171 1402       BOTTERILL,BROWN,CORBETT,CULLIGAN+   (OXFORD)
BOTTERI1 68 PR 174 1661       BOTTERILL,BROWN,CLEGG,CORBETT,+     (OXFORD)
BOTTERI2 68 PRL  21 766       BOTTERILL,BROWN,CLEGG,CORBETT +     (OXFORD)
BUTLER   68 UCRL-18420        +BLAND,GOLDHABER,GOLDHABER,HIRATA+      (LRL)
CHANG    68 PRL  20  510      CHANG,YODH,EHRLICH,PLANO+(MARYLAND,RUTGERS)

CHEN     68 PRL  20 73        CHEN,CUTTS,KIJEWSKI,STIENING +     (LRL,MIT)
CUTTS    68 PRL  20 955       CUTTS,STIENING,WIEGAND,DEUTSCH     (LRL,MIT)
    ALSO 65 PR 138 B969       CUTTS,ELIOFF,STIENING                   (LRL)
    ALSO 69 PR 184 1380       +STIENING,WIEGAND,DEUTSCH          (LRL,MIT)
EICHTEN  68 PL 27B 586        AACHEN-BARI-CERN-EP-ORSAY-PADOVA-VALENCIA
EISLER   68 PR   169   1090   EISLER,FUNG,MARATECK,MEYER,PLANO  (RUTGERS)
ESCHSTRU 68 PR   165   1487   ESCHSTRUTH,FRANKLIN,HUGHES+(PRINCETON,PENN)
GARLAND  68 PR   167   1225   +TSIPIS,DEVONS,ROSEN+  (COLUMBIA,RUTG,WISC)
MOSCOSO  68  THESIS           M L MOSCOSO                 (UNIV PARIS ORSAY)

CAMERINI 69 PRL  23 326       +LJUNG,SHEAFF,CLINE                (WISCONSIN)
DAVISON  69 PR   180 1333     +BACASTOW,BARKAS,EVANS,FUNG,PORTER+     (UCR)
ELY      69 PR   180 1319     ELY,GIDAL,HAGOPIAN,KALMUS+  (LOUC+WISC+LRL)
EMMERSON 69 PRL  23 393       EMMERSON,QUIRK                        (OXFORD)

HERZO    69 PR 186 1403       +BANNER,BEIER,BERTRAM,EDWARDS +           (ILL)
LOBKOWIC 69 PR 185 1676       +MELISSINOS,NAGASHIMA,TEWKSBURY+ (ROCH,BNL)
    ALSO 66 PRL  17 548       LOBKOWICZ,MELISSINOS,NAGASHIM+    (ROCH+BNL)
MACEK    69 PRL   22    32    MACEK,MANN,MC FARLANE,ROBERTS+(PENN,TEMPLE)
MAST     69 PR   183 1200     +GERSHWIN,ALSTON-GARNJOST,BANGERTER+  (LRL)
ZELLER   69 PR   182 1420     ZELLER,HADOOCK,HELLAND,PAHL+       (UCLA,LRL)

BOTTERIL 70 PL 31B 325        +BROWN,CLEGG,CORBETT,CULLIGAN+            (OXF)
FORD     70 PRL 25 1370       +PIROUE,REMMEL,SMITH,SOUDER              (PRIN)
GRAUMAN  70 PR D1 1277        +KOLLER,TAYLOR,PANDOULAS+  (STEV,SETO,LEHI)
    ALSO 69 PRL 23 737        +KOLLER,TAYLOR,PANDOULAS+  (STEV,SETO,LEHI)
MACEK    70 PR D1 1249        +MANN,MCFARLANE,ROBERTS                /(PENN)
PANDOULA 70 PR D2 1205        +TAYLOR,KOLLER,GRAUMAN +          (STEV,SETO)

BOURQUIN 71 PL 36B 615        +BOYMOND,EXTERMANN,MARASCO+       (GEVA,SACL)
HAIDT    71 PR D3 10          AACHEN+BARI+CERN+EP+NIJMEGEN+ORSAY+PADOVA+
    ALSO 69 PL   29B 691      +(AACH,BARI,CERN,EPOL,NIJM,ORSAY,PADO,TORI)
KLEMS    71 PR D4 66          +HILDEBRAND,STEINING                 (CHIC,LRL)
    ALSO 70 PRL 24 1086       KLEMS,HILDEBRAND,STEINING            (LRL,CHIC)
    ALSO 70 PRL 25 473        KLEMS,HILDEBRAND,STIENING            (LRL,CHIC)

KUNSELMA 71 PL 34B 485        R. KUNSELMAN                          (WYOMING)
OTT      71 PR D3 52          OTT,PRITCHARD                            (LOQM)
ROMANO   71 PL 36B 525        +RENTON,AUBERT,BURBAN-LUTZ (BARI,CERN,ORSA)
SCHWEINB 71 PL 36B 246        AACHEN+BELGIUM+CERN+NIJMEGEN+PADOVA COLLAB
STEINER  71 PL 36B 521        AACHEN+BARI+CERN+EPOL+ORSA+NIJM+PADO+TORIN

ABRAMS   72 PRL 29 1118       +CARROLL,KYCIA,LI,MENES,MICHAEL +         (BNL)
ANKENBRA 72 PRL 28 1472       ANKENBRANDT,LARSEN+     (BNL+LASL+NAL+YALE)
AUBERT   72 NC 12A 509        +HEUSSE,PASCAUD,VIALLE+    (ORSA+BRUX+EPOL)
BEIER    72 PRL 29 678        +BUCHHOLZ,MANN,PARKER          (PENNSYLVANIA)
CABLE    72 PL 40B 699        +HILDEBRAND,PANG,STEINING               (EFI,LBL)
CHIANG   72 PR D6 1254        +ROSEN,SHAPIRO,HANDLER,OLSEN+    (ROCH+WISC)
CLARK    72 PRL 29 1274       +CORK,ELIOFF,KERTH,MCREYNOLDS,NEWTON+ (LBL)
CLINE    72 PRL 28 1287       D CLINE, D LJUNG                     (WISCONSIN)
EDWARDS  72 PR D5 2720        +BEIER,BERTRAM,HERZO,KOESTER +            (ILL)
FORD     72 PL 38B 335        +PIROUE,REMMEL,SMITH,SOUDER          (PRINCETON)
HOFFMAST 72 NP B36 1          HOFFMASTER,KOLLER,TAYLOR+  (STEV+SETO+LEHI)
LJUNG    72 PRL 28 523        D LJUNG                              (WISCONSIN)

BACKENST 73 TO BE PUB.IN PL B BACKENSTOSS,BAMBERGER+(CERN,KARL,HEID,STOH)
LUCAS    73 PR TO BE PUBL.    P W LUCAS,H D TAFT,W J WILLIS             (YALE)

        QUANTUM NUMBER DETERMINATIONS NOT REFERRED TO IN THE DATA CARDS

BLOCK    62 CERN CONF 371     BLOCK,LENDINARA,MONARI          (NWES+BOLOGNA)

                              PAPERS NOT REFERRED TO IN DATA CARDS

BRENE    61 NP 22 553         BRENE,EGARDT,QVIST                        (NORD)
BIRGE    63 PRL  11  35       BIRGE,ELY,GIDAL,CAMERINI +  (LRL+WISC+BARI)
ADAIR    64 PL 12  67         ADAIR,LEIPUNER                        (YALE,BNL)
CABIBBO  64 PL   9 352        CABIBBO,MAKSYMOWICZ                       (CERN)
    ALSO 64 PL 11 360         CABIBBO,MAKSYMOWICZ                       (CERN)
    ALSO 65 PL 14  72         CABIBBO,MAKSYMOWICZ                       (CERN)
CABIBBO  66 BERKELEY CONF 33  CABIBBO                                   (CERN)
GINSBERG 67 PR 162  1570      EDWARD S GINSBERG             (U. MASS BOSTON)
WILLIS   67 HEIDELBERG 273    W J WILLIS -RAPPORTEUR TALK               (YALE)
CRONIN   68 VIENNA CONF 241   RAPPORTEUR TALK                      (PRINCETON)
HAIDT 2  69 PL 29B 696        + (AACH,BARI,CERN,EPOL,NIJM,ORSA,PADO,TORI)
FEARING  70 PR D3 542         +FISCHBACK,SMITH                     (STON+BOHR)
GINSBERG 70 PR D1 229         E S GINSBERG                          (IIT HAIFA)

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K^0

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          11  NEUTRAL K (498,JP=0-) I=1/2
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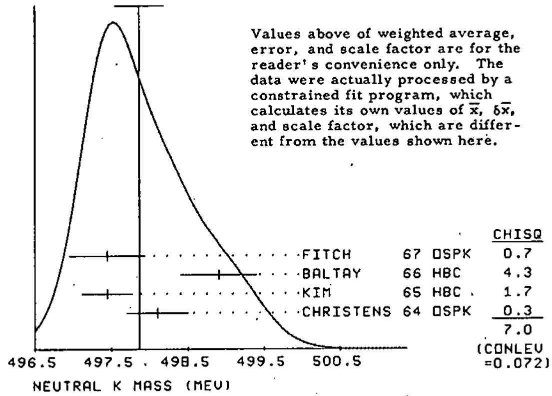
          11  NEUTRAL K MASS (MEV)

M          498.1     0.4            CHRISTENS 64 OSPK
M   2223   497.44    0.33           KIM       65 HBC   KO FROM PBAR P   6/66
M   4500   498.9     0.5            BALTAY    66 HBC   KO FROM PBAR P   6/66
M          497.44    0.50           FITCH     67 OSPK                  11/67
M          . . . . . . . . .
M   AVG    497.87    0.32    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.5)
M   FIT    497.71    0.13  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)  1/73*
           WEIGHTED AVERAGE = 497.87 ± 0.32
                ERROR SCALED BY 1.5
```



Values above of weighted average, error, and scale factor are for the reader's convenience only. The data were actually processed by a constrained fit program, which calculates its own values of $\overline{x}$, $\delta\overline{x}$, and scale factor, which are different from the values shown here.

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          11  (KO) - (K+-) MASS DIFFERENCE (MEV)

D          3.9     0.6          ROSENFELD 59 HBC  -
D          5.4     1.1          CRAWFORD  59 HBC  +
D     9    3.90    0.25         BURNSTEIN 65 HBC  -
D     7    3.71    0.35         KIM       65 HBC  -  K- P TO KO N     6/68
D   417    3.95    0.21         HILL      68 DBC  +  K+D TO KOPP      3/68
D          . . . . . . . . .
D   AVG    3.92    0.14    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
D   FIT    3.99    0.13  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)  1/73*

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                    REFERENCES FOR NEUTRAL K

CRAWFORD 59 PRL   2  112      CRAWFORD,CRESTI,GOOD,STEVENSON,TICHO  (LRL)
ROSENFEL 59 PRL   2  110      A H ROSENFELD,F SOLMITZ,R D TRIPP     (LRL)
CHRISTEN 64 PRL 13 138        CHRISTENSON,CRONIN,FITCH,TURLAY (PRINCETON)
BURNSTEI 65 PR  138 B 895     R A BURNSTEIN,H A RUBIN          (MARYLAND)
KIM      65 PR 140 B 1334     J K KIM,L KIRSCH,D MILLER        (COLUMBIA)
BALTAY   66 PR 142   932      BALTAY,SANDWEISS,STONEHILL +     (YALE+BNL)
FITCH    67 PR 164  1711      FITCH,ROTH,RUSS,VERNON          (PRINCETON)
HILL     68 PR 168  1534      HILL,ROBINSON,SAKITT,CANTER  (BNL,CARNEGIE)

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K^0_S

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          12  SHORT-LIVED NEUTRAL K (498, JP=0-) I=1/2
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Note on the K^0_S Mean Life

In a bubble chamber experiment SKJEGGESTAD 72 obtain a value for the K^0_S mean life, $\tau_S = (0.8958 \pm 0.0045) \times 10^{-10}$ sec, which is significantly higher than the combined results of previous experiments $[(0.862 \pm 0.006) \times 10^{-10}$ sec from our 1972 edition$]$. In addition, the CERN-Heidelberg Collaboration (in a vacuum regeneration experiment) reported a preliminary value $(0.899 \pm 0.005) \times 10^{-10}$ sec (Batavia 1972) in agreement with SKEGGESTAD. However, it should be pointed out that the CERN-Heidelberg number is highly correlated with $|\eta_{+-}|$ for which they find a value of $(2.35 \pm .07) \times 10^{-3}$.

Data Card Listings

For notation, see key at front of Listings.

Stable Particles

K^0_S

We have not entered the CERN-Heidelberg results in our listings because they have not been published yet.

The corrections for systematic biases in SKJEGGESTAD 72 and in HILL 68 (updated) amount to +1% and 0.7% respectively. Similar corrections, if applied to the older bubble chamber results, would probably increase their average by only about one standard deviation and would not account for the discrepancy. We therefore retain all results in the average, $\tau_S = (0.882 \pm 0.008) \times 10^{-10}$ sec, where we have increased the error by a scale factor of 2.5 because of the disagreement.

Because of the uncertain future of τ_S, we have not attempted to adjust the K^0_L-K^0_S mass difference, ϕ_{+-} or ϕ_{00} values. The fitted K^0_S rates, $|\eta_{+-}|$, and $|\eta_{00}|$ are automatically adjusted to our new τ_S value by our fitting procedure.

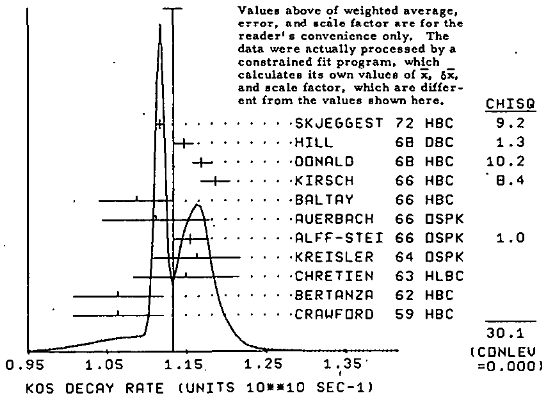
To show how $\Delta m(K^0_L$-$K^0_S)$ and ϕ_{+-} are affected by our new τ_S, we use the correlation given by ARONSON 70 (K^0_L) between $\Delta m(K^0_L$-$K^0_S)$ and τ_S, which indicates that a change in τ_S from 0.862 to 0.882 increases their value of Δm by about .006 x 10^{10} sec^{-1}. A change in Δm of this amount would lead to an increase in ϕ_{+-} of about 3.5°, using the Δm dependence of JENSEN 70, which is the most precise measurement of ϕ_{+-}. (See the F_{+-} section in the K^0_L Data Card Listings.)

```
                   12  KOS MEAN LIFE (UNITS 10**-10 SEC)
T        KOS MEAN LIFE
T   O   90   (1.07)   (0.13)   (0.13) BOLDT     58 CC
T      512    0.94     0.05     0.05  CRAWFORD  59 HBC
T   O   63   (1.09)   (0.18)   (0.15) BOWEN     60 CC
T   O   OLD EXPTS WITH LOW STATISTICS NOT INCLUDED IN AVERAGE.          6/68
T      378    0.94     0.05     0.05  BERTANZA  62 HBC
T      503    0.87     0.05           CHRETIEN  63 HLBC
T      545    0.86     0.04           KREISLER  64 OSPK
T             0.866    0.016          ALFF-STEI 66 OSPK                 9/66
T      572    0.90     0.06     0.05  AUERBACH  66 OSPK                 8/67
T     4500    0.92     0.04           BALTAY    66 HBC                  6/66
T   B        (0.904)  (0.024)         BOTT-BODE 66 OSPK                 9/66
T     5000    0.843    0.013          KIRSCH    66 HBC                  6/66
T    19994    0.856    0.008          DONALD    68 HBC                  6/68
T   H 20000   0.872    0.009          HILL      68 DBC                 11/72*
T   H   50K   0.8958   0.0045         SKJEGGEST 72 HBC                  1/73*
T   H   HILL 68 HAS BEEN CHANGED BY THE AUTHORS FROM THE PUBLISHED VALUE 11/72*
T   H   (0.865+-0.009) BECAUSE OF A CORRECTION IN THE SHIFT DUE TO ETA+-. 11/72*
T   H   SKJEGGESTAD 72 AND HILL 68 GIVE DETAILED DISCUSSIONS OF SYSTEMATICS
T   H   ENCOUNTERED IN THIS TYPE OF EXPERIMENT.
T   B   KOS MEAN LIFE NOT THE PRIMARY QUANTITY MEASURED IN THIS EXPT.   6/68
T
T   AVG       0.8824   0.0092   0.0091 AVERAGE (ERROR INCL. SCALE FACTOR OF 2.7)
T   FIT       0.8824   0.0082 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 2.5)
                              (SEE IDEOGRAM BELOW )
------ --------- -------- -------- --------- -------- -------- --------

                   12  KOS PARTIAL DECAY MODES

                                                       DECAY MASSES
P1     KOS INTO PI+ PI-                                139+ 139
P2     KOS INTO PIO PIO                                134+ 134
P3     KOS INTO MU+ MU-                                105+ 105
P4     KOS INTO E+ E-                                   .5+  .5
P5     KOS INTO PI+ PI- GAMMA                          139+ 139+   0
P6     KOS INTO GAMMA GAMMA                              0+   0
------ --------- -------- -------- --------- -------- -------- --------
```

WEIGHTED AVERAGE = 1.133 ± 0.012
ERROR SCALED BY 2.7

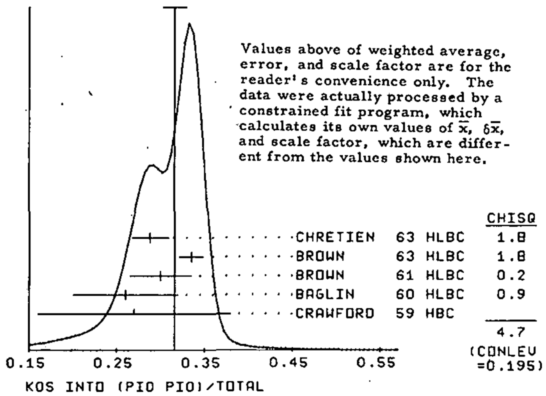



```
                   12  KOS BRANCHING RATIOS

R1      KOS INTO (PI+ PI-)/TOTAL                          (P1)
R1            0.68     0.04          CRAWFORD  59 HBC
R1            0.70     0.08          COLUMBIA  60 HBC
R1   U       (0.740)  (0.024)        ANDERSON  62 HBC
R1 U  1648    0.684    0.011         DOYLE     69 HBC    PI-P TO LAM.KO   2/71
R1   U   ANDERSON RESULT NOT PUBLISHED, EVENTS ADDED TO DOYLE SAMPLE      2/71
R1
R1   AVG      0.684    0.011   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R1   FIT      0.6881   0.0029 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)

R2      KOS INTO (PIO PIO)/TOTAL                          (P2)
R2            0.27     0.11          CRAWFORD  59 HBC
R2            0.26     0.06          BAGLIN    60 HLBC
R2            0.30     0.035         BROWN     61 HLBC
R2     1066   0.335    0.014         BROWN     63 HLBC
R2      198   0.288    0.021         CHRETIEN  63 HLBC
R2
R2   AVG      0.316    0.014   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.3)
R2   FIT      0.3119   0.0029 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)
                       (SEE IDEOGRAM BELOW )
```

WEIGHTED AVERAGE = 0.316 ± 0.014
ERROR SCALED BY 1.3



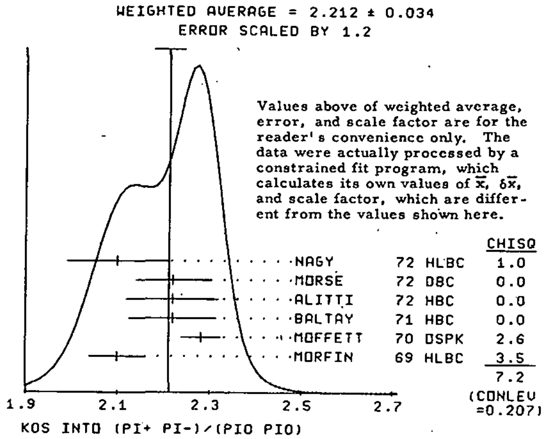

```
R3      KOS INTO (PI+ PI-)/(PIO PIO)                        (P1)/(P2)
R3  G 3016   (2.285)  (0.055)        GOBBI     69 OSPK     K+N TO KOP       5/69
R3    3700.   2.10     0.06          MORFIN    69 HLBC     K+N TO KOP      10/69
R3 G  7944    2.282    0.043         MOFFETT   70 OSPK     K+N TO KOP       2/72
R3 B  6150    2.22     0.095         BALTAY    71 HBC  K-P TO KO +NEUTRALS 12/71
R3 A  3068    2.22     0.10          ALITTI    72 HBC     K+P TO PI+ P KO  6/72*
R3    6380    2.22     0.08          MORSE     72 DBC      K+N TO KOP       2/72
R3     701    2.10     0.11          NAGY      72 HLBC     K+N TO KOP       1/73*
R3 A    THE DIRECTLY MEASURED QUANTITY IS KOS TO PI+ PI-/ALL KO=.345+-.005  6/72*
R3 B    THE DIRECTLY MEASURED QUANTITY IS KS TO PI+PI-/ALL KOBAR=.345+-.005 12/71
R3 G    MOFFETT 70 IS A FINAL RESULT WHICH INCLUDES GOBBI 69.               2/72
R3
R3  AVG       2.212    0.034   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.2)
R3  FIT       2.207    0.029  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)
                       (SEE IDEOGRAM BELOW )
```

Stable Particles

K_S^0, K_L^0

Data Card Listings

For notation, see key at front of Listings.



Values above of weighted average, error, and scale factor are for the reader's convenience only. The data were actually processed by a constrained fit program, which calculates its own values of $\bar{x}$, $\delta\bar{x}$, and scale factor, which are different from the values shown here.

```
R4      (KOS INTO PI+ PI- PIO, CP VIOLATING)/(KOL INTO PI+ PI- PIO)
R4       TEST OF CP VIOLATION - SEE TEXT SECTION IV F.3A FOR DEFINITIONS
R4       CPT ASSUMED VALID - (I.E. RE(A)=0) - ONLY (IMA)**2 QUOTED HERE
R4       18   (3.8)  OR LESS  CL=.90   ANDERSON  65 HBC                   10/69
R4              0.45 OR LESS  CL=.90   BEHR      66 HLBC                   8/66
R4       53   (1.7)  OR LESS  CL=.90   WEBBER    70 HBC                    8/70
R4 C     71    0.8   OR LESS  CL=.90   WEBBER    70 HBC                    8/70
R4       99    1.2   OR LESS  CL=.90   CHO       71 DBC                    4/71
R4  M    50   (1.2)  OR LESS  CL=.95   MEISNER   71 HBC     CL=.9 NOT AVAIL.  2/71
R4      180    0.66  OR LESS  CL=.90   JAMES     72 HBC                    1/73*
R4       99    1.2   OR LESS  CL=.90   JONES     72 OSPK                  10/72*
R4      384    0.27  OR LESS  CL=.90   METCALF   72 ASPK                  11/72*
R4  M    THESE AUTHORS FIND REAL(A)= 2.75+-.65, ABOVE VALUE AT RE(A)=0     2/71
R4 C     THIS IS THE COMBINED RESULT OF ANDERSON 65 AND WEBBER 70

R5      KOS INTO (MU+ MU-)/CHARGED (UNITS 10**-5)          (P3)/(P1)
R5            10.0   OR LESS  CL=.90   BOTT-BODE 67 OSPK                   8/67
R5            20.0   OR LESS  CL=.90   BOHM      69 OSPK                   2/71
R5             1.07  OR LESS  CL=.90   HYAMS     69 OSPK                  10/69
R5    S       32.6   OR LESS  CL=.90   STUTZKE   69 OSPK                   5/69
R5    S  VALUE CALCULATED BY US, USING 2.3 INSTEAD OF U EVENT, 90 PERC.CL

R6      KOS INTO (PI+ PI- GAMMA)/(PI+ PI-) (UN.10**-3)   (P5)/(P1)
R6       27        NO RATIO GIVEN       BELLOTTI  66 HBC     PG GT 50 MEV/C  10/69
R6       10    3.3       1.2            WEBBER    70 HBC     PG GT 50 MEV/C  10/69

R7      KOS INTO (E+ E-)/CHARGED (UNITS 10**-5)            (P4)/(P1)
R7            50.0   OR LESS  CL=.90   BOHM      69 OSPK                   2/71

R8      KOS INTO 2 GAMMA/TOTAL (UNITS 10**-3)              (P6)
R8 R     0    21.0   OR LESS  CL=.90   BANNER    69 OSPK                  12/71
R8 R     0     2.2   OR LESS  CL=.90   REPELLIN  71 OSPK                  12/71
R8 R     0     0.71  OR LESS  CL=.90   BANNER    72 OSPK                   8/72*
R8       0     2.0   OR LESS  CL=.90   MORSE     72 DBC                    2/72
R8 R     THESE LIMITS ARE FOR MAXIMUM INTERFERENCE IN KS-KL TO 2 GAMMAS   12/71

R9      (KOS INTO PI+ PI- PIO, CP CONSERVING)/(KOL INTO PI+ PI- PIO)
R9      384    0.42  OR LESS  CL=.90   METCALF   72 ASPK                  11/72*

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REFERENCES FOR KOS


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BOLOT    58 PRL    1  150        E BOLOT,D O CALDWELL,Y PAL                 (MIT)
CRAWFORD 59 PRL    2  266        CRAWFORD,CRESTI,DOUGLASS,GOOD,TICHO +     (LRL)

BAGLIN   60 NC    18 1043        BAGLIN,BLOCH,BRISSON,HENNESSY +          (EPOL)
BOWEN    60 PR   119 2030        BOWEN,HARDY,REYNOLDS,SUN,MOORE+      (PRIN+BNL)
COLUMBIA 60 ROCH CONF 727        M SCHWARTZ +                         (COLUMBIA)

BROWN    61 NC    19 1155        BROWN,BRYANT,BURNSTEIN,GLASER,KADYK+ (MICH)
ANDERSON 62 CERN CONF 836        J A ANDERSON,F S CRAWFORD +               (LRL)
BERTANZA 62  PREPRINT D105       BERTANZA,CONNOLLY,CULWICK,EISLER +        (BNL)
    UNPUBLISHED, BUT RECERTIFIED BY AUTHORS, AUGUST 66.

CHRETIEN 63 PR   131 2208        CHRETIEN+      (BRANDEIS+BROWN+HARVARD+ MIT)
BROWN    63 PR   130  769        BROWN,KADYK,TRILLING,ROE +           (LRL+MICH)
KREISLER 64 PR   136 B 1074      M KREISLER,O OVERSETH,J CRONIN    (PRINCETON)
ANDERSON 65 PRL 14 475           +CRAWFOR,GOLDEN,STERN,BINFORD +     (LRL+WISC)

ALFF-STE 66 PL 21 595            ALFF-STEINBERGER,HEUER,KLEINKNECHT + (CERN)
AUERBACH 66 PR 149 1052          AUERBACH,DOBBS,LANDE,MANN,SCIULLI+      (PENN)
  . ALSO 65 AUERBACH
BALTAY   66 PR 142   932         BALTAY,SANDWEISS,STONEHILL +        (YALE+BNL)
BEHR     66 PL  22  540          BEHR,BRISSON,PETIAU+ (EPOL,MILA,PADO,ORSAY)
BELLOTTI 66 NC 45A 737           +PULLIA,BALDO-CEOLIN +           (MILAN+PADUA)
BOTT-BOD 66 PL  23 277           BOTT-BODENHAUSEN,DE BOUARD +            (CERN)
KIRSCH   66 PR  147  939         L KIRSCH,P SCHMIDT                  (COLUMBIA)

BOTT-BOD 67 PL 24B 194           BOTT-BODENHAUSEN,DE BOUARD,CASSEL+      (CERN)
DONALD   68 PL 27B  58           DONALD,EDWARDS,NISAR+ (LIVP,CERN,IPNP,COEF)
HILL     68 PR 171 1418          HILL,ROBINSON,SAKITT +        (BNL,CARNEGIE)

BANNER   69 PR 188 2033          +CRONIN,LIU,PILCHER                (PRINCETON)
BOHM     69 THESIS               A. BOHM                                 (AACH)
DOYLE    69 UCRL 18139-THESIS J.C. DOYLE                                  (LRL)
GOBBI    69 PRL 22 682           GOBBI,GREEN,HAKEL,MOFFETT,ROSEN+(ROCHESTER)
HYAMS    69 PL  29B 521          +KOCH,POTTER,VON LINDERN,LORENZ+ CERN(MPIM)
MORFIN   69 PRL    23  660       MORFIN,SINCLAIR                         (MICH)
STUTZKE  69 PR    177  2009      +ABASHIAN,JONES,MANTSCH,ORR,SMITH(ILLINOIS)

MOFFETT  70 BAPS 15 512          +GOBBI,GREEN,HAKEL,ROSEN         (ROCHESTER)
WEBBER   70 PR D1 1967           +SOLMITZ,CRAWFORD,ALSTON-GARNJOST       (LRL)
    ALSO 69 UCRL 19226 THESIS B R WEBBER                                 (LRL)
BALTAY   71 PRL 27 1678          +BRIDGEWATER,COOPER,GERSHWIN,HABIBI+ (COLU)
    ALSO 71 NEVIS-187 THESIS     WILLIAM A. COOPER                   (COLUMBIA)
CHO      71 PR D3 1557           +DRALLE,CANTER,ENGLER,FISK+ (CARN+BNL+CASE)
MEISNER  71 PR D3 59             +MANN,HERTZBACH,KOFLER +     (MASA+BNL+YALE)
REPELLIN 71 PL 36B 603           +WOLFF,CHOLLET,GAILLARD,JANE+    (ORSA+CERN)

ALITTI   72 PL 39B 568           J ALITTI,E LESQUOY,A MULLER          (SACLAY)
BANNER   72 PRL 29 237           +CRONIN,HOFFMAN,KNAPP,SHOCHET    (PRINCETON)
JAMES    72 NP B49 1             +MONTANET,PAUL,SAETRE+     (CERN+SACL+OSLO)
    ALSO 71 PL 35B 265           JAMES,MONTANET,PAUL,PAULI+ (CERN+SACL+OSLO)
JONES    72 NC 9A 151            +ABASHIAN,GRAHAM,MANTSCH,ORR,SMITH+    (ILL)
METCALF  72 PL 40B 703           +NEUHOFER,NIEBERGALL+        (CERN+IPN+WIEN)
MORSE    72 PRL 28 388           +NAUENBERG,BIERMAN,SAGER+    (COLO+PRIN+UMD)
NAGY     72 NP B47 94            +TELBISZ,VESZTERGOMBI               (BUDAPEST)
    ALSO 69 PL 30B 498           BOZOKI,FENYVES,GOMBOSI,NAGY+        (BUDAPEST)
SKJEGGES 72 NP B48 343           SKJEGGESTAD,JAMES,MONTANET+(OSLO+CERN+SACL)

                                 PAPERS NOT REFERRED TO IN DATA CARDS

BIRGE    60 ROCH CONF 601        R W BIRGE,P P ELY +           (LRL+WISCONSIN)
MULLER   60 PRL    4  418        MULLER,BIRGE,FOWLER,GOOD,PICCIONI+(LRL+BNL)
FITCH    61 NC    22 1160        V FITCH,P PIROUE,R PERKINS        (PRIN+LASL)
GOOD     61 PR   124 1223        GOOD,MATSEN,MULLER,PICCIONI +            (LRL)
CRAWFORD 62 CERN CONF 827        F S CRAWFORD                             (LRL)
AUERBACH 65 PRL 14 192           AUERBACH,LANDE,MANN,SCIULLI,UTO +       (PENN)
TRILLING 65 UCRL 16473           GEORGE H TRILLING                        (LRL)
    UPDATED FROM 1965 ARGONNE CONF., PAGE 115.
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K_L^0

13 LONG-LIVED NEUTRAL K (498, JP=0-) I=1/2

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                 13  (KOL) - (KOS) MASS DIFFERENCE
    WE GIVE (KOL-KOS MASS DIFFERENCE / HBAR) IN UNITS OF 10**10 SEC-1

D  T        (2.20)   (0.35)          FITCH     61 CNTR
D            0.84     0.29      0.22 GOOD      61 HLBC
D  T         1.02     0.23           CAMERINI  62 HLBC    SEE NOTE C BELOW  8/67
D   C  VALUE CHANGED FROM 1.7 (SEE TABLE 1 OF CAMERINI 66)                  8/67
D  T         0.55     0.24           AUBERT    65 HLBC                      6/66
D            0.26     0.36      0.26 BALDO-CEO 65 HLBC    ASSUMES CP CONS.
D  T A       0.64     0.12           CHRISTENS 65 OSPK                      6/66
D    A CHRISTENSON 65 HAS BEEN CORRECTED FOR INTERFERENCE BY FITCH 65 FTNOT 1/71
D  T        (0.70) OR LESS           FITCH     65 OSPK    CF. MEISNER 66    7/66
D   V  130  (0.89)   (0.15)          VISHNEVSK 65 OSPK    CU AND AL REGEN   8/67
D   V  VISHNEVSKY 65 NOT CORRECTED FOR INTERFERENCE EFFECTS                 3/68
D            0.514    0.039          ALFF-STEI 66 OSPK                      6/66
D       84   0.42     0.24      0.36 BALDO-CEO 66 HLBC    KO+N INTO HYPER.  8/67
D  B        (0.531)  (0.027)         BOTT-BODE 66 OSPK    C REGEN           9/66
D  T    77   0.58     0.17           CAMERINI  66 HBC, DBC KO+N INTO HYPER  8/67
D   N   72 (+ 0.64)  (0.18)          CANTER    66 DBC     KO SCATTER IN D2 11/66
D   N   ERROR IGNORES UNCERTAINTY OF PHASE SHIFTS.  THESE EVENTS ARE       10/71
D   N   USED IN HILL 71.
D       95   0.62     0.10      0.16 CHANG     66 HBC     KO+P INTO HYPER.  8/67
D            0.81     0.17           FUJII     66 OSPK    IRON REGENERATOR  9/66
D       59   0.74     0.34           MEISNER1  66 HBC     SEE NOTE M1       6/66
D   M1   . + SIGN FAVORED            MEISNER2  66 HBC                       9/66
D            0.38     0.16           JOVANOVIC 66 OSPK   C+URANIUM REGEN. 11/66
D  T   136 + 0.64     0.19           CANTER    67 DBC     KO+D INTO HYPER. 11/67
D            0.65     0.11           MISCHKE   67 OSPK                     11/67
D      590   0.59     0.13           BALATZ    68 OSPK    AL REGENERATOR    3/68
D            0.520    0.044          CARNEGIE  68 HBC     GAP METHOD        3/68
D  T        +0.487    0.046          MELHOP    68 OSPK    ST.STEEL REGEN    6/68
D  B         0.547    0.024          BOTT-BOD  69 OSPK    C REGEN           1/71
D  B   BOTT-BOD 69 IS A REEVALUATION OF BOTT-BOD 66                         1/71
D  F         0.555    0.020          FAISSNER  69 ASPK    REGEN IN CU      10/69
D  F   ESTIMATED ADDITIONAL SYSTEMATIC UNCERTAINTY LESS THAN TWO PERCENT    1/71
D            0.542    0.006          CULLEN    70 CNTR                      1/71
D            0.542    0.006          ARONSON   70 ASPK    GAP METHOD        1/71
D            0.481    0.052    0.075 BALATS    71 OSPK                      9/71
D            0.534    0.007          CARNEGIE  71 ASPK    GAP METHOD        8/71
D  TH  119 (+ 0.67)  (0.14)          HILL      71 DBC                      10/71
D   H   THE PRIMARY RESULT OF THIS EXPERIMENT IS THAT DM IS POSITIVE.      10/71
D   H   THE MAGNITUDE MAY HAVE AN ADDITIONAL SYSTEMATIC ERROR OF ABOUT 0.12 10/71
D  T    A KOS MEAN LIFE OF 0.862 10**-10 SEC WAS USED IN CONVERTING THE     1/71
D  T    MASS DIFFERENCE FROM UNITS OF INVERSE KOS MEAN LIVES TO ABSOLUTE    1/71
D  T    UNITS. VALUES NOT BEARING THIS FOOTNOTE EITHER WERE GIVEN IN        1/71
D  T    ABSOLUTE UNITS OR WERE CONVERTED USING THE AUTHORS' VALUE OF THE    1/71
D  T    KOS MEAN LIFE.                                                      1/71
D            . . . . . . . . .
D   AVG      0.5402   0.0035  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

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                    13  KOL MEAN LIFE (UNITS 10**-8 SEC)

T         KOL MEAN LIFE
T        34    8.1        3.2        2.4    BARDON     58 CNTR
T        ASSUMED DS=DQ AND DELTA I=1/2 CRAWFORD   59 HBC
T        15    5.1        2.4        1.3    DARMON     62 FBC
T              5.3        0.6               FUJII      64 OSPK
T      1700    6.1        1.5        1.2    ASTBURY3   65 CNTR
T              5.15       0.14              DEVLIN     67 CNTR
T   L         (5.0)      (0.5)              LOWYS      67 HLBC
T      .4M     5.154      0.044             VOSBURGH   72 CNTR                  2/71
T   L    SUM OF PARTIAL DECAY RATES.
T            . . . . . . . . .
T   AVG        5.158      0.042      0.042  AVERAGE (ERROR INCL. SCALE FACTOR OF 1.0)
T   FIT        5.181      0.041   FROM FIT (ERROR INCLUDFS SCALE FACTOR OF 1.0)

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Data Card Listings

For notation, see key at front of Listings.

Stable Particles

K_L^0

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                       13  KOL PARTIAL DECAY MODES

                                                            DECAY MASSES
P1      KOL INTO 3PIO                          TAU O PRIME   134+ 134+ 134
P2      KOL INTO PI+ PI- PIO                   TAU O         139+ 139+ 134
P3      KOL INTO PI MU NEUTRINO                KL MU3        139+ 105+   0
P4      KOL INTO PI E NEUTRINO                 KL E3         139+  .5+   0
P5      KOL INTO PI+ PI-                       KL PI+ PI-    139+ 139
P6      KOL INTO MU+ MU-                       KL 2MU        105+ 105
P7      KOL INTO E+ E-                         KL 2E          .5+  .5
P8      KOL INTO E MU                          KL EMU         .5+ 105
P9      KOL INTO TWO GAMMAS                    KL 2GAMMA       0+   0
P10     KOL INTO PI+ PI- GAMMA                 KL PI+-G      139+ 139+   0
P11     KOL INTO PIO PIO                       KL 2PIO       134+ 134
P12     KOL INTO PI E NEU GAMMA                KL E3GAM      139+  .5+   0+   0
P13     KOL INTO PIO TWO GAMMAS                KL PI2GAMMA   134+   0+   0

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                  NEUTRAL K CONSTRAINED FIT
             OVERALL FIT OF MEAN LIFE, WIDTHS AND BRANCHING
             RATIOS USES 62 DATA POINTS TO DETERMINE SIX
             QUANTITITES.  OVERALL FIT HAS CHISQ=56.5.

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FITTED PARTIAL DECAY MODE BRANCHING FRACTIONS

The matrix below is derived from the error matrix for the fitted partial decay mode branching fractions, P_i, as follows: The diagonal elements are $P_i \pm \delta P_i$, where $\delta P_i = \sqrt{\langle \delta P_i \delta P_i \rangle}$, while the off-diagonal elements are the normalized correlation coefficients $\langle \delta P_i \delta P_j \rangle / (\delta P_i \cdot \delta P_j)$. For the definitions of the individual P_i, see the listings above; only those P_i appearing in the matrix are assumed in the fit to be nonzero and are thus constrained to add to 1.

```
         P 1        P 2        P 3        P 4        P 5        P11
 P 1 .2151+-.0079
 P 2   -.2656  .1257+-.0027
 P 3   -.4833    -.0695  .2691+-.0059
 P 4   -.5850    -.0638    -.3326  .3876+-.0065
 P 5   -.2849     .0431     .1412     .1702  .0016+-.0001
 P11    .1531    -.0508    -.0862    -.1044    -.0511  .0009+-.0002
```

FITTED PARTIAL DECAY MODE RATES

The matrix below is the branching fraction matrix above, transformed into rate space; i.e., $G_i \equiv \Gamma_i = \Gamma_{total} P_i$, in appropriate units. In analogy to the matrix above, the diagonal elements are $G_i \pm \delta G_i$, where $\delta G_i = \sqrt{\langle \delta G_i \delta G_i \rangle}$, while the off-diagonal elements are the normalized correlation coefficients $\langle \delta G_i \delta G_j \rangle / (\delta G_i \cdot \delta G_j)$. Note that, because of the error in Γ_{total}, the errors and correlations here are not directly derivable from those above.

```
         G 1        G 2        G 3        G 4        G 5        G11
 G 1 .0415+-.0016
 G 2   -.1448  .0243+-.0005
 G 3   -.3444     .0341  .0519+-.0012
 G 4   -.4047     .0572    -.1801  .0748+-.0013
 G 5   -.2032     .1036     .1950     .2298  .0003+-.0000
 G11    .1617    -.0300    -.0638    -.0751    -.0379  .0002+-.0000

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                       13  KOL DECAY RATES

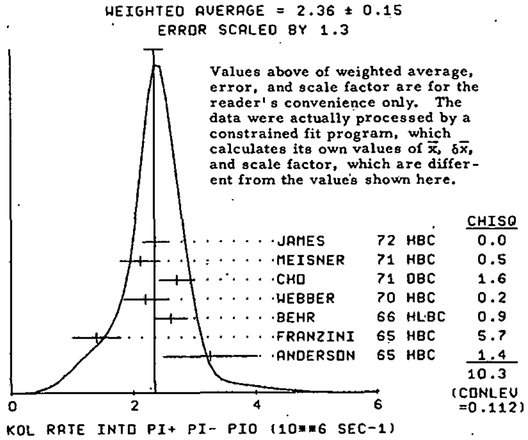
W1      KOL INTO PIO PIO PIO (UNITS 10**6 SEC-1)            (G1)
W1       54     5.22    1.03        0.84  BEHR      66 HLBC   ASSUMES CP         8/66
W1              . . . . . . . . . .
W1   FIT        4.15    0.16    FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.3)

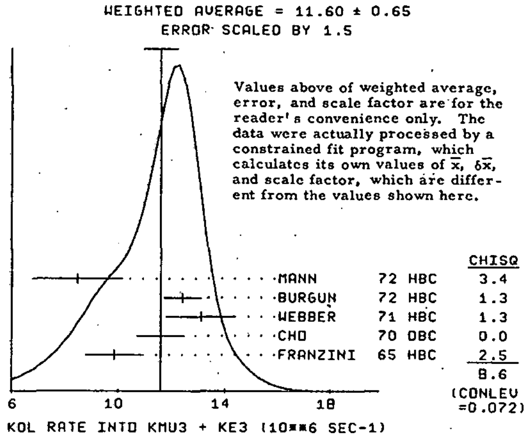
W2      KOL INTO PI+ PI- PO (UNITS 10**6 SEC-1)             (G2)
W2       18     3.26    0.77              ANDERSON  65 HBC                       8/66
W2       14     1.4     0.4               FRANZINI  65 HBC                       6/66
W2      136     2.62    0.28        0.27  BEHR      66 HLBC   ASSUMES CP         8/66
W2       53     2.20    0.35              WEBBER    70 HBC    ASSUMES CP        10/71
W2       99     2.71    0.28              CHO       71 DBC    ASSUMES CP         4/71
W2       50     2.12    0.33              MEISNER   71 HBC    ASSUMES CP        10/71
W2      180     2.35    0.20              JAMES     72 HBC    ASSUMES CP         1/73*
W2      IN THE OVERALL FIT THIS RATE IS WELL DETERMINED BY THE MEAN LIFE AN
W2       THE BRANCHING RATIO R2. FOR THIS REASON THE DISCREPANCY BETWEEN THE
W2       W2 MEASUREMENTS DOES NOT AFFECT THE SCALE FACTOR OF THE OVERALL FIT
W2              . . . . . . . . . .
W2   AVG        2.36    0.15     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.3)
W2   FIT        2.425   0.054   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)
                         (SEE IDEOGRAM BELOW )

W3      KOL INTO PI E NEUTRINO (UNITS 10**6 SEC-1)          (G4)
W3              7.52    0.85        0.72  AUBERT    65 HLBC   DS=DQ,CP ASSUMED  8/67
W3      620     7.81    0.56              CHAN      71 HBC                      2/72
W3              . . . . . . . . . .
W3   AVG        7.71    0.46     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
W3   FIT        7.48    0.13    FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)

W4      KOL INTO CHARGED (3-BODY) (UNITS 10**6 SEC-1)     (G2+G3+G4)
W4       98    15.1     1.9               AUERBACH  66 OSPK                     8/67
W4              . . . . . . . . . .
W4   FIT       15.10    0.18    FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)

W5      KOL INTO LEPTONIC (KMU3+KE3) (UNITS 10**6 SEC-1) (G3+G4)
W5    D 109     9.85    1.15        1.05  FRANZINI  65 HBC                      2/72
W5    C 335   (10.3)   (0.8)              HILL      67 DBC    K+N TO KO P       8/67
W5    D 393    11.6     0.9               CHO       70 DBC    K+N TO KOP       10/70
W5    D 252    13.1     1.3               WEBBER    71 HBC    K- P TO KOBAR N   2/72
W5    D 410    12.4     0.7               BURGUN    72 HBC    K+P TO KOPPI+     1/73*
W5    D 126     8.47    1.69              MANN      72 HBC    K- P TO KOBAR N   9/72*
W5    C  CHO 70 INCLUDES EVENTS OF HILL 67
W5    D  ASSUMES DS=DQ RULE
W5              . . . . . . . . . .
W5   AVG       11.60    0.65     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.5)
W5   FIT       12.68    0.16    FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)
                         (SEE IDEOGRAM BELOW )
```



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W6      KOL INTO PI MU NEUTRINO UNITS 10**6 SEC-1)          (G3)
W6       19     4.54    1.24        1.08  LOWYS     67 HLBC                     8/67
W6              . . . . . . . . . .
W6   FIT        5.19    0.12    FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)

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                       13  KOL BRANCHING RATIOS

R1      KOL INTO (PIO PIO PIO)/CHARGED                   (P1)/(P2+P3+P4)
R1       24     0.24    0.08              ANIKINA   64 CC                        6/66
R1      549     0.251   0.014             BUDAGOV   68 HLBC   ORSAY MEASUR.     10/68
R1      444     0.277   0.021             BUDAGOV   68 HLBC   EC. POLYTEC.MEAS  10/68
R1       29     0.31    0.07        0.06  KULYUKINA 68 CC                        2/71
R1              . . . . . . . . . .
R1   AVG        0.260   0.011    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R1   FIT        0.275   0.013   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.3)

R2      KOL INTO (PI+ PI- PIO)/CHARGED                   (P2)/(P2+P3+P4)
R2       59     0.185   0.038             ASTIER    61 CC                        8/66
R2       79     0.151   0.020             ADAIR     64 HBC                       8/66
R2       75     0.157   0.03        0.04  LUERS     64 HBC                       8/66
R2       66     0.15    0.03        0.04  ASTBURY1  65 CC                        8/66
R2      326     0.159   0.015             ASTBURY2  65 CC                        6/66
R2      566     0.178   0.017             GUIDONI   65 HBC                       6/66
R2     1729    (0.144) (0.004)            HOPKINS   65 HBC    SEE HOPKINS 67     6/66
R2      126     0.162   0.015             HAWKINS   66 HBC                       6/66
R2              0.161   0.005             HOPKINS   67 HBC                       8/67
R2     1402     0.167   0.016             KULYUKINA 68 CC                        2/71
R2      558     0.159   0.010             EVANS     73 HLBC                      1/73*
R2              . . . . . . . . . .
R2   AVG        0.1615  0.0038   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R2   FIT        0.1606  0.0034 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R3      KOL INTO (PI MU NEUTRINO)/CHARGED                (P3)/(P2+P3+P4)
R3    C 251    (0.356) (0.07)             LUERS     64 HBC
R3    C 172    (0.39)  (0.08)      (0.10) ASTBURY1  65 CC                        7/66
R3    C 330    (0.335) (0.055)            KULYUKINA 68 CC                        2/71
R3    C THIS MODE NOT MEASURED INDEPENDENTLY FROM R2 AND R4
R3              . . . . . . . . . .
R3   FIT        0.3440  0.0066 FROM FIT

R4      KOL INTO (PI E NEUTRINO)/CHARGED                 (P4)/(P2+P3+P4)
R4      153     0.487   0.05              LUERS     64 HBC
R4      202     0.46    0.08        0.10  ASTBURY1  65 CC                        7/66
R4      500     0.498   0.052             KULYUKINA 68 CC                        2/71
R4              . . . . . . . . . .
R4   AVG        0.488   0.033    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R4   FIT        0.4954  0.0067 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)
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Stable Particles

K_L^0

Data Card Listings

For notation, see key at front of Listings.

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R5      KOL INTO (PI E NEU)/((PI E NEU)+(PI MU NEU))        (P4)/(P3+P4)
R5      320    0.415    0.120             ASTIER    61 CC
R5             . . . . . . . . . .
R5   FIT       0.5902   0.0077 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R6      KOL INTO (PI+ PI- PIO)/TOTAL                         (P2)
R6
R6             . . . . . . . . . .
R6   FIT       0.1257   0.0027 FROM FIT

R7      KOL INTO (LEPTON PI NEUTRINO)/TOTAL                  (P3+P4)
R7
R7             . . . . . . . . . .
R7   FIT       0.6568   0.0072 FROM FIT

R8      KOL INTO (2 GAMMA)/TOTAL (UN. 10**-4)                (P9)
R8   C         (1.3)    (0.6)             CRIEGEE   66 OSPK                    8/66
R8       32    6.7      2.2               TODOROFF  67 OSPK   REPL.  CRIEGEE66 11/68
R8   K   33    (7.4)    (1.6)             CRONIN 1  67 OSPK                   11/67
R8       90    5.5      1.1               KUNZ      68 OSPK   NORM.TO 3PI(C+N)  2/71
R8       23    4.5      1.0               ENSTROM   71 OSPK   KOL 1.5-9 GEV/C   2/72
R8 R           5.0      (1.0)             REPELLIN  71 OSPK                   11/71
R8 B           4.54     0.84              BANNER2   72 OSPK                    8/72*
R8 B     THIS VALUE USES (E00/E+-)**2=1.05+-0.14. IN GENERAL, S13R8 =          8/72*
R8 B     (4.32+-0.55)*(10**-4)*((E00/E+-)**2).                                 8/72*
R8 R     ASSUMES REGEN AMPL IN COPPER AT 2GEV IS 22  MB. TO EVALUATE          11/71
R8 R     FOR A GIVEN REGEN AMPL AND ERROR, MULTIPLY BY (REGEN AMPL/22MB)**2   11/71
R8   C       CRIEGEE 66 REPLACED BY TODOROFF 67                               11/68
R8   K       CRONIN1 67 REPLACED BY KUNZ 68.                                   2/71
R8             . . . . . . . . . .
R8   AVG       4.89     0.54   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

R9      KOL INTO (PI+ PI-)/CHARGED (UNIT 10**-3)             (P5)/(P2+P3+P4)
R9       45    2.0      0.4               CHRISTENS 64 OSPK ETA +- = 1.94
R9       54    2.08     0.35              GALBRAITH 65 OSPK ETA +- = 2.02
R9             1.93     0.26              BASILE    66 OSPK ETA +- = 1.86        9/66
R9             1.993    0.080             BOTT-BODE 66 OSPK ETA +- = 1.935       9/66
R9             . . . . . . . . . .
R9   AVG       1.992    0.073  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R9   FIT       2.001    0.063  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R10     KOL INTO (PI MU NEU)/(PI E NEU)                      (P3)/(P4)
R10            0.81     0.19              ADAIR     64 HBC                     6/66
R10            0.82     0.10              DEBOUARD  67 OSPK                   11/67
R10     273    0.7      0.2               HAWKINS   67 HBC                     8/67
R10            0.81     0.08              HOPKINS   67 HBC                     8/67
R10     770    0.71     0.05              BUDAGOV   68 HLBC                   10/68
R10            0.67     0.13              KULYUKINA 68 CC                      2/71
R10 B          (0.71)   (0.04)            BEILLIERE 69 HLBC                   10/69
R10    1309    (0.648)  (0.030)           EVANS     69 HLBC REPL. BY EVANS 73  1/73*
R10    3548    0.68     0.08              BASILE    70 OSPK                   10/70
R10    1309    0.662    0.030             EVANS     73 HLBC                    1/73*
R10 B  BEILLIERE 69 IS A SCANNING EXPT USING SAME EXPOSURE AS BUDAGOV 68
R10            . . . . . . . . . .
R10 AVG        0.695    0.022  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R10 FIT        0.694    0.022  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R11     KOL INTO (MU+MU-)/CHARGED (UNITS 10**-6)             (P6)/(P2+P3+P4)
R11          100.0    OR LESS             ANIKINA   65 CC                      6/66
R11          250.0    OR LESS  CL=.90     ALFF-STEI 66 OSPK                    9/66
R11            2.0    OR LESS  CL=.90     BOTT-BODE 67 OSPK                    8/67
R11           35.0    OR LESS  CL=.90     FITCH     67 OSPK                    3/68

R12     KOL INTO (PI+ PI- GAMMA)/TOTAL (UNITS 10**-3)        (P10)
R12           15.0    OR LESS             ANIKINA   65 CC                      6/66
R12       0    5.0    OR LESS             BELLOTTI  66 HLBC   GAM KE 40-130 MV 8/67
R12       1    3.0    OR LESS             NEFKENS   66 OSPK   GAM KE 120 MEV   6/66
R12            0.4    OR LESS  CL=.90     THATCHER  68 OSPK   GAM KE 20-170 MV 2/71

R13     KOL INTO (E+ E-)/CHARGED (UNITS 10**-6)              (P7)/(P2+P3+P4)
R13         1000.0    OR LESS             ANIKINA   65 CC                      6/66
R13          200.0    OR LESS  CL=.90     ALFF-STEI 66 OSPK                    6/66
R13           23.0    OR LESS  CL=.90     BOTT-BODE 67 OSPK                    8/67

R14     KOL INTO (E MU)/CHARGED (UNITS 10**-4)               (P8)/(P2+P3+P4)
R14           10.0    OR LESS             ANIKINA   65 CC                      6/66
R14            1.0    OR LESS  CL=.90     CARPENTER 66 OSPK                    8/66
R14            0.1    OR LESS  CL=.90     BOTT-BODE 67 OSPK                    8/67
R14            0.08   OR LESS  CL=.90     FITCH     67 OSPK                    3/68

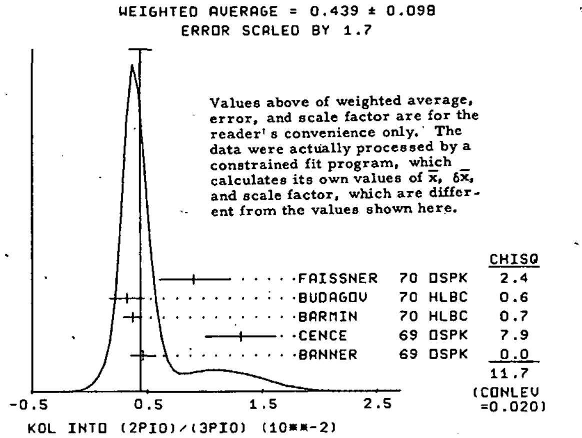
R15     KOL INTO (E+ PI- NEU)/(E- PI+ NEU)
R15 O    97    (0.90)   (0.18)            NEAGU     61 CC
R15 O          (1.01)   (0.16)            LUERS     64 HBC                     8/66
R15 O   894    (0.99)   (0.023)           KULYUKINA 66 CC                      9/66
R15 O  1539    (1.06)   (0.05)            VERHEY    66 OSPK                    8/67
R15 O    LOW PRECISION EXPTS NOT AVERAGED.  FOR MORE PRECISE VALUE,
R15 O    SEE S13A2 (BENNETT 70, MARX 70)

R16     KOL INTO (MU+ PI- NEU)/(MU- PI+ NEU)
R16      1M    1.0081   0.0027            DORFAN    67 OSPK                   11/67
R16      SEE ALSO S13A2 AND S13AL IN THE CP VIOLATION SECTION                  2/71

R17     KOL INTO (PIO PIO)/TOTAL (UNITS 10**-3)              (P11)
R17 C     7    (1.2)    (1.5)    (1.2)    CRIEGEE   66 OSPK                    7/66
R17 C    CRIEGEE EXPT NOT DESIGNED TO MEASURE 2 PIO DECAY MODE
R17 G   189    (2.5)    (0.8)             GAILLARD  69 OSPK   E00=3.6+-0.6     5/69
R17 G    LATEST RESULT OF THIS EXPERIMENT GIVEN BY FAISSNER 70 R19             1/71
R17            . . . . . . . . . .
R17 FIT        0.94     0.19   FROM FIT

R18     KOL INTO (3PIO)/(PI+PI-PIO)                          (P1)/(P2)
R18     188    2.0      0.6               ALEKSANYA 64 FBC                     9/66
R18    1010    1.80     0.13              BUDAGOV   68 HLBC                   10/68
R18            . . . . . . . . . .
R18 AVG        1.81     0.13   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R18 FIT        1.711    0.081  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.3)

R19     KOL INTO (2PIO)/(3PIO) (UNITS 10**-2)                (P11)/(P1)
R19 C   109    (1.89)   (0.31)            CRONIN 1  67 OSPK   ETA00=4.9+-0.5    8/67
R19 C          (1.36)   (0.18)            CRONIN 2  67 OSPK   ETA00=3.92+-0.3  11/67
R19 C        CRONIN2 IS FURTHER ANALYSIS OF CRONIN1 ,NOW BOTH WITHDRAWN        11/68
R19       NO EVENTS SEEN                  BARTLETT  68 OSPK   SEE E00 BELOW    11/68
R19      57    0.46     0.11              BANNER    69 OSPK   ETA00=2.2+-0.3    2/72
R19     133    1.31     0.31              CENCE     69 OSPK   ETA00=3.7+-0.5   10/69
R19      29    0.37     0.08              BARMIN    70 HLBC   ETA00=2.02+-0.23 12/70
R19      30    0.32     0.15              BUDAGOV   70 HLBC   ETA00=1.9+-0.5   10/70
R19   F 172    0.90     0.30              FAISSNER  70 OSPK   ETA00=3.2+-0.5   12/70
R19   F FAISSNER 70 CONTAINS SAME 2PIO EVENTS AS GAILLARD 69 R17
R19            . . . . . . . . . .
R19 AVG        0.439    0.098  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.7)
R19 FIT        0.44     0.29   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 5.1)
                        (SEE IDEOGRAM BELOW )
```

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R20     KOL INTO (PI+ PI-)/(KE3 + KMU3) (UNITS 10**-3)   (P5)/(P3+P4)
R20     309    2.51     0.23              DEBOUARD  67 OSPK                    6/68
R20     525    2.35     0.19              FITCH     67 OSPK   ETA+-=1.91+-.06  6/68
R20            . . . . . . . . . .
R20 AVG        2.41     0.15   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R20 FIT        2.384    0.076  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R21     KOL INTO (2GAMMA)/(3 PIO) (UNITS 10**-3)         (P9)/(P1)
R21      16    2.5      0.7               ARNOLD    68 HLBC   VACUUM DECAY    11/68
R21 $   BANNER 69 IS NEW EXPT. NOT TO BE CONF WITH R8 OF CRONIN1 67            2/72
R21     115    2.24     0.28              BANNER    69 OSPK                   11/68
R21      28    2.13     0.43              BARMIN    71 HLBC                    8/71
R21            . . . . . . . . . .
R21 AVG        2.24     0.22   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
```

Note on the $K_L^0 \to \mu^+\mu^-$ Controversy

The $K_L^0 \to \mu^+\mu^-$ branching ratios (R22) given by CLARK 71 and CARITHERS 73 are incompatible. We therefore make no attempt to combine their results.

CARITHERS 73 is a preliminary result based on their reported observation of 6 events. They are continuing data-taking and analysis.

CLARK 71 observe no events but would expect around 12 based on the CARITHERS 73 rate. CLARK 71 are rechecking their analysis but have found nothing, which could account for the loss of these events (A. Clark, private communication).

The discrepancy is interesting on theoretical grounds because the CLARK 71 result is below the "unitarity" lower limit for this decay.

```
R22     KOL INTO (MU+MU-)/(PI+PI-) (UNITS 10**-5)          (P6)/(P5)
R22       0   14.0    OR LESS  CL=.90   FOETH      69 ASPK                   5/70
R22       0    1.8    OR LESS  CL=.90   DARRIULAT  70 ASPK                  11/70
R22       0    0.12   OR LESS  CL=.90   CLARK      71 ASPK                   6/71
R22 C     6   (0.6)                     CARITHERS  73 ASPK   PRELIMINARY     1/73*
R22 C   CARITHERS 72 GIVES K3L TO MU+MU-/ALL=9*10**-9. WE CONVERT TO R22.    1/73*

R23     KOL INTO (E+ E- )/(PI+PI-) (UNITS 10**-5)          (P7)/(P5)
R23       0   10.0    OR LESS  CL=.90   FOETH      69 ASPK                   5/70
R23            0.10   OR LESS  CL=.90   CLARK      71 ASPK                   6/71

R24     KOL INTO (E MU)/(PI+PI-) (UNITS 10**-5)            (P8)/(P5)
R24            0.10   OR LESS  CL=.90   CLARK      71 ASPK                   6/71

R25     KOL INTO (PI E NEU GAM)/(KL E3) (UNITS 10**-2)     (P12)/(P3)
R25      10    3.3      2.0             PEACH      71 HLBC GAM KE GT 15 MEV  6/71

R26     KOL INTO (PIO TWO GAMMAS)/(3PIO) (UNITS 10**-3)  (P13)/(P1)
R26       0    1.1    OR LESS  CL=.90   BANNER     69 OSPK                   2/72

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Data Card Listings

For notation, see key at front of Listings.

Stable Particles

K^0_L

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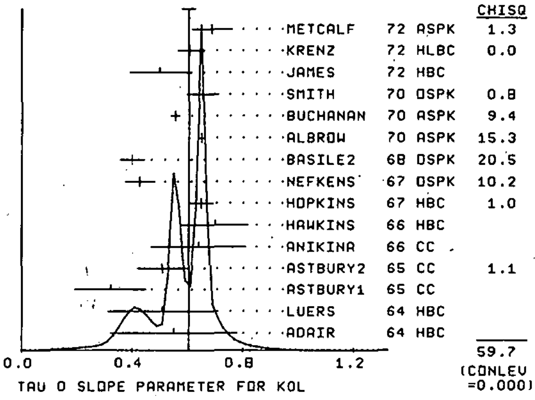
                13  KOL ENERGY DEPENDENCE OF DALITZ PLOT

        RELATED TEXT SECTION IV F.1, APPENDIX I, AND MINI-REVIEW ON SLOPE
        PARAMETERS IN THE CHARGED K SECTION OF THE DATA CARD LISTINGS ABOVE

       MATRIX ELEMENT SQUARED =  1 + G (S3-SO)/(MPI+**2)

GTO  LINEAR ENERGY DEPENDENCE (G) FOR TAU DECAYS  KLONG INTO PI+ PI- PIO
GTO     79     0.55     0.23            ADAIR      64 HBC  AV=-7.6 +- 1.7        3/71
GTO     77     0.51     0.20            LUERS      64 HBC  AV=-7.3 +- 1.6        3/71
GTO     66     0.32     0.13            ASTBURY1   65 CC   AV=-5.5 +- 1.5        3/71
GTO    310     0.51     0.09            ASTBURY2   65 CC   AV=-(7.3 +.6 -.8)     3/71
GTO    280     0.64     0.17            ANIKINA    66 CC   AV=-(8.2 +.9 -1.3)    3/71
GTO    126     0.70     0.12            HAWKINS    66 HBC  AV=-8.6 +- 0.7        3/71
GTO   1350     0.649    0.044           HOPKINS    67 HBC  AT=-0.294 +- .018    10/69
GTO   1198     0.428    0.055           NEFKENS    67 OSPK AU=-0.204 +- .025     3/71
GTO   2446     0.400    0.045           BASILE2    68 OSPK AT=-0.188 +- .020     3/71
GTO  29000     0.651    0.012           ALBROW     70 ASPK AY=-0.862 +- .015     1/71
GTO  B 36K     0.555    0.016           BUCHANAN   70 ASPK AU=-0.261 +- .007     3/71
GTO   4400     0.656    0.058           SMITH      70 OSPK AT=-0.297 +- .024     3/71
GTO    180     0.50     0.11            JAMES      72 HBC                        1/73*
GTO   1486     0.608    0.043           KRENZ      72 HLBC AT=-0.277 +- .018    11/72*
GTO    384     0.688    0.074           METCALF    72 ASPK AT=-0.31  +- .03     11/72*
GTO  B  BUCHANAN 70 GIVES A=0.257 +- .005 FOR A QUADRATIC FIT WITH               3/71
GTO  B  STATISTICAL ERRORS ONLY.  THE A VALUE USED HERE IS FOR A LINEAR          3/71
GTO  B  FIT AND INCLUDES SYSTEMATIC ERRORS. QUADRATIC FIT DOES NOT               1/73*
GTO  B  IMPROVE CHI SQUARED PROBABILITY.                                         1/73*
GTO          . . . . . . . . . .
GTO AVG        0.604    0.023   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 2.7)
                                (SEE IDEOGRAM BELOW )
```

WEIGHTED AVERAGE = 0.604 ± 0.023
ERROR SCALED BY 2.7



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                13  KOL FORM FACTORS

        RELATED TEXT SECTION IV F.2 AND MINI-REVIEW ON FORM FACTORS
        IN THE CHARGED K SECTION OF THE DATA CARD LISTINGS ABOVE

XIA     XIA = F-/F+ (DETERMINED FROM SPECTRA AND KMU3/KE3)  -------------
XIA   SOME OF THE OLDER EXPERIMENTS HAVE EVALUATED XI ASSUMING THAT IT IS
XIA     INDEPENDENT OF THE MOMENTUM TRANSFER (T), I.E., THEY SET L+=L-=0.
XIA     OTHERS HAVE ASSUMED A VALUE FOR L+ AND USED L-=0. ONLY RECENTLY
XIA     BOTH L+,L- AND XI(0) (OR THREE RELATED PARAMETERS) HAVE BEEN INCLU-
XIA     DED IN THE FITS. SEE CHIEN 70, DALLY 72, ALBROW 72.
XIA L  389  (+1.1)     (0.9)     (1.3)  ADAIR      64 HBC    KMU3/KE3            8/67
XIA L       (+0.66)    (0.9)     (1.3)  LUERS      64 HBC    KMU3/KE3            8/67
XIA L 1371  (+1.2)     (0.8)            CARPENTER  66 OSPK   MU,PI SPECTRA       8/67
XIA K         (0.2)    (0.8)     (1.2)  KULYUKINA  68 CC     MU,PI SPECTRA       2/71
XIA    770   +0.3      +0.4             BUDAGOV    68 HLBC   KM3/KE3,LM+=.023   11/68
XIA E 1309  (-0.22)    (0.30)           EVANS      69 HLBC   KM3/KE3,LM+=.02    10/69
XIA   3140   -3.9       0.4             BASILE     70 OSPK   DAL.PLT.LM+=.02    10/70
XIA   3548   -0.50      0.5             BASILE     70 OSPK   KM3/KE3,LM+=.02    10/70
XIA C  16K  (-0.68)    (0.12)   (0.20)  CHIEN      70 ASPK   DAL.PLT.LM+=.08     2/71
XIA  A9086   -1.5       0.7             ALBROW     72 ASPK   DAL.PLT.LM+=.085    8/72*
XIA  C 16K    0.50      0.61            DALLY      72 ASPK   DAL.PLT.LM+=.11     1/73*
XIA  E1309   -0.08      0.25            EVANS      73 HLBC   KM3/KE3,LM+=.02     1/73*
XIA L   LM+ AND LM- ASSUMED TO BE ZERO.
XIA K   LM+ AND LM- NOT GIVEN.
XIA C   CHIEN 70 VALUE AT L-=0 . L- AND XI(0) ARE HIGHLY CORRELATED.             2/71
XIA  C  DALLY 72 IS A REANALYSIS OF CHIEN 70, LAMBDA=-0.37+-0.15                 1/73*
XIA  A  ALBROW 72 GETS LM-=0.030+-0.060, LAMBDA=0.15+0.17-0.11                   1/73*
XIA  E  EVANS 73 REPLACES EVANS 69.  LM-=0                                       1/73*
XIA          . . . . . . . . . .
XIA AVERAGE MEANINGLESS (SCALE FACTOR = 4.0)

XIB     XIB = F-/F+ (DETERMINED FROM MU POLARIZATION IN KMU3)   -----------
XIB     THE MU POLARIZATION IS A MEASURE OF XI(T). NO ASSUMPTIONS ON L+-
XIB     NECESSARY, T SHOULD BE SPECIFIED.
XIB      FOR RAD. CORR. TO MUON POLARIZATION IN KMU3, SEE GINSBERG 71.           2/72
XIB   2608   -1.2       0.5             AUERBACH   66 OSPK   POLARIZATION        8/67
XIB    638   -1.6       0.5             ABRAMS     68 OSPK   POLARIZATION        5/69
XIB          -1.81      0.50      0.26  LONGO      69 CNTR   POL. T=2.65        11/69
XIB          . . . . . . . . . .
XIB AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

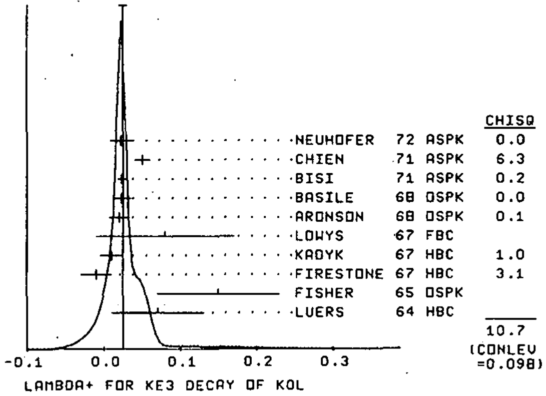
IXI        IMAGINARY PART OF XI  (TEST OF T REVERSAL)   -----------------
IXI          -0.2       0.6             ABRAMS     68 OSPK   MU POLARIZATION    10/69
IXI          -0.02      0.08            LONGO      69 CNTR   POL. T=2.65        11/69
IXI          . . . . . . . . . .
IXI AVG      -0.023     0.079   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

FS      FS/F+  RATIO OF SCALAR TO F+ COUPLINGS FOR KE3 DECAY(ABS. VALUE)----
FS             0.15  OR LESS  CL=.68   KULYUKINA 67 CC                          10/69

FT      FT/F+  RATIO OF TENSOR TO F+ COUPLINGS FOR KE3 DECAY(ABS. VALUE)----
FT             1.0   OR LESS  CL=.68   KULYUKINA 67 CC                          10/69
```

```
L+E      LAMBDA +  (LINEAR ENERGY DEPENDENCE OF F+ IN KO E3 DECAY)  ------
L+E      FOR RAD. CORR. TO THE DALITZ PLOT OF KE3, SEE GINSBERG 67.
L+E    153    +0.07      .06              LUERS      64 HBC    DLTZ PLOT,NO R.C
L+E    577    +0.15      .08              FISHER     65 OSPK   DLTZ PLT,NO R.C.   8/67
L+E    762    -0.01      .02              FIRESTONE  67 HBC    DLTZ PLT,NO R.C.   8/67
L+E    531    +0.01      .015             KADYK      67 HBC    E,PI SPEC,NO R.C   8/67
L+E    240    +0.08      .10       .08    LOWYS      67 FBC    PI SPEC, RAD COR   8/67
L+E   1000     0.02      0.013            ARONSON    68 OSPK   PI SPECTRUM        5/69
L+E   4800    +0.023     0.012            BASILE     68 OSPK   DLTZ PLT,NO R.C.   3/68
L+E    42K     0.023     0.005            BISI       71 ASPK   DLTZ PLT,R.C.     12/71
L+E    16K     0.05      0.01             CHIEN      71 ASPK   DLTZ PLT,NO R.C.   6/71
L+E   1910     0.022     0.014            NEUHOFER   72 ASPK   PI SPEC, RAD COR   1/73*
L+E          . . . . . . . . . .
L+E AVG        0.0249    0.0049  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.3)
                         (SEE IDEOGRAM BELOW )
```

WEIGHTED AVERAGE = 0.0249 ± 0.0049
ERROR SCALED BY 1.3

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L+M     LAMBDA +  (LINEAR ENERGY DEPENDENCE OF F+ IN KMU3 DECAY)
L+M       FOR RAD. CORR. TO DALITZ PLOT OF KMU3  SEE GINSBERG 70
L+M C  16K    (0.07)    (0.02)          CHIEN      70 ASPK   XIA=-.68+.12-.20  3/71
L+M  A9086     0.085     0.015          ALBROW     72 ASPK   XIA=-1.5+-0.7     8/72*
L+M  C 16K     0.11      0.04           DALLY      72 ASPK   XIA=.50+-.61      1/73*
L+M C   CHIEN 70 VALUE AND ERROR HAVE BEEN CHANGED FROM 0.08 +- 0.01 TO        3/71
L+M C   INCLUDE SYSTEMATIC EFFECTS. DALLY 72 IS A REANALYSIS OF CHIEN 70.      3/71
L+M     SEE ALSO THE CORRESPONDING ENTRIES AND FOOTNOTES IN SEC. XIA ABOVE.    1/73*
L+M          . . . . . . . . . .
L+M AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)
```

```
                 13  CP VIOLATION PARAMETERS IN KOL DECAYS

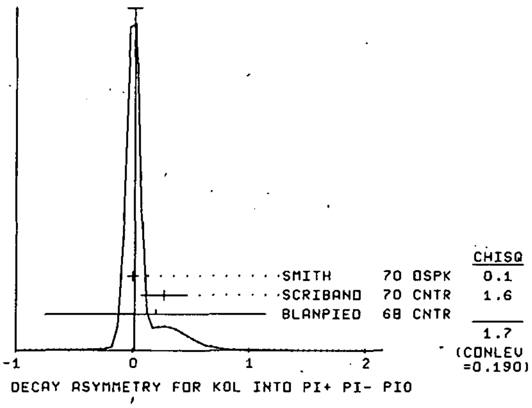
        RELATED TEXT SECTION IV F.3 AND MINI-REVIEW BELOW

-------------------13 CHARGE ASYMMETRY IN TAU DECAYS-------------------
TEXT SECTION IV F.3 B

      SEE SCRIBANO 70 FOR DEFINITION (HIS SIGMA+-). A=1 FOR MAX ASYMMETRY
      (M)**2 = 1+ SIG+- (2/SQRT(3) *((T+)-(T-))/ TMAX)  AS SCRIBANO 70

A       DECAY ASYMMETRY PARAMETER FOR PI+ PI- PIO   (UNITS 10**-2)
A       .3M     0.2       0.95            BLANPIED   68 CNTR                  4/70
A        3M     0.27      0.2             SCRIBANO   70 CNTR                 12/70
A      4400     0.000     0.050           SMITH      70 OSPK                 10/70
A            . . . . . . . . . .
A     AVG       0.016     0.063   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.3)
                                  (SEE IDEOGRAM BELOW )
```

WEIGHTED AVERAGE = 0.016 ± 0.063
ERROR SCALED BY 1.3



Stable Particles

K_L^0


```
--------------------13  CHARGE ASYMMETRY IN LEPTONIC DECAYS (PERCENT)------
TEXT SECTION IV F.3 C

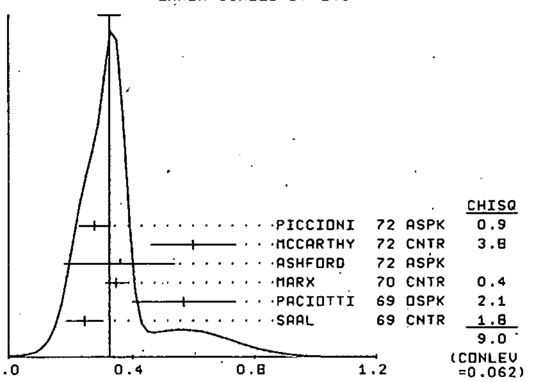
     SUCH ASYMMETRY VIOLATES CP . IT IS RELATED TO REAL(EPSILON).

A1      KOL INTO (MU+PI-NU)-(MU-PI+NU)/(MU+PI-NU)+(MU-PI+NU)     (PERCENT)
A1  D   1M    (0.403)  (0.134)          DORFAN    67 OSPK   DERIVED FROM R16 11/67
A1 D    1M     0.57     0.17            PACIOTTI  69 OSPK                     1/73*
A1     4.1M    0.60     0.14            MCCARTHY  72 CNTR                     1/73*
A1     7.7M    0.278    0.051           PICCIONI  72 ASPK                     1/73*
A1 D    PACIOTTI 69 IS A REANALYSIS OF DORFAN 67 AND IS CORRECTED FOR         1/73*
A1 D    MU+ MU- RANGE DIFFERENCE IN MC CARTHY 72.                             1/73*
A1            . . . . . . . . . .
A1  AVG        0.334    0.085   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.8)

A2      KOL INTO (E+PI-NU)-(E-PI+NU)/(E+PI-NU)+(E-PI+NU)         (PERCENT)
A2  B  10M    (0.224)  (0.036)          BENNETT   67 CNTR                    11/67
A2 B   10M     0.246    0.059           SAAL      69 CNTR                    10/70
A2     10M     0.346    0.033           MARX      70 CNTR                    10/70
A2    600K     0.36     0.18            ASHFORD   72 ASPK                     2/72
A2     18M    (0.266)  (0.034)          WEBB      72 ASPK    PRELIMINARY     11/72*
A2  B SAAL 69 IS A REANALYSIS OF BENNETT 67
A2            . . . . . . . . . .
A2  AVG        0.323    0.042   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.5)

AL       KOL INTO ((L+)-(L-))/((L+)+(L-))  (COMBINED A1 AND A2) (PERCENT)
AL B   10M     0.246    0.059           SAAL      69 CNTR                     2/71
AL D    1M     0.57     0.17            PACIOTTI  69 OSPK                     1/73*
AL     10M     0.346    0.033           MARX      70 CNTR                     2/71
AL    600K     0.36     0.18            ASHFORD   72 ASPK                     2/72
AL    4.1M     0.60     0.14            MCCARTHY  72 CNTR                     1/73*
AL    7.7M     0.278    0.051           PICCIONI  72 ASPK                     1/73*
AL     18M    (0.266)  (0.034)          WEBB      72 ASPK    PRELIMINARY     11/72*
AL      SEE FOOTNOTES IN SECTIONS A1 AND A2 ABOVE.                            1/73*
AL            . . . . . . . . . .
AL  AVG        0.326    0.036   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.5)
                               (SEE IDEOGRAM BELOW )
```

WEIGHTED AVERAGE = 0.326 ± 0.036
ERROR SCALED BY 1.5



CHARGE ASYMMETRY FOR KOL INTO LEPTONS

```
-------------------13  PARAMETERS FOR KOL INTO 2PI DECAY----------------
TEXT SECTION IV F.3 D

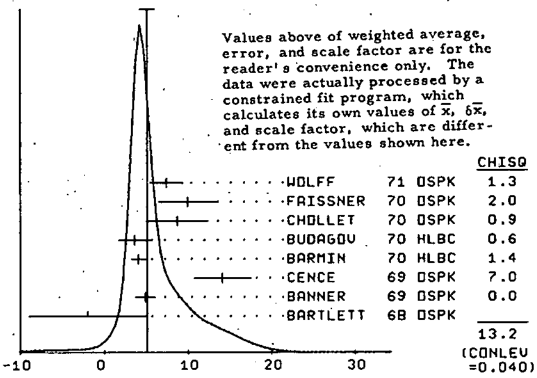
     ETA+- = A(KL TO PI+PI-)/A(KS TO PI+PI-)
     ETA00 = A(KL TO PI0PI0)/A(KS TO PI0PI0)

     THE FITTED VALUES OF ETA+- AND ETA00 GIVEN BELOW ARE DERIVED
     PRIMARILY FROM THE FITTED BRANCHING RATIOS FOR THE TWO PION DECAY
     MODES OF KOL AND KOS.  FOR THE QUANTITIES MEASURED BY INDIVIDUAL
     EXPERIMENTS SEE THE KOL BRANCHING RATIOS R9 AND R20 (ETA+-) AND
     R17 AND R19 (ETA00).  FOR THE READER'S CONVIENENCE WE LIST THE
     DERIVED QUANTITIES ETA+- (CALLED E+- BELOW) AND (ETA00)**2 (CALLED
     EOS BELOW).  HOWEVER, THE FIT FOR ETA+- AND ETA00 USES ONLY THOSE
     VALUES BELOW WHICH ARE INDEPENDENT OF BRANCHING RATIO MEASUREMENTS--
     ETA00 OF CHOLLET 70 AND WOLFF 71, AND (ETA00/ETA+-) OF BANNER1 72
     AND HOLDER 72.

EOS      (ETA00)**2 = (A(KL TO 2PI0)/A(KS TO 2PI0))**2  (UNITS 10**-6)   --
EOS       0    -2.       7.0            BARTLETT  68 OSPK                    10/69
EOS      57     4.9      1.2            BANNER    69 OSPK                     2/72
EOS     133    14.1      3.4            CENCE     69 OSPK                    10/69
EOS F   180   (13.)     (4.)            GAILLARD  69 OSPK                    10/69
EOS      29     4.08     0.9            BARMIN    70 HLBC                    12/70
EOS      30     3.61     1.9            BUDAGOV   70 HLBC                    10/70
EOS  C          8.7      3.7            CHOLLET   70 OSPK   CU REG.,4 GAMMAS  2/72
EOS  F 172      9.9      3.4            FAISSNER  70 OSPK                    12/70
EOS  C  56      7.4      2.0            WOLFF     71 OSPK   CU REG.,4GAMMAS  12/71
EOS  C  CHOLLET 70 GIVES ETA00=(1.23+-0.24)*(REGEN AMPL,2GEV/C CU)/10000MB    2/72
EOS  C  WOLFF 71   GIVES ETA00=(1.13+-0.12)*(REGEN AMPL,2GEV/C CU)/10000MB    2/72
EOS  C  WE COMPUTE BOTH ETA00**2 VALUES FOR (REGEN AMPL,2GEV/C CU)=24+-2MB.   2/72
EOS  C  THIS REGEN AMPL RESULTS FROM AVERAGING OVER FAISSNER 69,              2/72
EOS  C  EXTRAPOLATED USING OPTICAL MODEL CALCULTIONS OF BOHM ET AL.           2/72
EOS  C  PL 27B 594 (1968) AND THE DATA OF BALATS 71. (FROM H. FAISSNER,       2/72
EOS  C  PRIVATE COMMUNICATION)                                                2/72
EOS  F  FAISSNER 70 CONTAINS SAME 2PI0 EVENTS AS GAILLARD 69
EOS           . . . . . . . . . .
EOS AVG         5.13     0.90   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.5)
EOS FIT         4.35     0.40  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)  1/73*
                               (SEE IDEOGRAM BELOW )

E+-     ETA+-  = A(KL TO PI+PI-)/A(KS TO PI+PI-) UNITS 10**-3  ----------
E+-      45   (1.94)                    CHRISTENS 64 OSPK                    10/69
E+-      54   (2.02)                    GALBRAITH 65 OSPK                    10/69
E+-           (1.86)                    BASILE    66 OSPK                    10/69
E+-           (1.935)                   BOTT-BODE 66 OSPK                    10/69
E+-     525    1.91      .06            FITCH     67 OSPK                    10/69
E+-           . . . . . . . . . .
E+- FIT        1.980    0.036  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)  1/73*
```

WEIGHTED AVERAGE = 5.13 ± 0.90
ERROR SCALED BY 1.5



ETA00**2 FOR KOL INTO 2PIO

```
ER      RATIO OF ETA00 OVER ETA+-
ER      124    1.03     0.07            BANNER1   72 OSPK                     8/72*
ER      167    1.00     0.06            HOLDER    72 ASPK                     8/72*
ER            . . . . . . . . . .
ER  AVG        1.013    0.046   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
ER  FIT        1.054    0.046  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)  1/73*
```

Note on $K_L^0 \to 2\pi$ and K_S Regeneration

Some experiments obtain ϕ_{+-} (the phase of η_{+-}) using K_S, $K_L \to \pi^+\pi^-$ interference behind a regenerator. In these interference experiments the measured quantity is the difference of ϕ_{+-} and the regeneration phase ϕ_R, as shown in the expression below. After the regenerator, the intensity of the $\pi^+\pi^-$ decays in the forward direction is

$$I(t,p) = S(p)\Big[|R(p)|^2 e^{-\Gamma_S t} + |\eta_{+-}|^2 e^{-\Gamma_L t} + 2|R(p)||\eta_{+-}| \times e^{-(\Gamma_S+\Gamma_L)t/2} \cos(\Delta m t + \phi_R(p) - \phi_{+-})\Big], \quad (1)$$

where:

t is the decay time in the K^0 rest frame,

$\Delta m = m_L - m_S$, and m_L, Γ_L, m_S, Γ_S are the masses and decay rates of the long- and short-lived K^0,

$\eta_{+-} = |\eta_{+-}| e^{i\phi_{+-}}$ is the ratio of decay amplitudes $A(K_L \to \pi^+\pi^-)/A(K_S \to \pi^+\pi^-)$,

$S(p)$ is propotional to the K_L momentum spectrum, and

$R(p) = |R(p)| e^{i\phi_R(p)}$ is the transmission-regenerated K_S amplitude (relative to the K_L):

$$R(p) = \pi N \Lambda i \frac{[f_0(p) - \bar{f}_0(p)]}{p} \left\{ \frac{1 - e^{-\frac{1}{2}\Gamma_S \ell(p)[1-2i\Delta m/\Gamma_S]}}{\frac{1}{2}\Gamma_S[1-2i\Delta m/\Gamma_S]} \right\}, \quad (2)$$

where

Data Card Listings

For notation, see key at front of Listings.

Stable Particles

K^0_L

$\ell(p)$ is the thickness of regenerator measured in units of the mean decay length of K_S,

N is the number of nuclei per cubic centimeter,

Λ is the K_S mean decay length, and

$f_0(p), \overline{f}_0(p)$ are the forward scattering amplitude of K^0 and $\overline{K}^0$.

From (1) above it is clear that the value of ϕ_{+-} is correlated with the value of Δm and ϕ_R. Usually Δm is a parameter of the fit and ϕ_R is determined by some other means (optical model calculations, time dependence of the charge asymmetry in K_{e3} decay, etc.).

We list ϕ_{+-} and give in comment cards both the value of ϕ_R used by the authors and the Δm dependence of ϕ_{+-}.

```
F+-     PHASE OF ETA +-          (DEGREES)  ------------------------------
F+-      DM IS (KOL-KOS MASS DIFFERENCE / HBAR) IN UNITS OF 10**10 SEC-1     2/71
F+-           SEE SECTION D OF KOL LISTINGS FOR LATEST VALUE
F+-      WE HAVE ADDED THE MASS DEPENDENCE AND PROPAGATED THE ERROR IN DM    2/71
F+-      USING DM=0.5398+-0.0033 FOR BENNETT 69, BOHM 69, FAISSNER 69,       2/71
F+-      JENSEN 70, AND BALATS 71. THE APRIL 1972 DM(0.5402+-0.0035) WOULD   3/72
F+-      NOT MAKE A SIGNIFICANT CHANGE IN THE PHASE.                         3/72
F+-          45.0     50.0              FITCH     65 OSPK    BE REGEN       11/67
F+-          30.0     45.0              FIRESTONE 66 HBC                    11/67
F+-          70.0     21.0              BOTT-BODE 67 OSPK    C REGEN        11/67
F+-          25.0     35.0              MISCHKE   67 OSPK    CU REGEN        7/68
F+- N       (51.0)   (11.0)             BENNETT2  68 CNTR    CU REG. USES    8/68
F+-  C       34.5     10.0              BENNETT   69 CNTR    CU REGEN        2/71
F+-  B       47.6     12.1              BOHM      69 OSPK    VACUUM REGEN    2/71
F+-  F       46.2      7.4              FAISSNER  69 ASPK    CU REGEN        2/71
F+-  J       43.4      4.4              JENSEN    70 ASPK    VACUUM REGEN    2/71
F+-  D       38.0     12.0              BALATS    71 OSPK    CU REGEN        9/71
F+-  P       36.2      6.1              CARNEGIE  72 ASPK                    1/73*
F+-        . . . . . . . . . .
F+- AVG      41.8      2.8    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
                     COMMENTS
F+-  N  BENNETT 69 IS A REEVALUATION OF BENNETT2 68.                        11/69
F+-  C  BENNET 69 USES MEASUREMENT OF (F+-)-(PHIF) OF ALFF-STEI 66           2/71
F+-  C  BENNETT 69 F+-= 34.9+-10.0, NOT INCLUDING ERROR IN DM                2/71
F+-  C  DM DEPENDENCE OF BENNETT 69 IS 69*(DM-0.545) DEG. FR=-49.9+-5.4DEG.  2/71
F+-  B  BOHM 69 F+-=41+-12, NOT INCLUDING ERROR IN DM.                       2/71
F+-  B  DM DEPENDENCE OF BOHM 69 IS 479*(DM-0.526) DEG.                      2/71
F+-  F  FAISSNER 69 ERROR ENLARGED TO INCLUDE ERROR IN REGENERATOR PHASE.   11/69
F+-  F  FAISSNER 69 F+-=49.3+-7.4, NOT INCLUDING ERROR IN DM.                2/71
F+-  F  DM DEPENDENCE OF FAISSNER 69 IS 205*(DM-0.555) DEG. FR=-42.7+-5DEG.  2/71
F+-  J  JENSEN 70 F+-=42.4+-4.0, NOT INCLUDING ERROR IN DM.                  2/71
F+-  J  DM DEPENDENCE OF JENSEN 70 IS 576*(DM-0.538) DEG.                    2/71
F+-  D  BALATS 71 F+-=39+-12, NOT INCLUDING ERROR IN DM. FR=-43+-4 DEG.      9/71
F+-  D  DM DEPENDENCE OF BALATS 71 IS 198*(DM-.544) DEG.                     9/71
F+-  P  CARNEGIE 72 INSENSITIVE TO DM. FR=-56.2+-5.2 DEG..                   1/73*

F00     PHASE OF ETA 00    (DEGREES)     ------------------------------
F00    FIRST QUADRANT PREFERRED         GOBBI     69 OSPK                   11/69
F00  C       51.      30.               CHOLLET   70 OSPK    CU REG.,4 GAMMAS 10/70
F00  W  56   38.0     25.0              WOLFF     71 OSPK    CU REG.,4GAMMAS  12/71
F00        . . . . . . . . . .
F00 AVG      43.3     19.2    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
F00  C  CHOLLET 70 USES REGENERATOR PHASE FR=-46.5+-4.4 DEG.                 1/73*
F00  W  WOLFF 71   USES REGENERATOR PHASE FR=-48.2+-3.5 DEG.                 1/73*
```

Superweak Model Predictions for $\phi_{\eta_{+-}}$ and $\phi_{\eta_{00}}$

The superweak model of Wolfenstein, Phys. Letters 13, 562 (1964) predicts that

$$\phi_{+-} = \phi_{00} = \tan^{-1}\left(\frac{2\Delta m\,\tau_S}{\hbar}\right)$$

and

$$\mathrm{Re}\,\epsilon = |\eta_{+-}|\left[1 + \left(\frac{2\Delta m\,\tau_S}{\hbar}\right)^2\right]^{-1/2}$$

The K^0_L-K^0_S mass difference, the K_S lifetime, and $|\eta_{+-}|$ given in the Stable Particle Table result in the predictions that

$$\phi_{+-} = \phi_{00} = (43.63 \pm 0.32)^\circ$$

and

$$\mathrm{Re}\,\epsilon = (1.433 \pm 0.027) \times 10^{-3}.$$

These can be compared with the experimental values

$$\phi_{+-} = (41.8 \pm 2.8)^\circ$$
$$\phi_{00} = (43 \pm 19)^\circ$$
$$\mathrm{Re}\,\epsilon = (1.62 \pm 0.20) \times 10^{-3}$$

where ϵ has been computed from δ, the charge asymmetry parameter for leptonic K^0_L decays, and (Re x, Im x), the $\Delta S = -\Delta Q$ amplitude, using Eq. (34) of the text.

As noted in the mini-review preceding the K^0_S mean life, the measured values of Δm and ϕ_{+-} used above have not been adjusted for our new value of τ_S. Had we used the adjusted value for Δm, the predictions would be

$$\phi_{+-} = \phi_{00} = (43.95 \pm .32)^0$$

and

$$\mathrm{Re}\,\epsilon = (1.426 \pm 0.027) \times 10^{-3}.$$

The measured value of ϕ_{+-} would be adjusted to

$$\phi_{+-} \simeq (45.2 \pm 2.8)^0.$$

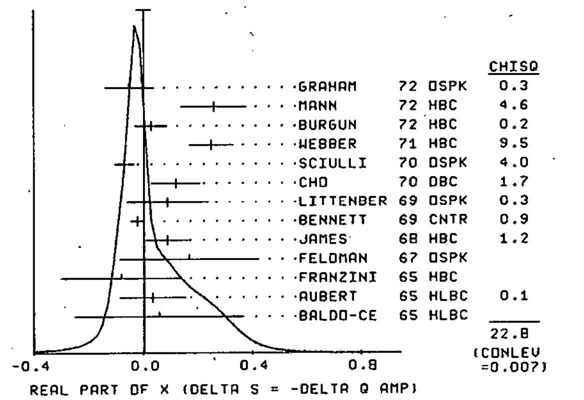
```
               13  X = (DS=-DQ AMPLITUDE)/(DS=+DQ AMPLITUDE)

      RELATED TEXT SECTION IV F.4

REX      REAL PART OF X
REX   C 152    0.06     0.18     0.44  BALDO-CE  65 HLBC   K+ CHARGE EXCHNG 11/67
REX     196    0.035    0.11     0.13  AUBERT    65 HLBC   K+ CHARGE EXCHNG 11/67
REX   F 109   -0.08     0.16     0.28  FRANZINI  65 HBC    PBAR P           11/67
REX     116    0.17     0.16     0.35  FELDMAN   67 OSPK   PI-P TO KO LMBDA 11/67
REX N   335   (0.17)   (0.10)          HILL      67 DBC    K+D YIELDS KOPP  11/67
REX B         (0.03)   (0.03)          BENNETT1  68 CNTR                     7/68
REX     121    0.09     0.07     0.09  JAMES     68 HBC    PBAR P            5/69
REX   B       -0.020    0.025          BENNETT   69 CNTR   CHAR ASYM+ CU RE 10/69
REX     686    0.09     0.14     0.16  LITTENBER 69 OSPK   K+N TO KOP        4/69
REX   N 215    0.12     0.09           CHO       70 DBC    K+D TO KOPP      10/70
REX    1079   -0.069    0.036          SCIULLI   70 OSPK   PI-P             11/70
REX     252    0.25      .07      .09  WEBBER    71 HBC    K-P TO KBAR N    10/69
REX     410    0.03     0.06     0.06  BURGUN    72 HBC    K+P TO KOPPI+     1/73*
REX     126    0.26     0.10     0.14  MANN      72 HBC    K-P TO KOBAR N    9/72*
REX G   342   (-0.13)  (0.11)          MANTSCH   72 OSPK   KE3  FROM KO LMB  2/72
REX G   100   (0.04)   (0.10)   (0.13) GRAHAM    72 OSPK   KMU3 FROM KO LMB  2/72
REX   G 442   -0.05     0.09           GRAHAM    72 OSPK   PI-P TO KO LMBDA  2/72
REX G   SECOND GRAHAM 72 VALUE IS FIRST GRAHAM 72 VALUE COMBINED WITH        2/72
REX G   MANTSCH 72.                                                          2/72
REX  B  BENNETT 69 IS A REANALYSIS OF BENNETT1 68
REX  C  BALDO-CE 65 GIVES X AND THETA.CONVERTED BY US TO REX AND IMX.       11/67
REX  F  FRANZINI 65 GIVES X AND THETA.FOR REX AND IMX SEE SCHMIDT 67.       11/67
REX N   CHO 70 IS ANALYSIS OF UNAMBIGUOUS EVENTS IN NEW DATA AND HILL 67.
REX          . . . . . . . . .
REX AVG        0.003    0.027   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.6)
                       (SEE IDEOGRAM BELOW ).
```

WEIGHTED AVERAGE = 0.003 ± 0.027

ERROR SCALED BY 1.6

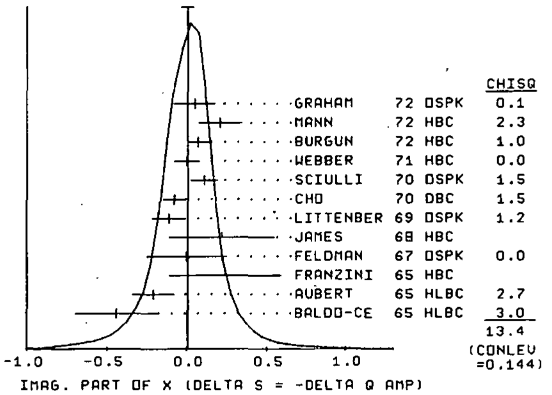


Stable Particles

K_L^0


```
IMX      IMAGINARY PART OF X (ASSUMES M(KL)-M(KS) POSITIVE -- SEE S130)
IMX  C 152    -0.44      0.32      0.19  BALDO-CE  65 HLBC   K+ CHARGE EXCHNG  3/68
IMX    196    -0.21      0.11      0.15  AUBERT    65 HLBC   K+ CHARGE EXCHNG  3/68
IMX  F 109    +0.24      0.40      0.30  FRANZINI  65 HBC    PBAR P            3/68
IMX    116     0.0       0.25            FELDMAN   67 OSPK   PI-P TO KO LMBDA 11/67
IMX N  335   (-0.20)    (0.10)           HILL      67 DBC    K+D YIELDS KOPP  11/67
IMX    121    +0.22      0.37      0.29  JAMES     68 HBC    PBAR P            5/69
IMX    686    -0.11      0.10      0.11  LITTENBER 69 OSPK   K+N TO KOP        4/69
IMX  N 215    -0.08      0.07            CHO       70 DBC    K+D TO KOPP      10/70
IMX   1079     0.108     0.092     0.074 SCIULLI   70 OSPK   PI-P             11/70
IMX    252     0.0       .08             WEBBER    71 HBC    K-P TO KBAR N    10/69
IMX    410     0.07      0.06      0.07  BURGUN    72 HBC    K+P TO KOPPI+     1/73*
IMX    126     0.21      0.15      0.12  MANN      72 HBC    K-P TO KOBAR N    9/72*
IMX G  342   (-0.04)    (0.16)           MANTSCH   72 OSPK   KE3  FROM KO LMB  2/72
IMX G  100    (0.12)    (0.17)    (0.16) GRAHAM    72 OSPK   KMU3 FROM KO LMB  2/72
IMX  G 442     0.05      0.13            GRAHAM    72 OSPK   PI-P TO KO LMBDA  2/72
IMX G    SECOND GRAHAM 72 VALUE IS FIRST GRAHAM 72 VALUE COMBINED WITH         2/72
IMX G    MANTSCH 72.                                                           2/72
IMX  C   BALDO-CE 65 GIVES X AND THETA.CONVERTED BY US TO REX AND IMX.        11/67
IMX  F   FRANZINI 65 GIVES X AND THETA.FOR REX AND IMX SEE SCHMIDT 67.        11/67
IMX N    FTNOTE 10 OF HILL 67 SHOULD READ +0.58, NOT -0.58 (PRIV.COMM.).       3/68
IMX N    CHO 70 IS ANALYSIS OF UNAMBIGUOUS EVENTS IN NEW DATA AND HILL 67.
IMX            . . . . . . . . . .
IMX AVG        0.005     0.038    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.2)
                                  (SEE IDEOGRAM BELOW )
```

WEIGHTED AVERAGE = 0.005 ± 0.038
ERROR SCALED BY 1.2



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REFERENCES FOR KOL


```
BARDON   58 ANP 5 156           M BARDON,K LANDE,L LEDERMAN  (COLUMBIA+BNL)
CRAWFORD 59 PRL 2 361           CRAWFORD,CRESTI,DOUGLASS,GOOD +        (LRL)
ASTIER   61 AIX CONF 1 227      ASTIER,BLASKOVIC,RIVET,SIAUD +        (EPOL)
FITCH    61 NC  22 1160         V FITCH,P PIROUE,R PERKINS       (PRINCETON)
GOOD     61 PR 124 1223         GOOD,MATSEN,MULLER,PICCIONI,POWELL +  (LRL)
NEAGU    61 PRL  6  552         NEAGU,OKONOV,PETROV,ROSANOVA,RUSAKOV (JINR)

CAMERINI 62 PR 128 362          CAMERINI,FRY,GAIDOS,BIRGE,ELY +  (WISC+LRL)
DARMON   62 PL 3 57             J DARMON,A ROUSSET,J SIX              (EPOL)

ADAIR    64 PL 12 67            R K ADAIR,L B LEIPUNER            (YALE+BNL)
ALEKSANY 64 DUBNA 2 102         ALEKSANYAN,ALIKHANYAN,VARTAZARYAN+ (EREVAN)
   ALSO  64 JETP 19 1019        ALEKSANYAN+    (LEBEDEV+MOS ENG PHYS+EREVAN)
ANIKINA  64 JETP 19 42          ANIKINA,ZHURAVLEVA+ (GEORG ACAD SCI+ DUBNA)
CHRISTEN 64 PRL 13 138          CHRISTENSON,CRONIN,FITCH,TURLAY (PRINCETON)
FUJII    64 DUBNA 2 146         FUJII,JOVANOVICH,TURKOT+ (BNL,MARYLAND,MIT)
LUERS    64 PR 133 B 1276       LUERS,MITTRA,WILLIS,YAMAMOTO           (BNL)

ANIKINA  65 JINR P 2488         ANIKINA,VARDENGA,ZHURAVLEVA,KOTLYA+ (DUBNA)
ANDERSON 65 PRL 14 475          ANDERSON,CRAWFORD,GOLDEN,STERN + (LRL+WISC)
ASTBURY1 65 PL 16 80            ASTBURY,FINOCCHIARO,BEUSCH +  (CERN+ZURICH)
   ALSO  65 HELV.PH.AC.39 523   M PEPIN
ASTBURY2 65 PL 18 175           ASTBURY,MICHELINI,BEUSCH +    (CERN+ZURICH)
ASTBURY3 65 PL 18 178           ASTBURY,MICHELINI,BEUSCH +    (CERN+ZURICH)
AUBERT   65 PL 17 59            AUBERT,BEHR,CANAVAN,CHOUNET+   (EPOL+ORSAY)
   ALSO  67 LOWYS
BALDO-CE 65 NC 38 684           BALDO-CEOLIN,CALIMANI,CIAMPOLILLO +  (PADO)

CHRISTEN 65 PR 140 B 74         CHRISTENSON,CRONIN,FITCH,TURLAY (PRINCETON)
FISHER   65 ANL 7130 83         FISHER,ABASHIAN,ABRAMS,CARPENTER+      (ILL)
FITCH    65 PRL 15 73           FITCH,ROTH,RUSS,VERNON           (PRINCETON)
FRANZINI 65 PR 140 B 127        FRANZINI,KIRSCH,PLANO +  (COLUMBIA+RUTGERS)
GALBRAIT 65 PRL 14 383          GALBRAITH,MANNING,JONES +  (AERE+BRIS+RHEL)
GUIDONI  65 ARGONNE CONF 49     +BARNES,FOELSCHE,FERBEL,FIRESTO+ (BNL+YALE)
HOPKINS  65 ARGONNE CONF 67     H W K HOPKINS,BACON,EISLER   (VAND+RUTGERS)
VISHNEVS 65 PL  18   339        VISHNEVSKY,GALANINA,SEMENOV +         (ITEP)

ALFF-STE 66 PL 21 595           ALFF-STEINBERGER,HEUER,RUBBIA +       (CERN)
ANIKINA  66 SJNP 2 339          ANIKINA, VARDENGA, ZHURAVLEVA+        (JINR)
AUERBACH 66 PRL  17  980        AUERBACH,MANN,MCFARLANE,SCIULLI       (PENN)
AUERBACH 66 PR  149 1052        AUERBACH,DOBBS,LANDE,MANN,SCIULLI+    (PENN)
   ALSO  65 PRL  14  192        +LANDE,MANN,SCIULLI,UTO,WHITE,YOUNG   (PENN)
BALDO-CE 66 NC  45A  733        BALDO-CEOLIN,CALIMANI,CIAMPOLILLO+   (PADUA)
BASILE   66  BALATON CONF       BASILE,CRONIN,THEVENET +            (SACLAY)

BEHR     66 PL  22 540          +BRISSON,BALDO-CEOLIN,AUBERT+    (PADO,EPOL)
BELLOTTI 66 NC  45A  737        BELLOTTI,PULLIA,BALDO-CEOLIN+ (MILAN,PADUA)
BOTT-BOD 66 PL  23  277         BOTT-BODENHAUSEN,DE BOUARD,CASSEL+    (CERN)
CAMERINI 66 PR  150 1148        CAMERINI,CLINE,ENGLISH,FISCHBEIN+WISCONSIN
CANTER   66 PRL 17 942          +CHO,ENGLER,FISK,HILL +       (CARNEGIE+BNL)
CARPENTE 66 PR  142  871        CARPENTER,ABASHAN,ABRAMS,FISHER  (ILLINOIS)
CHANG    66 PL  23  702         CHANG,BASSANO,KIKUCHI,DODD+   (SYRACUSE,BNL)

CRIEGEE  66 PRL 17 150          +FOX,FRAUENFELDER,HANSON,MOSCAT+ (ILLINOIS)
FIRESTON 66 PRL 16 556          FIRESTONE,KIM,LACH,SANDWEISS+     (YALE,BNL)
FIRESTON 66 PRL 17 116          FIRESTONE,KIM,LACH,SANDWEISS+     (YALE,BNL)
FUJII    66 PRL 13 253          FUJII,JOVANOVICH,TURKOT,ZORN (BNL+MARYLAND)
   FUJII 66 IS THE CORRECTED VALUE GIVEN BY JOVANOVICH+ 66
HAWKINS  66 PL 21 238           C J B HAWKINS                         (YALE)
   ALSO  67 PR  156  1444       C J B HAWKINS                         (YALE)

JOVANOVI 66 PRL 17 1075         JOVANOVICH,FUJII,TURKOT,ZORN +(BNL+UMD+MIT)
KULYUKIN 66  BERKELEY 28        KULYUKINA,MESTVIRISHVILI,NEAGU,PETR+ (JINR)
MEISNER1 66 PRL 16 278          G W MEISNER,B B CRAWFORD,F CRAWFORD    (LRL)
MEISNER2 66 PRL  17  492        G MEISNER,B CRAWFORD,F CRAWFORD        (LRL)
NEFKENS  66 PL 19 706           NEFKENS,ABASHIAN,ABRAMS,CARPENTER+     (ILL)
VERHEY   66 PRL 17 669          VERHEY,NEFKENS,ABASHIAN+               (ILL)

BENNETT  67 PRL  19  993        BENNETT,NYGREN,SAAL,STEINBERGER +(COLUMBIA)
BOTT-BOD 67 PL  24B  194        BOTT-BODENHAUSEN,DEBOUARD,CASSEL +    (CERN)
BOTT-BOD 67 PL  24B  438        BOTT-BODENHAUSEN,DEBOUARD,DEKKERS+    (CERN)
   ALSO  66 PL  20  212         BOTT-BODENHAUSEN,DEBOUARD,CASSEL+     (CERN)
   ALSO  66 PL  23  277         BOTT-BODENHAUSEN,DEBOUARD,CASSEL+     (CERN)
CANTER   67 THESIS              J.M. CANTER                       (CARNEGIE)
CRONIN 1 67 PRL 18 25           +KUNZ,RISK,WHEELER               (PRINCETON)
CRONIN 2 67 PRINC CONF(11/67)   +KUNZ,RISK,WHEELER               (PRINCETON)
DEBOUARD 67 NC  52A  662        DEBOUARD,DEKKERS,JORDAN,MERMOD +      (CERN)
   ALSO  65 PL  15  58          DE BOUARD,DEKKERS,SCHARFF+ (CERN+ORSA+MPIM)

DEVLIN   67 PRL 18 54           DEVLIN,SOLOMON,SHEPARD,BEALL+     (PRIN+UMD)
   ALSO  68 PR 169 1045         SAYER,BEALL,DEVLIN,SHEPHARD+ (UMD+PPA+PRIN)
DORFAN   67 PRL  19  987        DORFAN,ENSTROM,RAYMOND,SCHWARTZ +(SLAC+LRL)
FELDMAN  67 PR  155  1611       FELDMAN,FRANKEL,HIGHLAND,SLOAN        (PENN)
FIRESTON 67 PRL 18  176         FIRESTONE,KIM,LACH,SANDWEISS,+    (YALE,BNL)
FITCH    67 PR 164  1711        FITCH,ROTH,RUSS,VERNON           (PRINCETON)
HAWKINS  67 PR  156  1444       C J B HAWKINS                         (YALE)
HILL     67 PRL  19  668        HILL,LUERS,ROBINSON,CANTER+  (BNL,CARNEGIE)

HOPKINS  67 PRL 19  185         HOPKINS,BACON,EISLER                   (BNL)
KADYK    67 PRL 19  597         KADYK,CHAN,DRIJARD,OREN,SHELDON        (LRL)
KULYUKIN 67  PREPRINT           KULYUKINA+MESTVIRISHVILI+NEAGU +      (JINR)
LOWYS    67 PL  24B  75         LOWYS,AUBERT,CHOUNET,PASCAUD+    (EPOL,ORSA)
MISCHKE  67 PRL 18  138         MISCHKE,ABASHIAN,ABRAMS+          (ILLINOIS)
NEFKENS  67 PR  157  1233       +ABASHIAN,ABRAMS,CARPENTER,FISHER+     (ILL)
TODOROFF 67  THESIS             JOHN A TODOROFF                   (ILLINOIS)

ABRAMS   68 PR   176  1603      +ABASHIAN,MISCHKE,NEFKENS,SMITH+ (ILLINOIS)
ARNOLD   68 PL 28B 56           ARNOLD,BUDAGOV,CUNDY,AUBERT+   (CERN+ORSAY)
ARONSON  68 PRL 20 287          S.H.ARONSON, K.W.CHEN            (PRINCETON)
   ALSO  69 PR   175 1708       S H ARONSON, K W CHEN            (PRINCETON)
BALATZ   68 PL 26B  320         BALATZ,BEREZIN,VISHNEVSKY,GALANINA+  (ITEP)
BARTLETT 68 PRL 21 558          BARTLETT,CARNEGIE,FITCH+         (PRINCETON)

BASILE   68 PL 26B  542         BASILE,CRONIN,THEVENET,TURLAY+      (SACLAY)
BASILE2  68 PL 28B  58          +CRONIN,THEVENET,TURLAY,ZYLBERAJCH+(SACLAY)
BENNETT1 68 PL 27B 244          BENNETT,NYGREN,STEINBERGER+ (COLUMBIA+CERN)
BENNETT2 68 PL 27B 248          BENNETT,NYGREN,STEINBERGER+ (COLUMBIA+CERN)
BLANPIED 68 PRL 21 1650         BLANPIED,LEVIT,ENGELS+      (CASE+HARV+MCGI)
BUDAGOV  68 NC 57A 182          BUDAGOV,BURMEISTER,CUNDY+   (CERN,ORSA,IPNP)
   ALSO  68 PL   28B 215        +CUNDY,MYATT,NEZRICK+       (CERN,ORSA,EPOL)

CARNEGIE 68 PRINC TR44 THESIS   R.K.CARNEGIE                     (PRINCETON)
JAMES    68 NP  B8 365          F JAMES, H BRIAND                (IPNP,CERN)
   ALSO  68 PRL 21 257          HELLAND,LONGO,YOUNG              (UCLA,MICH)
KULYUKIN 68 JETP 26 20          KULYUKINA,MESTVIRISHVILI,NEAGU+       (JINR)
KUNZ     68 THESIS (PU 46)      P F KUNZ                         (PRINCETON)
MELHOP   68 PR 172 1613         MELHOP MURTY BOWLES,BURNETT+     (LA JOLLA)
THATCHER 68 PR 174 1674         THATCHER,ABASHIAN,ABRAMS,CARPENTER +   (ILL)

BANNER   69 PR 188 2033         +CRONIN,LIU,PILCHER              (PRINCETON)
   ALSO  68 PRL 21 1103         BANNER,CRONIN,LIU,PILCHER        (PRINCETON)
   ALSO  68 PRL 21 1107         BANNER CRONIN,LIU,PILCHER        (PRINCETON)
BEILLIER 69 PL  30B 202         BEILLIERE,BOUTANG,LIMON               (EPOL)
BENNETT  69 PL  29B 317         +NYGREN,SAAL,STEINBERGER+         (COLU,BNL)
BOHM     69 NP  B9 605          +DARRIULAT,GROSSO,KAFTANOV+           (CERN)
   ALSO  68 PL 27B 321          BOHM,DARRIULAT,GROSSO,KAFTANOV        (CERN)

BOTT-BOD 69 CERN 69-7 329       BOTT-BODENHAUSEN,DE BOUARD,CASSEL+    (CERN)
CENCE    69 PRL 22 1210         CENCE,JONES,PETERSON,STENGER+   (HAWAII,LRL)
EVANS    69 PRL 23 427          EVANS,GOLDEN,MUIR,PEACH+   (EDINBURGH,CERN)
FAISSNER 69 PL  30B 204         +FOETH,STAUDE,TITTEL+       (AACH,CERN,TORI)
FOETH    69 PL 30B 282          +HOLDER,RADERMACHER +  (AACHEN,CERN,TORINO)

GAILLARD 69 NC  59A 453         +GALBRAITH,HUSSRI,JANE+  (CERN,RHEL,AACHEN)
   ALSO  67 PRL 18 20           +KRIENEN,GALBRAITH,HUSSRI+ (CERN+RHEL+AACH)
GOBBI    69 PRL 22 685          +GREEN,HAKEL,MOFFETT,ROSEN,GOZ+ (ROCH+RUTG)
LITTENBE 69 PRL 22 654          LITTENBERG,FIELD,PICCIONI,MEHLHOP+    (UCSD)
LONGO    69 PR 181  1808        M J LONGO,K K YOUNG,J A HELLAND (MICH,UCLA)
PACIOTTI 69 THESIS,UCRL 19446   M A PACIOTTI                           (LRL)
SAAL     69 THESIS              H J SAAL                          (COLUMBIA)

ALBROW   70 PL 33B 516          +ASTON,BARBER,BIRD,ELLISON +     (MCHS+DARE)
ARONSON  70 PRL 25 1057         +EHRLICH,HOFER,JENSEN+      (EFI,ILLC,SLAC)
BARMIN   70 PL 33B 377          +BARYLON,BORISOV,BYSHEVA+        (ITEP,JINR)
BASILE   70 PR D2 78            +CRONIN,THEVENT,TURLAY,ZYLBERAJCH +  (SACL)
BUCHANAN 70 PL 33B 623          +DRICKEY,RUDNICK,SHEPARD+   (SLAC,JHU,UCLA)
   ALSO PRIVATE COMMUNICATION, B. COX, FEB. 71
BUDAGOV  70 PR D2 815           +CUNDY,MYATT,NEZRICK+      (CERN, ORSA,EPOL)
   ALSO  68 PL  28B 215         +CUNDY,MYATT,NEZRICK+       (CERN,ORSA,EPOL)

CHIEN    70 PL 33B 627          C-Y.CHIEN,COX,ETTLINGER +   (JHU+SLAC+UCLA)
   ALSO PRIVATE COMMUNICATION, B. COX, FEB. 71.
CHO      70 PR D1 3031          +DRALLE,CANTER,ENGLER,FISK+ (CARN,BNL,CASE)
   ALSO  67 PRL 19 668          HILL,LUERS,ROBINSON,SAKITT +      (BNL,CARN)
CHOLLET  70 PL 31B 658          +GAILLARD,JANE,RATCLIFFE,REPELLIN +   (CERN)
CULLEN   70 PL 32B 523          +DARRIULAT,DEUTSCH,FOETH + (AACH,CERN,TORI)

DARRIULA 70 PL 33B 249          +FERRERO,GROSSO,HOLDER +    (AACH,CERN,TORI)
FAISSNER 70 NC 70A 57           +REITHLER,THOME,GAILLARD+   (AACH,CERN,RHEL)
JENSEN   70 THESIS              D.A. JENSEN                            (EFI)
   ALSO  69 PRL 23 615          JENSEN,ARONSON,EHRLICH,FRYBERGER+ (EFI,ILL)
MARX     70 PL 32B 219          +NYGREN,PEOPLES,STEINBERGE+(COLU,HARV,CERN)
   ALSO  70 THESIS,NEVIS 179    JAY MARX                          (COLUMBIA)

SCIULLI  70 PRL 25 1214         +GALLIVAN,BINNIE,GOMEZ,MALLARY,PECK+   (CIT)
SCRIBANO 70 PL 32B 224          +MANNELLI,PIERAZZINI,MARX+ (PISA,COLU,HARV)
SMITH    70 PL 32B 133          +WANG,WHATLEY,ZORN,HORNBOSTEL      (UMD,BNL)
WEBBER   70 PR D1 1967          +SOLMITZ,CRAWFORD,ALSTON-GARNJOST      (LRL)
   ALSO  69 UCRL 19226 THESIS   B R WEBBER                             (LRL)

BALATS   71 SJNP 13 53          +BEREZIN,VISHNEVSKII,GALANINA+        (ITEP)
BARMIN   71 PL 35B 604          +BARYLOV,VESELOVSKY,DAVIDENKO+        (ITEP)
BISI     71 PL 36B 533          +DARRIULAT,FERRERO,RUBBIA+ (AACH,CERN,TORI)
CARNEGIE 71 PR D4 1             +CESTER,FITCH,STROVINK,SULAK          (PRIN)
CHAN     71 LBL-350  THESIS     J.HIONG-SING CHAN                      (LBL)
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Data Card Listings

For notation, see key at front of Listings.

Stable Particles

K_L^0, η

CHIEN	71	PL 35B 261	+COX,ETTLINGER,RESVANIS+	(JHU,SLAC,UCLA)
ALSO	72	DALLY		
CHO	71	PR D3 1557	+DRALLE,CANTER,ENGLER,FISK+	(CARN,BNL,CASE)
CLARK	71	PRL 26 1667	+ELIOFF,FIELD,FRISCH,JOHNSON,KERTH+	(LRL)
ALSO	70	UCRL 19709-THESIS	ROLLAND JOHNSON	(LRL)
ALSO	71	UCRL 20264-THESIS	HENRY FRISCH	(LRL)
ENSTROM	71	PR D4 2629	+AKAVIA,COOMBES,DORFAN+	(SLAC,STAN)
ALSO	70	THESIS (SLAC 125)	J E ENSTROM	(STANFORD)
HILL	71	PR D4 7	+SAKITT,SKJEGGESTAD,CANTER+	(BNL,CARN,CASE)
MEISNER	71	PR D3 59	+MANN,HERTZBACH,KOFLER +	(MASA+BNL+YALE)
PEACH	71	PL 35B 351	+EVANS,MUIR,BUDAGOV,HOPKINS+	(EDIN,CERN)
REPELLIN	71	PL 36B 603	+WOLFF,CHOLLET,GAILLARD,JANE+	(ORSA,CERN)
WEBBER	71	PR D3 64	+SOLMITZ,CRAWFORD,ALSTON-GARNJOST	(LRL)
ALSO	68	PRL 21 498	WEBBER,SOLMITZ,CRAWFORD,ALSTONGARNJOST	(LRL)
ALSO	69	UCRL 19266-THESIS	B R WEBBER	(LRL)
WOLFF	71	PL 36B 517	+CHOLLET,REPELLIN,GAILLARD+	(ORSA,CERN)
ALBROW	72	NP B44 1	+ASTON,BARBER,BIRD,ELLISON+	(MCHS+DARE)
ASHFORD	72	PL 38B 47	+BROWN,MASEK,MAUNG,MILLER,RUDERMAN+	(UCSD)
BANNER1	72	PRL 28 1597	+CRONIN,HOFFMAN,KNAPP,SHOCHET	(PRINCETON)
BANNER2	72	PRL 29 237	+CRONIN,HOFFMAN,KNAPP,SHOCHET	(PRINCETON)
BURGUN	72	NP B50 194	+LESQUOY,MULLER,PAULI,+	(SACL+CERN+OSLO)
ALSO	71	LNC 2 1169	BURGUN,LESQUOY,MULLER +	(SACL+CERN+OSLO)
CARNEGIE	72	PR D6 2335	+CESTER,FITCH,STROVINK,SULAK	(PRINCETON)
DALLY	72	PL 41B 647	+INNOCENTI,SEPPI,CHIEN,COX+	(SLAC+JHU+UCLA)
ALSO	70	CHIEN		
ALSO	71	CHIEN		
GRAHAM	72	NC 9A 166	+ABASHIAN,JONES,MANTSCH,ORR+	(ILL+NEAS)
HOLDER	72	PL 40B 141	+RADERMACHER,STAUDE+	(AACH+CERN+TORI)
JAMES	72	NP B49 1	+MONTANET,PAUL,SAETRE+	(CERN+SACL+OSLO)
ALSO	71	PL 35B 265	JAMES,MONTANET,PAUL,PAULI+	(CERN+SACL+OSLO)
KRENZ	72	LNC 4 213	+HOPKINS,EVANS,MUIR,PEACH	(AACH+CERN+EDIN)
MANN	72	PR D6 137	+KOFLER,MEISNER,HERTZBACH+	(MASA+BNL+YALE)
MANTSCH	72	NC 9A 160	+ABASHIAN,GRAHAM,JONES,ORR+	(ILL+NEAS)
MCCARTHY	72	PL 42B 291	+BREWER,BUDNITZ,ENTIS,GRAVEN,MILLER+	(LBL)
ALSO	71	THESIS LBL - 550	R.L.MCCARTHY	(LBL)
METCALF	72	PL 40B 703	+NEUHOFER,NIEBERGALL+	(CERN+IPN+WIEN)
NEUHOFER	72	PL 41B 642	+NIEBERGALL,REGLER,STIER+	(CERN+ORSA+VIEN)
PICCIONI	72	PRL 29 1412	+COOMBES,DONALDSON,DORFAN,FRYBERGER+	(SLAC)
VOSBURGH	72	PR D6 1834	+DEVLIN,ESTERLING,GOZ,BRYMAN +	(RUTG,MASA)
ALSO	71	PRL 26 866	VOSBURGH,DEVLIN,ESTERLING,GOZ +	(RUTG,MASA)
WEBB	72	THESIS	ROBERT CARROLL WEBB	(PRINCETON)
CARITHER	73	BAPS 18 26	CARITHERS,MODIS,NYGREN,PUN+	(COLU+CERN+NYU)
EVANS	73	PR D7 36	+MUIR,PEACH,BUDAGOV+	(EDINBURGH+CERN)
ALSO	69	PRL 23 427	EVANS,GOLDEN,MUIR,PEACH+	(EDINBURGH+CERN)

PAPERS NOT REFERRED TO IN DATA CARDS

ALEXANDE	62	PRL 9 69	G ALEXANDER,S ALMEIDA,F CRAWFORD	(LRL)
JOVANOVI	63	BNL CONF 42,	JOVANOVIC,FISCHER,BURRIS +	(BNL+MARYLAND)
STERN	64	PRL 12 459	STERN,BINFORD,LIND,ANDERSON +	(WISC+LRL)
BEHR	65	ARGONNE CONF 59	BEHR,BRISSON,BELLOTTI+	(EPOL,MILA,PADO)
MESTVIRI	65	JINR P 2449	MESTVIRISHVILI,NYAGU,PETROV,RUSAKOV+	(JINR)
TRILLING	65	UCRL 16473	GEORGE H TRILLING	(LRL)
UPDATED		FROM 1965 ARGONNE	CONF., PAGE 115.	
GINSBERG	67	PR 162 1570	EDWARD S GINSBERG	(U. MASS BOSTON)
RUBBIA	67	PL 24B 531	C.RUBBIA,J.STEINBERGER	(CERN+COLU)
ALSO 1	66	PL 20 207	ALFF-STEINBERGER,HEUER,KLEINKNECHT+	(CERN)
ALSO 2	66	PL 21 595	ALFF-STEINBERGER,HEUER,KLEINKNECHT+	(CERN)
ALSO 3	66	PL 23 167	C.RUBBIA,J.STEINBERGER	(CERN+COLU)
SCHMIDT	67	NEVIS 160(THESIS)	P. SCHMIDT	(COLUMBIA)
CRONIN	68	VIENNA CONF P.281	CRONIN,RAPPORTEURS TALK	(PRINCETON)
GINSBERG	70	PR D1 229	E S GINSBERG	(IIT HAIFA)
HEUSSE	70	LNC 3 449	+AUBERT,PASCAUD,VIALLE	(ORSAY)
GINSBERG	71	PR D4 2893	E S GINSBERG	(MIT)

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14 ETA (549,JPG=0-+) I=0

FOR C. BALTAY'S REVIEW OF THE ETA MESON, SEE PROC. UNIV. OF PENN. CONF. ON MESON SPECTROSCOPY (W.A.BENJAMIN, N.Y., 1968)

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14 ETA MASS (MEV)

M	53	549.0	1.2	BASTIEN	62 HBC	
M	35	546.0	4.0	PICKUP	62 HBC	
M	91	548.0	1.0	ALFF	62 HBC	
M		549.3	2.9	DELCOURT	63 CNTR	
M	148	549.0	0.7	FOELSCHE	64 HBC	
M	325	552.0	3.0	KRAEMER	64 DBC	
M		548.2	0.65	FOSTER3	65 HBC	7/66
M	250	555.0	2.0	JAMES	66 HBC	6/66
M		. . . .				
M	AVG	548.82	0.56	AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.4) (SEE IDEOGRAM BELOW)		

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14 ETA WIDTH (MEV)

W	91	(10.0) OR LESS		ALFF	62 HBC	
W	148	(10.0) OR LESS		FOELSCHE	64 HBC	
W	31	(12.0) OR LESS		JAMES	66 HBC	6/66
W	-	(4.0) OR LESS		BALTAY	66 DBC	7/66
W		(.9) OR LESS	CL=.95	JONES	66 CNTR	8/67

ALSO SEE ETA DECAY RATES (BELOW).

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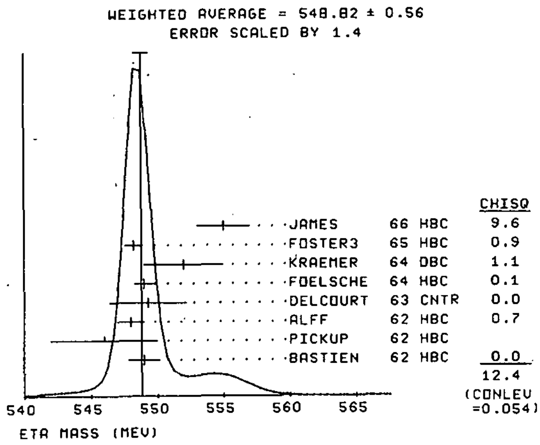

14 ETA PARTIAL DECAY MODES

		DECAY MASSES
P1	ETA INTO 2GAMMA	0+ 0
P2	ETA INTO 3PIO	134+ 134+ 134
P3	ETA INTO PI+ PI- PIO	139+ 139+ 134
P4	ETA INTO PI+ PI- GAMMA	139+ 139+ 0
P5	ETA INTO E+ E- PIO (VIOLATES C IN E.M.I.)	134+ .5+ .5
P6	ETA INTO E+ E- PI+ PI-	139+ 139+ .5+ .5
P7	ETA INTO PIO 2GAMMA	134+ 0+ 0
P8	ETA INTO E+ E- GAMMA	.5+ .5+ 0
P9	ETA INTO 2PIO GAMMA (VIOLATES C)	134+ 134+ 0
P10	ETA INTO PI+ PI- PIO GAMMA	139+ 139+ 134+ 0
P11	ETA INTO PI+ PI- 2GAMMA	139+ 139+ 0+ 0
P12	ETA INTO MU+ MU-	105+ 105
P13	ETA INTO MU+ MU- GAMMA	105+ 105+ 0
P14	ETA INTO MU+ MU- PIO	105+ 105+ 134

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FITTED PARTIAL DECAY MODE BRANCHING FRACTIONS

The matrix below is derived from the error matrix for the fitted partial decay mode branching fractions, P_i, as follows: The diagonal elements are $P_i \pm \delta P_i$, where $\delta P_i = \sqrt{\langle \delta P_i \delta P_i \rangle}$, while the off-diagonal elements are the normalized correlation coefficients $\langle \delta P_i \delta P_j \rangle / (\delta P_i \cdot \delta P_j)$. For the definitions of the individual P_i, see the listings above; only those P_i appearing in the matrix are assumed in the fit to be nonzero and are thus constrained to add to 1.

	P 1	P 2	P 3	P 4	P 7
P 1	.3800+-.0098				
P 2	-.2763	.3000+-.0107			
P 3	-.3387	-.2116	.2390+-.0055		
P 4	-.3091	-.1946	.8630	.0497+-.0013	
P 7	-.4203	-.5972	-.0815	-.0725	.0313+-.0111

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14 ETA DECAY RATES

W1 ETA INTO 2GAMMA (UNITS KEV) (G1)

W1 (0.93) (0.2) BEMPORAD 67 CNTR PRIMAKOFF EFFECT 11/67

The above value for $\Gamma_{\gamma\gamma}$ assumes that $\Gamma_{\gamma\gamma}/\Gamma_{total}$ = 31.4%. However, the results of that experiment may be stated more generally than is given in the paper, as

$$\Gamma_{\gamma\gamma} \times \frac{\Gamma_{\gamma\gamma}}{\Gamma_{total}} = 0.380 \pm 0.083 \text{ keV}$$

(private communication from C. Bemporad). Thus our new value of

$$\Gamma_{\gamma\gamma}/\Gamma_{total} = 38.0 \pm 1.0\%$$

would give

$$\Gamma_{\gamma\gamma} = 1.00 \pm 0.22 \text{ keV}$$

and

$$\Gamma_{total} = 2.63 \pm 0.58 \text{ keV}.$$

See G. Benfatto, "Coherent Nuclear Photoproduction of the η-meson," Nuovo Cimento 69A, 109 (1970) for a critique of this technique.

Stable Particles
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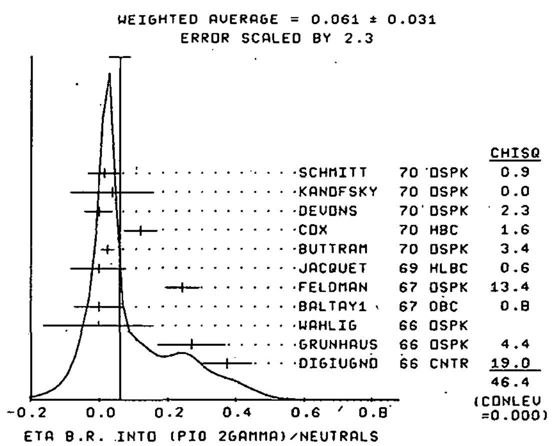
                    14  ETA BRANCHING RATIOS

R1      ETA INTO NEUTRALS/CHARGED                                  (P1+P2+P7)/(P3+P4)
R1  N   10   (2.5)    (1.0)            PICKUP     62 HBC
R1  N   53   (3.20)   (1.26)           BASTIEN    62 HBC
R1  N        (2.7)    (0.8)            SHAFER     62 HBC
R1            2.6       .9             BUSCHBECK  63 HBC                          7/66
R1  N  280   (4.5)    (1.0)            JAMES      66 HBC                          6/66
R1  N    THESE EXPERIMENTS HAVE NOT BEEN USED IN COMPUTING THE AVERAGES
R1  N    AS THEY WERE UNABLE TO SEPARATE CLEARLY PARTIAL MODES (3) AND (4)
R1  N    FROM EACH OTHER.  THE REPORTED VALUES THUS PROBABLY CONTAIN
R1  N    SOME (UNKNOWN) FRACTION OF MODE (4).
R1            2.64     0.23            BALTAY2    67 DBC                         11/67
R1          . . . . . . . . .
R1  AVG       2.64     0.22    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R1  FIT       2.463    0.080  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)

R2      ETA INTO 2GAMMA/CHARGED                                    (P1)/(P3+P4)
R2            0.99     0.48            CRAWFORD   63 HBC
R2          . . . . . . . . .
R2  FIT       1.316    0.053  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)
```

<u>Note on $\eta \to \pi^0 \gamma\gamma$</u>

The discrepancies between various measurements of branching ratios involving $\eta \to \pi^0\gamma\gamma$ are displayed in the ideogram below, in which all relevant experiments have been converted to a common ratio, $\pi^0\gamma\gamma$/neutrals. Our branching ratio fit does not include DIGIUGNO 66, FELDMAN 67 or the upper limit measurements. See page 43 of "Review of Particle Properties", Physics Letters <u>39B</u>, No. 1 (1972) for more discussion.

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R3      ETA INTO (PIO 2GAMMA)/NEUTRALS                            (P7)/(P1+P2+P7)
R3  S         (0.375)  (0.072)          DIGIUGNO  66 CNTR    ERROR DOUBLED       6/66
R3       THE ERRORS OF DIGIUGNO+ 66 HAVE BEEN INCREASED BY A FACTOR
R3       OF TWO, TO TAKE INTO ACCOUNT POSSIBLE SYSTEMATIC ERRORS, AS
R3       SUGGESTED BY THE AUTHORS.
R3             .27       .10            GRUNHAUS  66 OSPK                         8/67
R3  R        (.028)    (.044)           BUNIATOV  67 OSPK                        11/67
R3  S        (.244)    (.05)            FELDMAN   67 OSPK                         8/67
R3  S    SEE THE NOTE ON ETA DECAY INTO NEUTRALS ABOVE.
R3            .026      .019            BUTTRAM   70 OSPK                        12/70
R3            .122      .052      .044  COX       70 HBC                          6/70
R3           (.07) OR LESS  CL=.90      DEVONS    70 OSPK                        12/70
R3 R     16   .016      .047            SCHMITT   70 OSPK                        12/70
R3 R     SCHMITT 70 IS A REANALYSIS BUNIATOV 67
R3  E         (0.11)   (0.03)           STRUGALSK 71 HLBC                         5/71
R3  E    THIS MEASUREMENT HAS BEEN EXCLUDED BECAUSE THE ERROR APPEARS            2/71
R3  E    TO BE SERIOUSLY UNDERESTIMATED.                                          2/71
R3          . . . . . . . . .
R3  AVG       0.042    0.023    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.4)
R3  FIT       0.044    0.016   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.2)
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R4      ETA INTO (PI+ PI- GAMMA)/(PI+ PI- PIO)                    (P4)/(P3)
R4            0.14     0.08             FOELSCHE  64 HBC
R4  M   24   (0.73)   (0.25)            PAULI     64 DBC
R4  M    THIS EXPERIMENT HAS NOT BEEN INCLUDED IN THE AVERAGES SINCE IT IS
R4  M    NOT CLEAR THAT THEIR CLASS B EVENTS ARE ACTUALLY FROM ETAS.
R4            0.30     0.06             CRAWFORD  66 HBC                          6/66
R4             .10      .10             KRAEMER   64 DBC                          7/66
R4             .196     .041            FOSTER3   65 HBC                          7/66
R4             .25      .035            LITCHFIEL 67 DBC                          8/67
R4            0.28     0.04             BALTAY2   67 DBC                         11/67
R4    7250     .201     .006            GORMLEY   70 ASPK                         6/70
R4     18K    0.209    0.003            THALER2   72 ASPK                         1/73*
R4          . . . . . . . . .
R4  AVG       0.2080   0.0032  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.2)
R4  FIT       0.2080   0.0027 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1:0)
                       (SEE IDEOGRAM BELOW )
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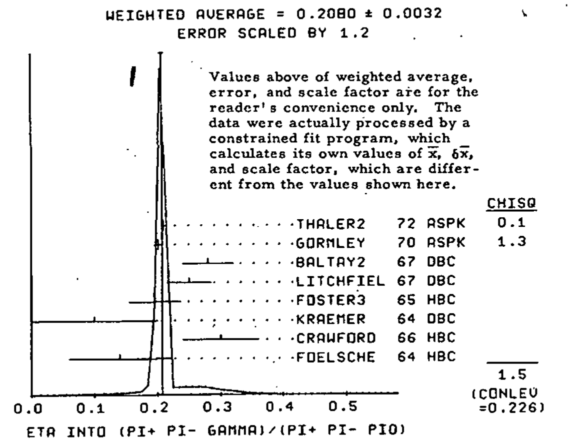


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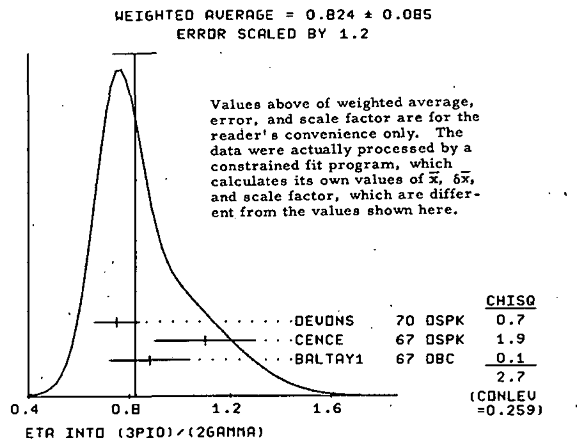
R5      ETA INTO (3PIO) + 2/3(PIO 2GAMMA)/ PI+PI-PIO      (P2+2/3P7)/P3
R5            0.83     0.32             CRAWFORD  63 HBC                          7/66
R5            2.0      1.0              FOELSCHE  64 HBC                          7/66
R5            0.90     0.24             FOSTER1   65 HBC                          7/66
R5          . . . . . . . . .
R5  AVG       0.91     0.19     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R5  FIT       1.342    0.055.  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)

R6      ETA INTO 3PIO/2GAMMA                                      (P2)/(P1)
R6           (.90) OR MORE              CHRETIEN  62 PBC
R6            0.88     0.16             BALTAY1   67 DBC                         11/67
R6            1.1      0.2              CENCE     67 OSPK                         1/68
R6            0.75     0.09             DEVONS    70 OSPK                        12/70
R6          . . . . . . . . .
R6  AVG       0.824    0.085    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.2)
R6  FIT       0.790    0.039   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)
                       (SEE IDEOGRAM BELOW )
```

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R7      ETA INTO 2GAMMA/(PI+ PI- PO)                              (P1)/(P3)
R7            1.61     0.39             FOSTER1   65 HBC
R7     401    1.72      .25             BAGLIN    69 HLBC                         7/69
R7          . . . . . . . . .
R7  AVG       1.69     0.21     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R7  FIT       1.590    0.064   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)
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Data Card Listings

For notation, see key at front of Listings.

Stable Particles

η

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R8      ETA INTO NEUTRAL/(PI+ PI- PIO)                    (P1+P2+P7)/(P3)
R8       50    3.6       0.8              KRAEMER   64 DBC
R8             3.8       1.1              PAULI     64 DBC                     7/66
R8             2.89      0.56             ALFF-STEI 66 HBC                     9/66
R8      244    3.6       0.6              FLATTE2   67 HBC                     1/68
R8       29    3.4       1.1              AGUILAR-B 72 HBC                    11/72*
R8 B     70    2.83      0.80             BLOODWORT 72 HBC                    11/72*
R8 B     ERROR INCREASED FROM PUBLISHED VALUE 0.5 BY BLOODWORTH, PRIV. COMM.  1/73*
R8            . . . . . . . . . .
R8  AVG        3.28      0.31    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R8  FIT        2.976     0.097  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)

R9      ETA INTO (E+E-PIO)/(PI+PI-PIO) (UNITS 10**-2)     (P5)/(P3)
R9             1.1   OR LESS              PRICE     65 HBC
R9        0    0.77  OR LESS              FOSTER2   65 HBC
R9             .42   OR LESS  CL=.90      BAGLIN1   67 HLBC                    8/67
R9        0    .16   OR LESS  CL=.90      BILLING   67 HLBC                   11/67

R10     ETA INTO (E+E-PI+PI-)/TOTAL (UNITS 10**-2)        (P6)
R10           (0.7)  OR LESS              RITTENBER 65 HBC                     6/66

R11     ETA INTO (E+E-PI+PI-)/(PI+PI-GAMMA)               (P6)/(P4)
R11       1    0.026     0.026            GROSSMAN  66 HBC                     6/66

R12     ETA INTO 2 GAMMA/NEUTRALS                         (P1)/(P1+P2+P7)
R12 S         (0.416)  (0.044)            DIGIUGNO  66 CNTR   ERROR DOUBLED    6/66
R12            .44       .07              GRUNHAUS  66 OSPK                    8/67
R12 S         (.579)   (.052)             FELDMAN   67 OSPK                    8/67
R12 S    SEE THE NOTE ON ETA DECAY INTO NEUTRALS ABOVE.
R12 T         (0.39)   (0.06)             JONES     66 CNTR                    8/67
R12 T    THIS RESULT FROM COMBINING CROSS SECTIONS FROM TWO DIFFERENT EXPTS.
R12            .59       .033             BUNIATOV  67 OSPK                   11/67
R12            .535      .018             BUTTRAM   70 OSPK                   12/70
R12            .486      .036             COX       70 HBC                     6/70
R12            0.57      0.09             STRUGALSK 71 HLBC                    5/71
R12           . . . . . . . . . .
R12 AVG        0.535     0.018   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.3)
R12 FIT        0.534     0.013  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.2)

R13     ETA INTO 3PIO/NEUTRALS                            (P2)/(P1+P2+P7)
R13 S         (0.209)  (0.054)            DIGIUGNO  66 CNTR   ERROR DOUBLED    6/66
R13 R         (.29)    (.10)              GRUNHAUS  66 OSPK                    8/67
R13 S         (.177)   (.035)             FELDMAN   67 OSPK                    8/67
R13 S    SEE THE NOTE ON ETA DECAY INTO NEUTRALS ABOVE.
R13            .41       .033             BUNIATOV  67 OSPK                   11/67
R13 R    REDUNDANT INFORMATION FROM THIS EXPERIMENT.
R13 R         (.439)   (.024)             BUTTRAM   70 OSPK                   12/70
R13            .392      .042             COX       70 HBC                     6/70
R13            0.32      0.09             STRUGALSK 71 HLBC                    5/71
R13           . . . . . . . . . .
R13 AVG        0.397     0.025   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R13 FIT        0.422     0.015  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)

R14     ETA INTO PIO (2 GAMMA)/2GAMMA                     (P7)/(P1)
R14           (.5)   OR LESS  CL=.90      WAHLIG    66 SPRK                    7/66
R14            0.0       0.14             BALTAY1   67 DBC                    11/67
R14 P         (0.05)   (0.04)             BONAMY    67 SPRK  PRELIMINARY RESULT 11/67
R14           . . . . . . . . . .
R14 FIT        0.082     0.030  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.2)

R15     ETA INTO (E+E-PIO)/TOTAL (UNITS 10**-2)           (P5)
R15           (0.7)  OR LESS              RITTENBER 65 HBC                     6/66
R15           (0.084)OR LESS  CL=.90      BAZIN     68 DBC                     6/68

R16     ETA INTO 2GAMMA/(3PIO + PIO 2GAMMA)               (P1)/(P2+P7)
R16            0.80      .25              BACCI     63 CNTR                    7/66
R16           . . . . . . . . . .
R16 FIT        1.147     0.060  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.2)

R17     ETA INTO (PI+PI-PIO GAMMA)/(PI+PI-PIO)            (P10)/(P3)
R17           (.07) OR LESS               FLATTE    67 HBC                     8/67
R17           (.009)OR LESS               PRICE     67 HBC                     8/67
R17           (.016)OR LESS  CL=.95       BALTAY2   67 DBC                    11/67
R17           (0.017)OR LESS  CL=.90      ARNOLD    68 HLBC                    9/68
R17            0.035 OR LESS  CL=.90      THALER2   72 ASPK                    1/73*

R18     ETA INTO (PI+PI- 2GAMMA)/(PI+PI-PIO)              (P11)/(P3)
R18           (.009)OR LESS               PRICE     67 HBC                     8/67
R18           (.016)OR LESS  CL=.95       BALTAY2   67 DBC                    11/67

R19     ETA INTO 3PIO/(PI+ PI- PIO)                       (P2)/(P3)
R19            1.3       .4               BAGLIN2   67 HLBC                    8/67
R19            1.47      0.20      0.17   BULLOCK   68 HLBC                    9/68
R19     199    1.50      .15       .29    BAGLIN    69 HLBC                    7/69
R19           . . . . . . . . . .
R19 AVG.       1.46      0.13    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R19 FIT        1.255     0.058  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)

R20     ETA INTO 2GAMMA/((3PIO)+2/3(PIO 2GAMMA))          (P1)/(P2+2/3P7)
R20            1.10      0.5              MULLER    63 DBC                     7/66
R20           . . . . . . . . . .
R20 FIT        1.184     0.058  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.2)

R21     ETA INTO NEUTRALS/TOTAL                           (P1+P2+P7)
R21            .79       .08              BUNIATOV  67 OSPK                   11/67
R21     16K    .705      .008             BASILE    71 CNTR MM SPECTROMETER    8/71
R21           . . . . . . . . . .
R21 AVG        0.7058    0.0080  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R21 FIT        0.7113    0.0067 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)

R22     ETA INTO (PIO 2GAMMA)/TOTAL                       (P7)
R22            .12  OR LESS  CL=.95       JACQUET   69 HLBC                    6/70
R22           . . . . . . . . . .
R22 FIT        0.031     0.011  FROM FIT

R23     ETA INTO MU+MU-/TOTAL (UNITS 10**-5)              (P12)
R23       0    2.    OR LESS  CL=.95      WEHMANN   68 OSPK                    4/68

R24     ETA INTO MU+MU-PIO/TOTAL (UNITS 10**-4)           (P14)
R24            5.    OR LESS              WEHMANN   68 OSPK                    4/68

R25     ETA INTO MU+MU-/2GAMMA (UNITS 10**-5)             (P12)/(P1)
R25            5.9       2.2              HYAMS     69 OSPK                    7/69

R26     ETA INTO (PIO 2GAMMA)/(3PIO + PIO 2GAMMA)         (P7)/(P2+P7)
R26  N         0.1       0.3              KANOFSKY  70 OSPK                    2/71
R26  N   WE HAVE CHANGED THE ERROR ON THIS EXPERIMENT FROM +0.3,-0.1          2/71
R26  N   TO THE ABOVE +0.3,-0.3 SINCE IT IS CLEAR FROM FIGURE 7 IN THE         2/71
R26  N   ARTICLE THAT A CENTRAL VALUE OF 0.0 IS ABOUT AS PROBABLE AS THE       2/71
R26  N   QUOTED VALUE OF 0.1.                                                  2/71
R26           . . . . . . . . . .
R26 FIT        0.094     0.032  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.2)
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              14  ETA C-NONCONSERVING DECAY PARAMETER

      RELATED TEXT SECTION IV G AND MINI-REVIEW BELOW

A   DECAY ASYMMETRY PARAMETER FOR PI+ PI- PIO   (UNITS 10**-2)
A      1351    7.2      2.8          BALTAY    66 DBC                       8/66
A      1300    5.8      3.4          CLPWY     66 HBC                       8/66
A     10665   (0.3)    (1.0)         CNOPS     66 OSPK REPL BY MULLER 69    8/67
A       705   -6.1      4.0          LARRIBE   66 HBC                       8/67
A     36800    1.5       .5          GORMLEY3  68 ASPK                      6/68
A     10709     .3      1.1          MULLER    69 OSPK                      9/69
A      1138   -1.4      3.           CARPENTR  70 HBC                       6/70
A       349    3.2      5.4          DANBURG   70 DBC                       2/71
A   L. 220K   -0.05     0.22         LAYTER    72 ASPK                      8/72*
A   L     ALSO REPORTS SEXTANT AND QUADRANT ASYMMETRIES.                     8/72*
A             . . . . . . . . . .
A   AVG        0.24     0.40    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 2.0)
                                (SEE IDEOGRAM BELOW )
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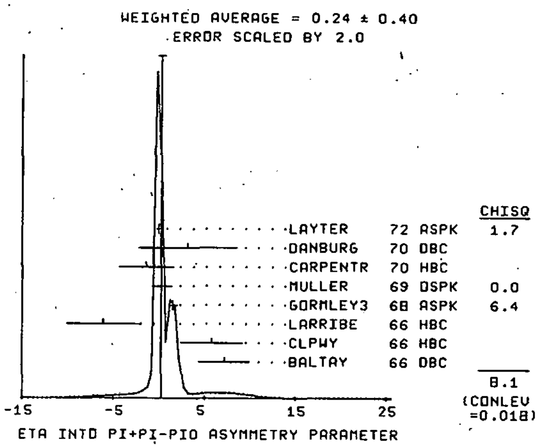

H. Yuta and S. Okubo [Phys. Rev. Letters 21, 781 (1968)] have pointed out that an asymmetry in the decay $\eta \rightarrow \pi^+\pi^-\pi^0$ of about 2% need not imply a breakdown of C invariance, since an asymmetry of this amount could be caused by an interference between the η and the 3π background. Gormley et al. [Phys. Rev. Letters 22, 198 (1969)], however, believe that this effect can account for only $\leq 0.23\%$ in their experiment (above). Also see: A. Frenkel and G. Vesztergombi, "C-Violation in η-Decay," Nucl. Phys. B15, 429 (1970) and K. Taggart, "Asymmetry and Background in $\eta \rightarrow 3\pi$," Phys. Rev. D 2, 1960 (1970).

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B   DECAY ASYMMETRY PARAMETER FOR PI+ PI- GAMMA (UNITS 10**-2)
B        33   -2.      17.           CRAWFORD  66 HBC                      11/66
B             -4.       8.           LITCHFIEL 67 DBC                       8/67
B   N  1620    1.5      2.5          MULLER    69 OSPK                      9/69
B   N  ABOVE EXPERIMENT IS SENSITIVE ONLY TO UPPER .4 OF GAMMA-RAY SPECTRUM
B      7257    1.22     1.56         GORMLEY   70 ASPK                      6/70
B       36K    0.5      0.6          THALERI   72 ASPK                      8/72*
B             . . . . . . . . . .
B   AVG        0.61     0.54    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

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REFERENCES FOR ETA


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PEVSNER  61 PRL 7 421           PEVSNER,KRAEMER,NUSSBAUM,RICHARDSON + (JHU)

ALFF     62 PRL 9 322           ALFF,BERLEY,COLLEY,BRUGGER + (COLU+RUTGERS)
BASTIEN  62 PRL 8 114           BASTIEN,BERGE,DAHL,FERRO-LUZZI +      (LRL)
CHRETIEN 62 PRL  9  127         CHRETIEN+    (BRAN+BROWN+HARVARD+MIT+PADOVA)
PICKUP   62 PRL 8 329           E PICKUP,ROBINSON,SALANT         (CNRC+BNL)
SHAFER   62 CERN CONF 307       J SHAFER,FERRO-LUZZI,MURRAY +    (UCB+LRL)

BACCI    63 PRL 11 37           BACCI,PENSO,SALVINI +            (ROMA+FRAS)
BUSCHBEC 63 SIENA CONF 1 166    BUSCHBECK-CZAPP,COOPER + (VIENNA,CERN,AMST)
CRAWFORD 63 PRL 10 546          F S CRAWFORD,LLOYD,FOWLER        (LRL+DUKE)
   ALSO  66 PRL 16 907          F S CRAWFORD,L LLOYD,E FOWLER    (LRL+DUKE)
DELCOURT 63 PL 7 215            DELCOURT,LEFRANCOIS,PEREZ Y JORBA+  (ORSAY)
MULLER   63 SIENA CONF 99       MULLER,PAULI +                   (SACL+ROMA)

FOELSCHE 64 PR 134 B 1138       H W FOELSCHE,H L KRAYBILL            (YALE)
KRAEMER  64 PR 136 B 496        KRAEMER,MADANSKY,FIELDS +   (JHU+NWES+WOOD)
PAULI    64 PL 13 351           E PAULI,A MULLER                   (SACLAY)

FOSTER1  65 PR 138 B 652        FOSTER,PETERS,MEER,LOEFFLER + (WISC+PURDUE)
FOSTER2  65 ATHENS              FOSTER,GOOD,MEER                (WISCONSIN)
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Stable Particles
η, p, n

Data Card Listings
For notation, see key at front of Listings.

FOSTER3 65 THESIS M.C.FOSTER (WISCONSIN)
PRICE 65 PRL 15 123 L.R.PRICE,F.S.CRAWFORD (LRL)
RITTENBE 65 PRL 15 556 RITTENBERG,KALBFLEISCH (LRL+BNL)

ALFF-STE 66 PR 145 1072 ALFF-STEINBERGER,BERLEY+ (COLUMBIA+RUTGERS)
BALTAY 66 PRL 16 1224 +FRANZINI,KIM,KIRSCH+(COLUMBIA+STONY BROOK)
CRAWFORD 66 PRL 16 333 F.S.CRAWFORD,L.R.PRICE (LRL)
DIGIUGNO 66 PRL 16 767 DIGIUGNO,GIORGI,SILVESTRI+ (NAPL,TRST,FRAS)
GROSSMAN 66 PR 146 993 R GROSSMAN,L PRICE,F CRAWFORD (LRL)
GRUNHAUS 66 THESIS J.GRUNHAUS (COLUMBIA)
JAMES 66 PR 142 896 F E JAMES,H L KRAYBILL (YALE+BNL)
JONES 66 PL 23 597 JONES,BINNIE,DUANE,HORSEY,MASON,(LOIC,RHEL)
WAHLIG 66 PRL 17 221 WAHLIG,SHIBATA,MANNELLI (MIT+PISA)

BAGLIN1 67 PL 24B 637 BAGLIN,BEZAGUET,DEGRANGE,+ (EPOL+UCB)
BAGLIN2 67 BAPS 12 567 BAGLIN,BEZAGUET,DEGRANGE,+ (EPOL+UCB)
BALTAY1 67 PRL 19 1495 BALTAY,FRANZINI,KIM,NEWMAN+ (COLU+BRAN)
BALTAY2 67 PRL 19 1498 BALTAY,FRANZINI,KIM,NEWMAN+ (COLU+STON)
BEMPORAD 67 PL 25B 380 BEMPORAD,BRACCINI,FOA,LUBELSMEY+(PISA,BONN)
ALSO PRIVATE COMMUNICATION
BILLING 67 PL 25B 435 BILLING,BULLOCK,ESTEN,GOVAN,+ (LOUC,OXF)
BONAMY 67 HEIDELBERG CONF. BONAMY,SONDEREGGER (SACLAY)
BUNIATOV 67 PL 25B 560 BUNIATOV,ZAVATTINI,DEINET,+ (CERN+KARL)
CENCE 67 PRL 19 1393 CENCE,PETERSON,STENGER,CHIU+ (HAWAII+LRL)
FELDMAN 67 PRL 18 868 FELDMAN,FRATI,GLEESON,HALPERN,+ (PENN)
FLATTE 67 PRL 18 976 S.M.FLATTE (LRL)
FLATTE2 67 PR 163 1441 S.M.FLATTE AND C.G.WOHL (LRL)
LITCHFIE 67 PL 24B 486 LITCHFIELD,RANGAN,SEGAR,SMITH+(RHEL+SACLAY)
PRICE 67 PRL 18 1207 L.R.PRICE,F.S.CRAWFORD (LRL)

ARNOLD 68 PL 27B 466 +PATY,BAGLIN,BINGHAM+ (STRB+MADR+EPOL+UCB)
BAZIN 68 PRL 20 895 BAZIN,GOSHAW,ZACHER,+ (PRINCETON,QUEENS)
BULLOCK 68 PL 27B 402 +ESTEN,FLEMING,GOVAN,HENDERSON,OWEN+ (LOUC)
WEHMANN 68 PRL 20 748 WEHMANN,ENGELS,+ (HARV+CASE+SLAC+CORN+MCGI)

BAGLIN 69 PL 29B 445 BAGLIN,BEZAGUET,+ (EPOL,UCB,MADR,STRB)
ALSO 70 NP B22 66 +BEZAGUET,DEGRANGE,MUSSET +(EPOL,MADR,STRB)
HYAMS 69 PL 29B 128 HYAMS,KOCH,POTTER,VON LINDERN,+ (CERN,MPIM)
JACQUET 69 NC 58 743 JACQUET,NGUYEN-KHAC,HAATUFT+ (EPOL,BERG)

BUTTRAM 70 PRL 25 1358 +KREISLER,MISCHKE (PRIN)
COX 70 PRL 24 534 COX,FORTNEY,GOLSON (DUKE)
DEVONS 70 PR D1 1936 +GRUNHAUS,KOZLOWSKI,NEMETHY + (COLU,SYRA)
GORMLEY 70 PR D2 501 GORMLEY,HYMAN,LEE,NASH,PEOPLES+ (COLU+BNL)
ALSO 70 NEVIS 181(THESIS) MICHAEL GORMLEY (COLU)
KANOFSKY 70 NC 68 413 A. KANOFSKY (LEHI)
SCHMITT 70 PL 32B 638 +BUNIATOV,ZAVATTINI,DEINET+ (CERN,KARL)

BASILE 71 NC 3A 796 +BOLLINI,DALPIAZ,FRABETTI+ (CERN,BGNA,STRB)
STRUGALS 71 NP B27 429 +CHUVILO,GEMESY,IVANOVSKAYA+ (JINR)
AGUILAR- 72 PR D6 29 AGUILAR-BENITEZ,CHUNG,EISNER,SAMIOS (BNL)
BLOODWOR 72 NP B39 525 BLOODWORTH,JACKSON,PRENTICE,YOON (TORONTO)

QUANTUM NUMBER DETERMINATIONS NOT REFERRED TO IN THE DATA CARDS

BASTIEN 62 PRL 8 114 BASTIEN,BERGE,DAHL,FERRO-LUZZI,MILLER+(LRL)
CARMONY 62 PRL 8 117 D CARMONY,A ROSENFELD,VAN DE WALLE (LRL)
ROSENFEL 62 PRL 8 293 A ROSENFELD,D CARMONY,VAN DE WALLE (LRL)

REFERENCES ON ETA ASYMMETRY PARAMETERS

BALTAY 66 PRL 16 1224 BALTAY,FRANZINI,KIM,KIRSCH+ (COLU+STON)
CNOPS 66 PL 22 546 CNOPS,FINOCCHIARS,LASSALLE,(CERN,ETHZ,SACL)
CRAWFORD 66 PRL 16 333 F.S.CRAWFORD,L.R.PRICE (LRL)
CLPWY 66 PR 149 1044 COLUMBIA,LRL,PURDUE,WISCONSIN,YALE
LARRIBE 66 PL 23 600 LARRIBE,LEVEQUE,MULLER,PAULI,+ (SACL+RHEL)

BOWEN 67 PL 24B 206 BOWEN,CNOPS ,FINOCCHIARO,+ (CERN+ETHZ+SACL)
LITCHFIE 67 PL 24B 486 LITCHFIELD,RANGAN,SEGAR,SMITH+(RHEL+SACLAY)
GORMLEY3 68 PRL 21 402 GORMLEY,HYMAN,LEE,NASH,PEOPLES+ (COLU+BNL)
MULLER 69 THESIS ARMAND MULLER (STRB)
CARPENTR 70 PR D1 1303 CARPENTER,BINKLEY,CHAPMAN,COX,DAGAN+ (DUKE)
DANBURG 70 PR D2 2564 +ABOLINS,DAHL,DAVIES,HOCH,KIRZ,+ (LRL)
LAYTER 72 PRL 29 316 +APPEL,KOTLEWSKI,LEE,STEIN,THALER (COLU)
THALER1 72 PRL 29 313 +APPEL,KOTLEWSKI,LAYTER,LEE,STEIN (COLU)
THALER2 72 NEVIS 194(THESIS) JON J THALER (COLU)

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p

16 PROTON (938,J=1/2) I=1/2

16 PROTON MASS (MEV)

M	(938.256)	(0.005)	COHEN	65 RVUE		7/66
M	938.2592	.0052	TAYLOR	69 RVUE	USING NEW E/H	7/70

16 PROTON MEAN LIFE (UNITS 10**26 YR)

T		(.000001)OR MORE	GOLDHABE	54 TH 232 FISS.MODE INDEPEN	
T		(0.002)OR MORE	FLEROV	57 TH 232 FISS.MODE INDEPEN	
T	B	(1.5) OR MORE	BACKENSTO	60 CNTR	
T	B	(60.0) OR MORE	KROPP	65 CNTR	
T		(200.0) OR MORE	GURR	67 CNTR DEP. ON DECAY MODE	
T	B	KROPP AND BACKENSTOSS SENSITIVE TO PARTICULAR DECAY MODES OF PROT			

16 PROTON MAGNET. MOMENT(E/2MP)

MM	(2.792763)	(0.000030)	COHEN	65 RVUE		
MM	2.792782	.000017	TAYLOR	69 RVUE	USING NEW E/H	7/70

16 ANTIPROTON MAGNETIC MOMENT (E/2MP)

MM1	-2.83	0.10	FOX	72	11/72*

16 PROTON ELECTRIC DIPOLE MOMENT (UNITS 10**-23 E CM)
NONZERO VALUE IMPLIES VIOLATION OF T AND P IN EM INTERACTION

EDM	1G	700.	900.	HARRISON	69 MBR	10/69

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REFERENCES FOR PROTON

GOLDHABE 54 PR 96 1157 FNOTE2 GOLDHABER,F REINES+ (LOS ALAMOS,BNL)
FLEROV 57 SOV PHYS DOK 3 79 FLEROV,KLOCHKOV,SKOBKIN,TERENTEV (USSR)
BACKENST 60 NC 16 749 BACKENSTOSS,FRAUENFELDER,HYAMS + (CERN)
COHEN 65 RMP 37 537 +DUMOND (N.AMER.AVIATION SCIENCE CENT.,CIT)
KROPP 65 PR 137 B 740 W R KROPP,F REINES (CASE INST TECHNOLOGY)
GURR 67 PR 158 1321 GURR,KROPP,REINES,MEYER (CASE,JOHANNESBURG)
HARRISON 69 PRL 22 1263 HARRISON,SANDARS,WRIGHT (CLARENDON OXFORD)
TAYLOR 69 RMP 41 375 +PARKER,LANGENBERG (PRIN+UCI+PENN)
FOX 72 PRL 29 193 FOX,BARNES,EISENSTEIN+ (CARN+VPI+WILL+WYOM)

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n

17 NEUTRON (939,J=1/2) I=1/2

17 NEUTRON MASS (MEV)

M T	939.5527	.0052	TAYLOR	69 RVUE	USING NEW E/H	7/70
M T	TAYLOR DETERMINATION OF NEUTRON MASS NOT INDEPENDENT OF					7/70
M T	NEUTRON-PROTON MASS DIFFERENCE MEASUREMENTS BELOW.					7/70

17 (NEUTRON) - (PROTON) MASS DIFFERENCE (MEV)

D M	1.29344	0.00007	MATTAUCH	65 RVUE	3/71
D M	WE HAVE CONVERTED MATTAUCH NEUTRON-HYDROGEN MASS DIFFERENCE TO				3/71
D M	NEUTRON-PROTON MASS DIFFERENCE USING CURRENT VALUE OF ELECTRON MASS				3/71
D M	AND A HYDROGEN BINDING ENERGY OF 13.6 EV.				3/71

17 NEUTRON MAGNETIC MOMENT (MAGNETONS,938.2 MEV)

MM	-1.913148	0.000066	COHEN	56 RVUE	7/66

17 NEUTRON ELECTRIC DIPOLE MOMENT (UNITS 10**-23 E CM)
TEST OF C VIOLATION IN THE EM INTERACTION

EDM	(5.)	OR LESS	BAIRD	69 MBR	10/69

17 NEUTRON MEAN LIFE (UNITS 10**3 SEC)

THE MEASUREMENT OF THE NEUTRON MEAN LIFE BY SOSNOVSKII 59 HAS BEEN DISCARDED SINCE 1. IT DISAGREES WITH THE BETTER AND MORE RECENT RESULT OF CHRISTENSEN 67. 2. THE VALUE OF GA/GV DERIVED FROM THE NEW VALUE OF THE MEAN LIFE AGREES WELL WITH THE GA/GV VALUE OBTAINED FROM THE FREE NEUTRON DATA.

T	(1.012)	(0.021)	SOSNOVSKI	59 PILE	SEE NOTE E	7/68
T	(0.935)	(0.014)	CHRISTENS	67 PILE	REPL BY CHRISTENS72	3/68
T	0.918	0.014	CHRISTENS	72 PILE		6/72*
E	ERROR CHANGED BECAUSE ERROR IN CROSS SECTION FOR NEUTRON ABSORPTION					
E	IN GOLD HAS BEEN REDUCED.					

17 NEUTRON BETA DECAY COUPLING CONSTANTS

RELATED TEXT SECTION IV H.1

AV	GA/GV (SEE TEXT FOR SIGN CONVENTION)					
AV C	(-1.250)	(0.044)	CONFORTO	67 RVUE	SEE NOTE C BELOW	
AV EP	(-1.23)	(0.01)	CHRISTENS	67 CNTR	N DECAY FT VALUE	11/68
AV P	(-1.22)	(0.08)	GRIGOREV	68 CNTR	E-NEU ANG CORREL	10/71
AV P	(-1.26)	(0.02)	CHRISTENS	70 CNTR	PE,NEUT SPIN CORREL	10/71
AV EP	(-1.27)	(0.025)	EROZOLIMS	71 CNTR	PE,NEUT SPIN CORREL	10/71
AV EP	(-1.239)	(0.011)	CHRISTENS	72 CNTR	N DEC.+ FT VALUE	1/73*
AV P	(-1.263)	(0.016)	KROPF	73 RVUE	N DECAY ALONE	1/73*
AV P	-1.248	0.010	KROPF	73 RVUE	N DEC.+ FT VALUE	1/73*
AV C	CONFORTO 67 COMBINES FREE NEUTRON DATA TO 1967. REPL. BY KROPF 73.					1/73*
AV E	THESE EXPERIMENTS MEASURE THE ABSOLUTE VALUE OF GA/GV ONLY					10/71
AV P	KROPF 73 VALUE OBTAINED BY FITTING ALL DATA THROUGH 1972.					1/73*

F	PHASE ANGLE OF GA RELATIVE TO GV (DEGREES)					
F C	(176.1)	(6.4)	CONFORTO	67 RVUE		11/68
F P	(181.3)	(1.3)	EROZOLIMS	70 CNTR	POLAR. NEUTRON	10/69
F P	181.1	1.3	KROPF	73 RVUE	N DECAY	1/73*
F C	CONFORTO 67 COMBINES FREE NEUTRON DATA TO 1967. REPL. BY KROPF 73.					1/73*
F P	KROPF 73 VALUE OBTAINED BY FITTING ALL DATA THROUGH 1972.					1/73*

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REFERENCES FOR NEUTRON

COHEN 56 PR 104 283 V W COHEN, CORNGOLD, RAMSEY (BNL+HARVARD)
SOSNOVSK 59 JETP 9 717 SOSNOVSKII,SPIVAK,PROKOFEV + (IAE MOSCOW)

MATTAUCH 65 NP 67 1 +THIELE,WAPSTRA (MAX PLANCK INST.CHEM.)
CHRISTEN 67 PL 26B 11 CHRISTENSEN,NIELSON,BAHNSEN,BROWN+ (RISO)
CONFORTO 67 APAH 22 15 G. CONFORTO (CERN)
GRIGOREV 68 SJNP 6 239 +GRISHIN,VLADIMIRSKII,NIKOLAEVSKII + (ITEP)

BAIRD 69 PR 179 1285 +MILLER,DRESS,RAMSEY (ORNL,HARV)
TAYLOR 69 RMP 41 375 +PARKER,LANGENBERG (PRIN+UCI+PENN)
CHRISTEN 70 PR C1 1693 CHRISTENSEN,KROHN,RINGO (ANL)
EROZOLIM 70 SJNP 11 583 EROZOLIMSKI,BONDARENKO, + (KURC MOSCOW)
ALSO PL 27B 557 EROZOLIMSKY,BONDARENKO + (KURC IN MOSCOW)
EROZOLIM 71 JETPL 13 252 EROZOLIMSKII,BONDARENKO + (KURC MOSCOW)
CHRISTEN 72 PR D5 1628 CHRISTENSEN,NIELSON,BAHNSEN,BROWN+ (RISO)
KROPF 73 SUBM. TO NP A A KROPF,H PAUL (LINZ)
ALSO 70 NP A154 160 H PAUL (VIEN)

PAPERS NOT REFERRED TO IN DATA CARDS

JACKSON 57 PR 106 517 JACKSON,TREIMAN,WYLD (PRINCETON)
COHEN 65 RMP 37 537 +DUMOND (N.AMER.AVIATION SCIENCE CENT.,CIT)
BHALLA 66 PL 19 691 C P BHALLA (ALABAMA)

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Stable Particles
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Data Card Listings
For notation, see key at front of Listings.

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                18  LAMBDA (1115,JP=1/2+) I=0
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                18  LAMBDA MASS (MEV)

M   N  SINCE OUR FINAL VALUES FOR THE SIGMA AND LAMBDA MASSES COME FROM
M   N  DOING AN OVERALL FIT TO ALL MEASURED MASSES AND MASS DIFFERENCES,
M   N  WE HAVE USED THE UNCORRELATED MEASUREMENTS FROM SCHMIDT 65 RATHER
M   N  THAN THE ONES COMING FROM THE OVERALL FIT REPORTED IN THAT PAPER.
M   N  SINCE THERE SEEMS TO BE NO CONVINCING ARGUMENT AS TO WHY ONE SHOULD
M   N  IGNORE DATA USING RANGE MEASUREMENTS, WE HAVE INCLUDED HERE VALUES
M   N  DEPENDING ON PROTON AND PION RANGES.

M          1115.44     0.12          BHOWMIK   63 RVUE +  SEE NOTE L BELOW
M   L  ABOVE LAMBDA MASS HAS BEEN RAISED 35 KEV TO ACCOUNT FOR 46 KEV
M   L  INCREASE IN PROTON MASS AND 11 KEV DECREASE IN CHARGED PION MASS.
M   S  635(1115.86)   (0.09)         BALTAY    65 HBC    ERROR IS STATIS.    6/66
M       488 1115.63    0.07          SCHMIDT   65 HBC   SEE NOTE N           6/68
M   S 1147(1115.74)   (0.04)         CHIEN     66 HBC       6.9 PBAR P       9/67
M   S  972(1115.69)   (0.05)         CHIEN     66 HBC       6.9 PBAR PANTIL  9/67
M          1115.6      0.4           LONDON    66 HBC                        6/66
M         (1116.0)    (0.2)          BADIER    67 HBC     2.4 PBAR P,LLBAR   8/67
M       195 1115.39    0.12          MAYEUR    67 EMUL                      11/67
M   B 1524(1115.52)   (0.03)         BOHM      70 EMUL                       3/72
M       935 1115.59    0.08          HYMAN     72 HEBC                      11/71
M   B  AVERAGE OF VERY INCONSISTENT DATA. ERROR STATISTICAL ONLY. AUTHORS    3/72
M   B  DETECT SYSTEMATIC EFFECT OF ABOUT .15 MEV, WHICH THEY ATTRIBUTE       3/72
M   B  TO ERROR IN RANGE-ENERGY RELATIONS, IN REGION BETA=0.6-0.7.           3/72
M   B  THIS EFFECT, IF CONFIRMED, WOULD AFFECT VERY LITTLE THE VALUES OF     3/72
M   B  BHOWMICK 63 AND MAYEUR 67.
M   S  ERROR PURELY STATISTICAL.
M          . . . . . . . . . . .
M   AVG    1115.558    0.052   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.2)
M   FIT    1115.592    0.046  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)  1/73*
                       (SEE IDEOGRAM BELOW )
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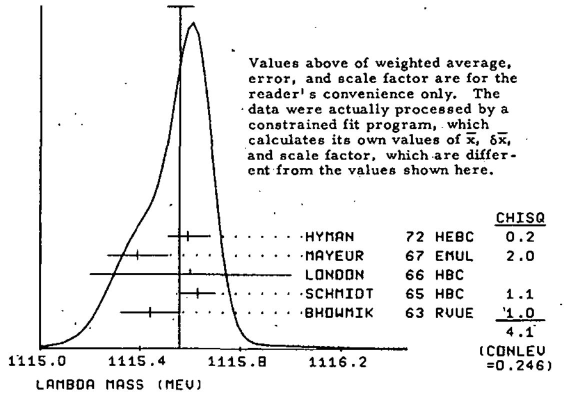
WEIGHTED AVERAGE = 1115.558 ± 0.052
ERROR SCALED BY 1.2



Values above of weighted average, error, and scale factor are for the reader's convenience only. The data were actually processed by a constrained fit program, which calculates its own values of $\bar{x}$, $\delta\bar{x}$, and scale factor, which are different from the values shown here.

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                18  LAMDA - ANTILAMBDA MASS DIFFERENCE (MEV)
DM             0.05      0.06          CHIEN      66 HBC      6.9 PBAR P     9/67
DM             0.29      0.15          BADIER     67 HBC     2.4 PBAR P      8/67
DM           . . . . . . . . . . .
DM  AVG        0.083     0.083   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.5)
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                18  LAMBDA MEAN LIFE (UNITS 10**-10)

T       188     2.63      0.21      0.21  BOLDT      58 CC
T       825     2.72      0.16      0.16  CRAWFORD   59 HBC
T       140     2.72      0.29      0.27  BOWEN      60 CC
T       186     2.60      0.28      0.20  CHANG      62 HBC
T       799     2.69      0.11      0.11  HUMPHREY   62 HBC
T      2239     2.36      0.06      0.06  BLOCK      63 HEBC
T       706     2.76      0.20            CHRETIEN   63 HLBC
T       794     2.59      0.09            HUBBARD    64 HBC
T      2260     2.31      0.10            KREISLER   64 OSPK
T      1378     2.59      0.07            SCHWARTZ   64 HBC
T       635     2.51      0.16            BALTAY     65 HBC                       6/66
T      2534     2.6       0.1             HILL       65 OSPK
T       916     2.35      0.09            BURAN      66 HLBC                      6/66
T    S 1147    (2.50)    (0.14)           CHIEN      66 HBC      6.9 PBAR P       9/67
T    S  972    (2.70)    (0.20)           CHIEN      66 HBC      6.9 PBAR P,ANTI  9/67
T      2213     2.452     0.056    0.054  ENGELMANN  66 HBC                       9/66
T       585     2.68      0.13     0.11   AUERBACH   67 OSPK                      8/67
T               2.44      0.15            BADIER     67 HBC     2.4 PBAR P        6/68
T               2.55      0.15            BADIER     67 HBC     2.4 PBAR P,ANTIL  6/68
T      8342     2.535     0.035           GRIMM      68 HBC                       6/68
T      2600     2.47      0.08            HEPP       68 HBC                       8/68
T      1059     2.39      0.10            DEMIDOV    70 HLBC PI-P, 3.86 GEV/C    12/70
T      4572     2.54      0.04            BALTAY     71 HBC     K-P AT REST       6/71
T    S   ERROR PURELY STATISTICAL.
T            . . . . . . . . . . .
T    AVG        2.521     0.021     0.021  AVERAGE (ERROR INCL. SCALE FACTOR OF 1.2)
                         (SEE IDEOGRAM BELOW )
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                18  ((LAMBDA) - (ANTI-LAMBDA))/AVG., MEAN LIFE DIFFERENCE

DT              0.044     0.085            BADIER     67 HBC     2.4 PBAR P       8/67
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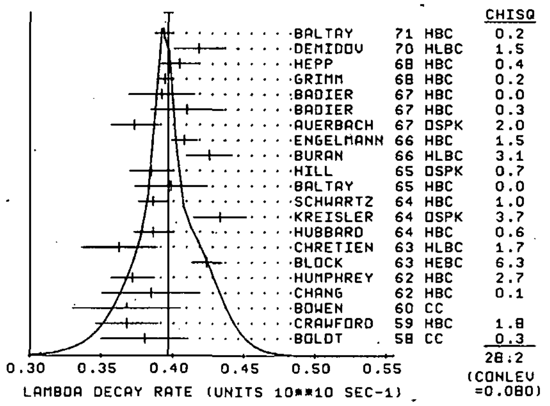
WEIGHTED AVERAGE = 0.3967 ± 0.0033
ERROR SCALED BY 1.2

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                18  LAMBDA MAGNETIC MOMENT (MAGNETONS,938.26 MEV)

MM            -1.5       0.5               COOL       62 OSPK
MM             0.0       0.6               KERNAN     63 CC
MM     8553   -1.39      0.72              ANDERSON   64 HBC
MM      151   -0.5       0.28              CHARRIERE  65 EMUL
MM       49   -0.67      0.31       0.37   BARKOV     71 EMUL   PRELIM. RESULT    2/72
MM     1300   -0.66      0.07              DAHLJENSE  71 EMUL   MAG FIELD=200KG   6/71
MM     3868   -0.73      0.18              HILL       71 OSPK                    10/71
MM            . . . . . . . . . . .
MM  AVG       -0.672     0.061   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
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                18  LAMBDA ELECTRIC DIPOLE MOMENT (UNITS 10**-14 E CM)
       NONZERO VALUE IMPLIES VIOLATION OF T AND P

EDM            5.0   OR LESS  CL=.95   GIBSON     66 EMUL                         2/72
EDM  B         1.0   OR LESS  CL=.95   BARONI     71 EMUL                         2/72
EDM  B  BARONI MEASURES (-5.9+-2.9)*10**-15 E CM                                  2/72
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                18  LAMBDA PARTIAL DECAY MODES

                                                         DECAY MASSES
P1     LAMBDA INTO PROTON PI-                            938+ 139
P2     LAMBDA INTO NEUTRON PIO                           939+ 134
P3     LAMBDA INTO PROTON MU- NEUTRINO                   938+ 105+   0
P4     LAMBDA INTO PROTON E- NEUTRINO                    938+  .5+   0
P5     LAMBDA INTO PROTON PI- GAMMA                      938+ 139+   0
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                18  LAMBDA BRANCHING RATIOS

R1     LAMBDA INTO (P PI-)/((P PI-)+(N PIO))              (P1)/(P1+P2)
R1             0.627     0.031             CRAWFORD   59 HBC
R1             0.65      0.05              COLUMBIA   60 HBC
R1   U        (0.685)   (0.017)            ANDERSON   62 HBC
R1      903    0.643     0.016             HUMPHREY   62 HBC
R1 U   6736    0.635     0.007             DOYLE      69 HBC    PI-P TO LAM. KO    2/71
R1     4572    0.646     0.008             BALTAY     71 HBC    K-P AT REST        6/71
R1   U  ANDERSON RESULT NOT PUBLISHED, EVENTS ADDED TO DOYLE SAMPLE.               2/71
R1            . . . . . . . . . . .
R1   AVG       0.6399    0.0049  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R1   FIT       0.6419    0.0049 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R2     LAMBDA INTO (N PIO)/((P PI-)+(N PIO))              (P2)/(P1+P2)
R2             0.23      0.09              EISLER     57 HLBC
R2             0.43      0.14              CRAWFORD   59 HBC
R2             0.28      0.08              BAGLIN     60 HLBC
R2             0.35      0.05              BROWN      63 HLBC
R2       75    0.291     0.034             CHRETIEN   63 HLBC
R2            . . . . . . . . . . .
R2   AVG       0.304     0.025   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R2   FIT       0.3581    0.0049 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R3     LAMBDA INTO (P E- NEU)/TOTAL (UNITS 10**-3)        (P4)/(P1+P2)
R3   O   15   (2.0)     (0.5)              HUMPHREY   61 RVUE
R3   O    8   (2.9)     (1.5)       (1.2)  AUBERT     62 FBC
R3   N  150   (0.82)    (0.12)             ELY        63 FBC    K- AT REST
R3   N  102   (0.78)    (0.12)      (0.13) BAGLIN     64 FBC    K- AT 1.45 GEV/C
R3   O   20   (1.55)    (0.34)             LIND       64 HBC
R3   N  143   (0.80)    (0.08)             MALONEY    69 HBC                      10/69
R3   N   86   (0.78)    (0.09)             CANTER     71 HBC    K-P AT REST        4/71
R3   N  218   (0.88)    (0.10)             LINDQUIST  71 OSPK   PI- P TO KO LAM    2/72
R3   N  THESE VALUES HAVE BEEN CHANGED BY US INTO RATIOS TO PROTON PI-,           3/72
R3   N  BECAUSE THAT IS THE DIRECTLY MEASURED QUANTITY. SEE R5 BELOW              3/72
R3   O  LOW STATISTICS EXPERIMENTS.  NOT AVERAGED                                  7/70

R4     LAMBDA INTO (P MU- NEU)/TOTAL (UNITS 10**-4)       (P3)/(P1+P2)
R4        1   (0.2)   OR MORE              GOOD       62 HBC
R4        1   (1.0)   OR LESS              ALSTON     63 HBC
R4        2   (1.0)   OR LESS              KERNAN     64 FBC
R4      BETWEEN 1.3 AND 6.0                LIND       64 HBC
R4        3    1.3       0.7               LIND       64 RVUE                      7/66
R4        2    1.5       1.2               RONNE      64 FBC
R4        9    2.4       0.8               CANTER1    71 HBC    STOPPED K-P        7/71
R4       14    1.4       0.5               BAGGETT2   72 HBC    STOP K-            8/72*
R4            . . . . . . . . . . .
R4   AVG       1.57      0.35    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
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Stable Particles — Data Card Listings

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For notation, see key at front of Listings.

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R5      LAMBDA INTO (P E- NEU)/(P PI-) (UNITS 10**-3)    (P4)/(P1)
R5      150     1.23      0.20            ELY        63 FBC                       2/72
R5      120     1.17      0.18            BAGLIN     64 FBC                       2/72
R5      143     1.20      0.12            MALONEY    69 HBC                       2/72
R5     1078     1.31      0.06            ALTHOFF1   71 OSPK                      2/72
R5   C  86      1.17      0.13            CANTER     71 HBC    K-P AT REST        3/72
R5   C 218      1.32      0.15            LINDQUIST 71 OSPK    PI-P TO KO LAM     3/72
R5   C  CALCULATED BY US FROM R3 ASSUMING THE AUTHORS USED (P PI-)/TOT=2/3        3/72
R5           . . . . . . . . . . .
R5  AVG      1.267     0.044    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

R6      LAMBDA INTO (P PI- GAMMA)/(P PI-) (UNITS 10**-3) (P5)/(P1)                1/73*
R6       72     1.32      0.22            BAGGETT3   72 HBC  PI- MOM LT 95 MEV/C  1/73*

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                    18  LAMBDA DECAY PARAMETERS

         RELATED TEXT SECTION IV H AND APPENDIX III

A-      ALPHA LAMBDA- (LAMBDA INTO PI- PROTON)
A-     1156     0.62      0.07            CRONIN     63 CNTR    LAMBDA FROM PI-P  8/67
A-             (0.663)   (0.022)          BERGE      66 RVUE  INCLUDES ABOVE      9/66
A-    10130     0.645     0.017           OVERSETH   67 OSPK    LAMBDA FROM PI-P  8/67
A-  M 2529     (0.747)   (0.086)          MERRILL    68 HBC  REPL BY DAUBER 68    6/68
A-     3520     0.67      0.06            DAUBER     69 HBC  FROM XI DECAY        6/68
A-    10325     0.649     0.023           CLELAND    72 OSPK    LAMBDA FROM PI-P  5/72*
A-           . . . . . . . . . . .
A-  AVG         0.647     0.013   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

AO      ALPHAO /ALPHA- FOR LAMBDA (L INTO PIO N/L INTO PI- P)
AO              1.10      0.27            CORK       60 CNTR
AO O  4760      1.000     0.068           OLSEN      70 OSPK PI+N TO K+ LAMBDA    5/70
AO           . . . . . . . . . . .
AO  AVG         1.006     0.066   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
AO O    DONE BY COMPARING PROTON DISTR.WITH N DISTR. FROM LAMBDA DECAY.

F-      PHI ANGLE (SIN(PHI)/COS(PHI)=BETA/GAMMA)  (DEGREES)
F-     1156    13.0      17.0             CRONIN     63 OSPK    LAMBDA FROM PI-P 11/67
F-    10130    -8.0       6.0             OVERSETH   67 OSPK    LAMBDA FROM PI-P 11/67
F-     7377   (-9.2)     (5.2)            CLELAND    67 OSPK REPL BY CLELAND 72   5/72*
F-    10325    -7.0       4.5             CLELAND    72 OSPK    LAMBDA FROM PI-P  5/72*
F-           . . . . . . . . . . .
F-  AVG        -6.5       3.5     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

AV      GA/GV FOR LAMBDA BETA DECAY (SEE TEXT SEC. IV H.1 FOR SIGN CONV.)
AV  C   22   (-1.03)                      LIND       64 HBC                       6/68
AV  C  102    (0.6)  OR MORE              BAGLIN     65 HLBC    NO SIGN GIVEN     1/71
AV  C        BETW 0. AND -1.1             BARLOW     65 OSPK                      6/68
AV  C  102    (0.7)  OR MORE  CL=.95      ELY        65 HLBC     ABS. VALUE       1/71
AV           -1.14      0.23      0.33    CONFORTO   65 RVUE                     11/67
AV M   148   -0.72      0.14      0.19    MALONEY    69 HBC                      10/69
AV A  1078   -0.62      0.08      0.09    ALTHOFF2   71 OSPK POLARIZED LAMBDAS    2/72
AV M   141   -0.75      0.15      0.18    CANTER     71 HBC                       4/71
AV L   173  (-0.32)    (0.13)    (0.17)   LINDQUIST 71 OSPK   UP-DOWN ASYMMETRY   9/71
AV ML  173  (-0.68)    (0.27)    (0.54)   LINDQUIST 71 OSPK   E-NEU CORRELATION   9/71
AV L   173   -0.40      0.13      0.17    LINDQUIST 71 OSPK   E-NEU AND UP-DOWN   9/71
AV M   352   -0.74      0.09      0.12    BAGGETT1   72 HBC     STOP.K-           2/72
AV  C   EXPERIMENTS INCLUDED IN CONFORTO 65, RVUE                                 6/68
AV M    EXPT MEASURES ONLY THE ABSOLUTE VALUE OF A/V
AV A    USES E AND PROTON UP-DOWN ASYMM AND E-NEU CORRELATIONS                    2/72
AV  L   LINDQUIST 71 GETS THREE VALUES.  WE AVERAGE THE ONE THAT USES            10/71
AV  L   ALL DATA.                                                                10/71
AV           . . . . . . . . . . .
AV  AVG      -0.665     0.063   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.2)
                               (SEE IDEOGRAM BELOW )
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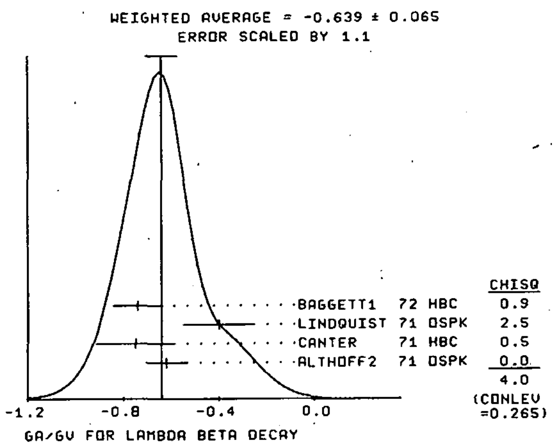


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REFERENCES FOR LAMBDA

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EISLER    57 NC     5 1700      EISLER,PLANO,SAMIOS,SCHWARTZ +     (COLU+BNL)
BOLDT     58 PRL    1  148      E BOLDT,D O CALDWELL,Y PAL              (MIT)
CRAWFORD  59 PRL    2  266      CRAWFORD,CRESTI,DOUGLASS,GOOD +         (LRL)

BAGLIN    60 NC     18 1043     BAGLIN,BLOCH,BRISSON,HENNESSY +        (EPOL)
BOWEN     60 PR    119 2030     BOWEN,HARDY,REYNOLDS,SUN +        (PRINCETON)
CORK      60 PR    120 1000     CORK,KERTH,WENZEL,CRONIN+     (LRL+PRIN+BNL)
COLUMBIA  60 ROCH CONF 726      M SCHWARTZ +                       (COLUMBIA)
HUMPHREY  61 PRL     6  478     HUMPHREY,KIRZ,ROSENFELD,RHEE +     (LRL+SYRA)

ANDERSON  62 CERN CONF 832      ANDERSON,CRAWFORD,GOLDEN,LLOYD +        (LRL)
AUBERT    62 NC     25  479     AUBERT,BRISSON,HENNESSY,SIX +          (EPOL)
CHANG     62 THESIS DUKE        CHUEN CHUEN CHANG                      (DUKE)
COOL      62 PR    127 2223     COOL,HILL,MARSHALL +        (BNL+MIT+NYU+ANL)
GOOD      62 PRL     9  518     M L GOOD,V G LIND                 (WISCONSIN)
HUMPHREY  62 PR    127 1305     W E HUMPHREY,R R ROSS                   (LRL)

ALSTON    63 UCRL 10926         ALSTON,KIRZ,NEUFELD,SOLMITZ,WOHLMUT     (LRL)
BHOWMIK   63 NC     28 1494     B BHOWMIK,D P GOYAL                   (DELHI)
BLOCK     63 PR    130  766     BLOCK,GESSAROLI,RATTI+(NWES+BGNA+SYRA+ORNL)
BROWN     63 PR    130  769     BROWN,KADYK,TRILLING,ROE +         (LRL+MICH)
CHRETIEN  63 PR    131  2208    CHRETIEN,CROUCH+    (BRAN+BROWN+HARVARD+MIT)
CRONIN    63 PR    129 1795     J W CRONIN,O E OVERSETH           (PRINCETON)
ELY       63 PR    131  868     ELY,GIDAL,KALMUS,OSWALD,POWELL +        (LRL)
KERNAN    63 PR    129  870     KERNAN,NOVEY,WARSHAW,WATTENBERG    (ANL+ILL)

ANDERSON  64 PRL    13  167     J A ANDERSON,F S CRAWFORD               (LRL)
BAGLIN    64 NC     35  977     BAGLIN,BINGHAM+  (EPOL+CERN+LOUC+RHEL+BERG)
HUBBARD   64 PR    135 B 183    HUBBARD,BERGE,KALBFLEISCH,SHAFER +      (LRL)
KERNAN    64 PR    133 B 1271   KERNAN,POWELL,SANDLER +            (LRL+LOUC)
KREISLER  64 PR 136 B 1074      M N KREISLER,O OVERSETH,J CRONIN       (PRIN)
LIND      64 PR    135 B 1483   LIND,BINFORD,GOOD,STERN           (WISCONSIN)
RONNE     64 PL     11    357   RONNE+           (CERN+EPOL+LOUC++UNIV.BERGEN)
SCHWARTZ  64 UCRL 11360 THESIS  JOSEPH ADAM SCHWARTZ                    (LRL)

BAGLIN    65 NC 35 977          BAGLIN +         (EPOL,CERN,LOUC,RHEL,BERGEN)
BALTAY    65 PR 140 B 1027      BALTAY,SANDWEISS,CULWICK,KOPP +    (YALE+BNL)
BARLOW    65 PL     18   64     J BARLOW,BLAIR,CONFORTO+      (CERN+RHEL+PENN)
CHARRIER  65 PL     15     66   CHARRIERE,GIBSON+        (EPOL+BRIS+CERN+MPIM)
     ALSO 66 NC     46A  205    CHARRIERE,GIBSON +       (EPOL,BRIS,CERN,MPIM)
CONFORTO  65 EC INT HERZEGNOVI  G CONFORTO                             (CERN)
ELY       65 PR 137 B1302       ELY,GIDAL,KALMUS,POWELL +          (LRL,LOUC)
HILL      65 PRL 15 85          HILL,LI,JENKINS,KYCIA,RUDERMAN      (MIT,BNL)
SCHMIDT   65 PR 140 B 1328      P SCHMIDT                          (COLUMBIA)

BERGE     66  BERKELEY 46       BERGE,CABIBBO                 ((RVUE) LRL,CERN)
BURAN     66 PL 20 318          BURAN,EIVINDSON,SKJEGGESTAD,TOFTE +    (OSLO)
CHIEN     66 PR    152  1171    +LACH,SANDWEISS,TAFT,YEH,OREN +    (YALE+BNL)
ENGELMAN  66 NC 45A  1038       ENGELMANN,FILTHUTH,ALEXANDER+     (HEID,REHO)
GIBSON    66 NC 45A 882         H M GIBSON,K GREEN                     (BRIS)
LONDON    66 PR 143 1034        LONDON,RAU,GOLDBERG,LICHTMAN+      (BNL,SYRA)

AUERBACH  67 NC   47A  19       AUERBACH,BOWEN,DOBBS,LANDE,MANN+       (PENN)
BADIER    67 PL 25B 152         +BONNET,BRIANDET,SADOULET              (EPOL)
CLELAND   67 PL 26B 45          CLELAND,BIENLEIN,CONFORTO+ (CERN+GEVA+LUND)
MAYEUR    67 U.LIBR.BRUX.BUL32  C.MAYEUR,E.TOMPA,J.WICKENS        (BELG,LOUC)
OVERSETH  67 PRL   19  391      O E OVERSETH, R F ROTH            (MICH+PRIN)
GRIMM     68 NC 54A 187         H.-J.GRIMM                       (HEIDELBERG)
HEPP      68 ZPHYS 214 71       V.HEPP,H. SCHLEICH               (HEIDELBERG)
MERRILL   68 PR 167 1202        MERRILL,SHAFER                          (LRL)

DAUBER    69 PR   179 1262      +BERGE,HUBBARD,MERRILL,MILLER           (LRL)
DOYLE     69 UCRL 18139-THESIS  J.C. DOYLE                              (LRL)
MALONEY   69 PRL 23 425         MALONEY,SECHI-ZORN           (UNIV MARYLAND)
BOHM      70 NC 70A 384         + KRECKER + (BERL+BRUX+DUUC+LOUC+LOWC+WARS)
DEMIDOV   70 SJNP 10 681        +KIRILLOV-UGRYUMOV,PONOSOV,PROTASOV+ (ITEP)
OLSEN     70 PRL 24 843         +PONDROM,HANDLER,LIMON,SMITH +    (WISC,MICH)

ALTHOFF1  71 PL 37B 531         +BROWN,FREYTAG,HEARD,HEINTZE +    (CERN,HEID)
ALTHOFF2  71 PL 37B 535         +BROWN,FREYTAG,HEARD,HEINTZE +    (CERN,HEID)
BALTAY    71 PR D4 670          +BRIDGEWATER,COOPER,HABIBI+       (COLU+BING)
BARKOV    71 JETPL 14 60        +GUREVICH,MAKARINA,MARTEMYANOV+        (ITEP)
BARONI    71 LNC 2 1256         G BARONI,S PETRERA,G ROMANO            (ROMA)
CANTER    71 PRL 26 868         +COLE,LEE-FRANZINI,LOVELESS +     (STON+COLU)

CANTER1   71 PRL 27 59          +COLE,LEE-FRANZINI,LOVELESS+      (STON+COLU)
DAHLJENS  71 NC 3A 1            DAHL-JENSEN +      (CERN+ANKA+LAUS+MPIM+ROMA)
HILL      71 PR D4 1979         +LI,JENKINS,KYCIA,RUDERMAN          (MIT,BNL)
     ALSO 65 PRL 15 85          HILL,LI,JENKINS,KYCIA,RUDERMAN      (MIT,BNL)
LINDQUIS  71 PRL 27 612         LINDQU+ST,SUMNE-+          (EFI,WUSL,OSU,ANL)

BAGGETT1  72 ZPHY 249 279       +BAGGETT,EISELE,FILTHUTH,FREHSE+       (HEID)
BAGGETT2  72 ZPHY 252 362       +BAGGETT,EISELE,FILTHUTH,FREHSE+       (HEID)
BAGGETT3  72 PL 42B 379         +BAGGETT,EISELE,FILTHUTH,FREHSE,HEPP+(HEID)
CLELAND   72 NP B40 221         +CONFORTO,EATON,GERBER+     (CERN+GEVA+LUND)
HYMAN     72 PR D5 1063         +BUNNELL,DERRICK,FIELDS,KATZ+     (ANL+CARN)

                                PAPERS NOT REFERRED TO IN DATA CARDS

ARMENTER  62 CERN CONF 236      ARMENTEROS+ (CERN+EPOL+LOIC+BIRM+CEN-SACLAY)
BALTAY    62 CERN CONF 233      BALTAY,FOWLER,SANDWEISS,CULWICK+ (YALE+BNL)
BERGE     63 THESIS (BERKELEY)  J PETER BERGE                           (LRL)
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Σ^+

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                 19  SIGMA+ (1189,JP=1/2+) I=1

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                 19  SIGMA+ MASS (MEV)

M   N SEE NOTE PRECEDING LAMBDA MASS LISTINGS

M      144 1189.38     0.15         BARKAS    63 EMUL +  SEE NOTE S BELOW
M       58 1189.48     0.22         BHOWMIK   64 EMUL +  SEE NOTE S BELOW
M   S  ABOVE SIGMA+ MASSES HAVE BEEN RAISED 30  KEV TO ACCOUNT FOR 46 KEV
M   S  INCREASE IN PROTON MASS AND 21 KEV DECREASE IN PION MASS
M     4205 1189.68     0.10         SCHMIDT   65 HBC   SEE NOTE N            6/68
M          1189.16     0.12         HYMAN     67 HEBC                        6/68
M      607 1189.39     0.06         BOHM      72 EMUL                        1/73*
M          . . . . . . . . . . .
M   AVG    1189.418    0.076   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.7)
M   FIT    1189.406    0.068  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.6)  1/73*
                              (SEE IDEOGRAM BELOW )
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Data Card Listings

For notation, see key at front of Listings.

Stable Particles

Σ^+

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WEIGHTED AVERAGE = 1189.418 ± 0.076
ERROR SCALED BY 1.7
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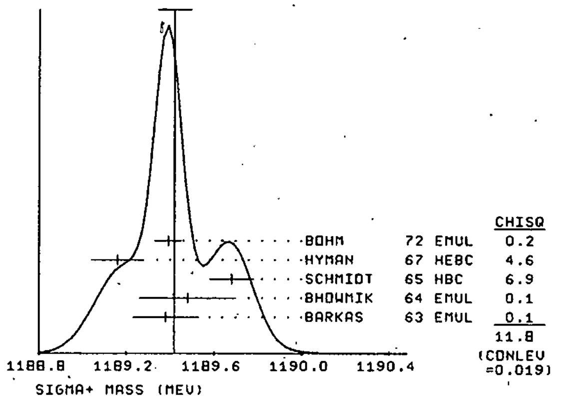


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                        19  SIGMA+ MEAN LIFE (UNITS 10**-10)

T                                        GLASER    58 RVUE
T      127    0.98     0.16     0.12  PUSCHEL   60 EMUL
T       41    0.82     0.34     0.20  EVANS     60 EMUL
T      117    0.85     0.14     0.11  FREDEN    60 EMUL
T       54    0.80     0.10     0.067 KAPLON    60 EMUL
T       23    0.76     0.22     0.14  CHIESA    61 EMUL
T       49    0.75     0.13     0.09  BERTHELOT 61 HLBC
T      140    0.82     0.10     0.08  BARKAS    61 EMUL
T      192    0.749    0.056    0.052 GRARD     62 HBC
T      456    0.765    0.04     0.04  HUMPHREY  62 HBC
T      203    0.84     0.12     0.08  BHOWMIK   64 EMUL
T      181    0.84     0.09           BALTAY    65 HBC                       6/66
T      900    0.76     0.03           CARAYAN   65 HBC                       6/66
T  C  1300    0.83     0.032          CHANG     66 HBC                       6/66
T   S  125   (0.86)   (0.15)          CHIEN     66 HBC  +  6.9 PBAR P        9/67
T   S  117   (1.10)   (0.24)          CHIEN     66 HBC  -  6.9 PBAR P,ANTI   9/67
T      381    0.80     0.07           COOK      66 OSPK                      7/66
T    10664    0.803    0.008          BARLOUTAU 69 HBC    K-P .4-1.2 GEV/C 11/69
T      20K    0.795    0.010          EISELE    70 HBC    K-P AT REST        2/71
T      526    0.83     0.04           BAKKER    71 DBC  - K-N TO SIG+ 2PI- 10/71
T  C    CHANG ERROR 0.018 RAISED BY US.  SEE 1970 EDITION, RMP 42,123(1970)  1/73*
T   S   ERROR PURELY STATISTICAL
T              . . . . . . . . .
T   AVG       0.8004   0.0058   0.0057 AVERAGE (ERROR INCL. SCALE FACTOR OF 1.0)
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                  19  SIGMA+ MAGNETIC MOMENT (MAGNETONS,938.26 MEV)

MM     381    1.5      1.1            COOK      66 OSPK                      7/66
MM      52    3.5      1.5            KOTELCHUC 67 EMUL    K-P AT 1.15BEV/C  8/67
MM      51    3.0      1.2            SULLIVAN  67 EMUL    PHOTOPRODUCTION   8/67
MM      69    3.5      1.2            COMBE     68 EMUL                     10/68
MM   29333    2.1      1.0            MAST      68 HBC     K-P AT .4 GEV/C   6/68
MM     955    2.67     0.97           ALLEY     71 OSPK    1.28 GEV/C PI+P  10/70
MM           . . . . . . . . .
MM  AVG       2.59     0.46    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
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                  19  SIGMA+ PARTIAL DECAY MODES

                                                        DECAY MASSES
P1    SIGMA+ INTO PROTON PIO                            938+ 134
P2    SIGMA+ INTO NEUTRON PI+                           939+ 139
P3    SIGMA+ INTO NEUTRON PI+ GAMMA                     939+ 139+    0
P4    SIGMA+ INTO LAMBDA E+ NEU                        1115+  .5+    0
P5    SIGMA+ INTO PROTON GAMMA                          938+   0
P6    SIGMA+ INTO NEUTRON MU+ NEUTRINO                  939+ 105+    0
P7    SIGMA+ INTO NEUTRON E+ NEUTRINO                   939+  .5+    0
P8    SIGMA+ INTO PROTON E+ E-                          938+  .5+   .5
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                  19  SIGMA+ BRANCHING RATIOS

R1    SIGMA+ INTO (NEUTRON PI+)/(NUCLEON PI)               (P2)/(P1+P2)
R1     308    0.490    0.024          HUMPHREY  62 HBC
R1     534    0.46     0.02           CHANG     66 HBC                       6/66
R1    1331    0.488    0.010          BARLOUTAU 69 HBC    K-P .4-1.2 GEV/C 11/69
R1     537    0.484    0.015          TOVEE     71 EMUL                     12/71
R1           . . . . . . . . .
R1  AVG       0.4835   0.0073  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

R2    SIGMA+ INTO (NEUT PI+ GAM)/(PI+N) (UNITS 10**-3) (P3)/P2)
R2           (1.8)     ABOUT          BAZIN2    65 HBC    PI+ LT 116 MEV/C  8/67
R2      29    0.27     0.05           ANG       69 HBC    PI+ LT 110 MEV/C 11/68

R3    SIGMA+ INTO (LAMBDA E+ NEU)/TOTAL (UNITS 10**-5) (P4)
R3  W    4   (3.3)    (1.7)           WILLIS    64 HBC    STOP. K-          9/66
R3  W                 EVENTS FROM THIS EXPERIMENT,INCLUDED IN EISELE1 69   11/69
R3       6    2.0      0.8            BARASH    67 HBC    STOP K-           8/67
R3       5    1.6      0.7            BALTAY    69 HBC    STOP K-          11/69
R3      10    2.9      1.0            EISELE1   69 HBC    STOP K-          10/69
R3           . . . . . . . . .
R3  AVG       2.02     0.47    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

R4    SIGMA+ INTO (P GAMMA)/(P PIO) (UNITS 10**-2)     (P5)/(P1)
R4     1    (0.68) OR LESS               CARRARA   64 HBC
R4    24     0.37     0.08               BAZIN     65 HBC
R4     4    (0.17)                       QUARENI   65 EMUL                  6/66
R4    45     0.21     0.03               ANG       69 HBC    STOP K-       10/69
R4    31     0.276    0.051              GERSHWIN  69 HBC                  10/69
R4           . . . . . . . . .
R4  AVG      0.240    0.035   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.4)
                              (SEE IDEOGRAM BELOW )
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WEIGHTED AVERAGE = 0.240 ± 0.035
ERROR SCALED BY 1.4
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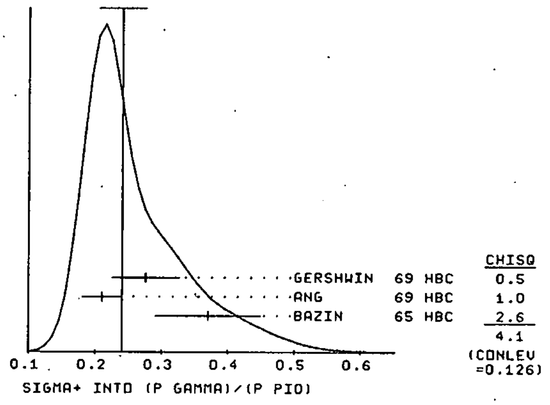


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R5     SIGMA+ INTO (N E+ NEU)/(N PI+) (UNITS 10**-5)    (P7)/(P2)
R5 E     0    16220 EFFECTIVE DENOM.  COURANT   64 HBC     SEE NOTE E      11/67
R5 E     0     2720 EFFECTIVE DENOM.  MURPHY    64 HBC     SEE NOTE E      11/67
R5 E     1     9690 EFFECTIVE DENOM.  NAUENBERG 64 HBC     SEE NOTE E       6/68
R5       0   (32406)EFFECTIVE DENOM.  BIERMAN   68 HBC                      6/68
R5 UA    0   (80400)EFFECTIVE DENOM.  EISELE2   69 HBC  +  STOP K-          6/68
R5 U     1    30000 EFFECTIVE DENOM.  NORTON    69 HBC                     11/69
R5 U     0   110200 EFFECTIVE DENOM.  EBENHOH   70 HBC     STOP K-         12/70
R5 U                EFFECTIVE DENOM. CALCULATED BY US
R5 E                EFFECTIVE DENOM.  TAKEN FROM EISELE 67                 11/67
R5  A      EISELE2 69 REPLACED BY EBENHOH 70
R5           . . . . . . . . .
R5     4.0     2.0    OR LESS  CL=.90   OUR AVERAGE USING ALL ABOVE        12/70
R5      NUMBER OF EVENTS INCREASED TO 4.0 FOR 90PC CONFIDENCE LEVEL         2/71

R6     SIGMA+ INTO (N MU+ NEU)/(PI+N) (UNITS 10**-5)    (P6)/(P2)
R6       1      (120)ANALYSED EVENTS  GALTIERI  62 EMUL    NO RATIO QUOTED 11/67
R6 E     0    10150 EFFECTIVE DENOM.  COURANT   64 HBC     SEE NOTE E      11/67
R6 E     0     1710 EFFECTIVE DENOM.  NAUENBERG 64 HBC     SEE NOTE E      11/67
R6 U     2    62000 EFFECTIVE DENOM.  EISELE2   69 HBC                      6/68
R6       0    33800 EFFECTIVE DENOM.  BAGGETT   69 HBC                     11/68
R6 E                EFFECTIVE DENOM.  TAKEN FROM EISELE 67                 11/67
R6           . . . . . . . . .
R6     5.3     4.9    OR LESS  CL=.90   OUR AVERAGE USING ALL ABOVE        11/69
R6      NUMBER OF EVENTS INCREASED TO 5.3 FOR 90PC CONFIDENCE LEVEL         2/71
R6                  SEE NOTES ACCOMPANYING R5

R7     (SIGMA+ INTO LEPTONS)/(SIGMA- INTO LEPTONS)
R7       0     0.034 OR LESS          BAGGETT   67 HBC                      6/68
R7       1     0.08  OR LESS          NORTON    69 HBC                     10/69
R7           . . . . . . . . .
R7     6.7     0.035 OR LESS  CL=.90   OUR AVERAGE  USING R5 AND R6         2/71
R7      NUMBER OF EVENTS INCREASED TO 6.7 FOR 90PC CONFIDENCE LEVEL         2/71

R8     SIGMA+ INTO (PROTON E+ E-)/TOTAL (UNITS 10**-6)  (P8)
R8             7.0    OR LESS         ANG       69 HBC     STOP K-         10/69
R8    A   ANG 69 FOUND 3 E+E- EVENTS IN AGREEMENT WITH GAMMA CONVERSION OF
R8    A   PROTON GAMMA DECAY -LIMIT GIVEN HERE IS FOR NEUTRAL CURRENT

R9     (SIGMA+ INTO N MU+ NEU)/(SIGMA- INTO N MU- NEU)
R9       2  0.06       0.045     0.03  EISELE2   69 HBC  +-   STOP K-       10/69
R9           . . . . . . . . .
R9     5.3     0.095 OR LESS  CL=.90   OUR AVERAGE  USING R6                2/71
R9      NUMBER OF EVENTS INCREASED TO 5.3 FOR 90PC CONFIDENCE LEVEL         2/71

R10    (SIGMA+ INTO N E+ NEU)/(SIGMA- INTO N E- NEU)
R10 E    0   (0.03) OR LESS  CL=.90   EISELE2   69 HBC  +- STOP K-          10/69
R10      0    0.019 OR LESS  CL=.90   EBENHOH   70 HBC     STOP K-          12/70
R10      0  , 0.12  OR LESS  CL=.95   COLE      71 HBC     STOP K-          10/71
R10 E     EISELE2 REPLACED BY EBENHOH 70
R10          . . . . . . . . .
R10    4.0     0.016 OR LESS  CL=.90   OUR AVERAGE  USING R5                2/71
R10     NUMBER OF EVENTS INCREASED TO 4.0 FOR 90PC CONFIDENCE LEVEL         2/71
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                  19  SIGMA+ DECAY PARAMETERS

       RELATED TEXT SECTION IV H AND APPENDIX III

A+0       ALPHA+/ALPHAO FOR SIGMA+ (SIG+ TO PI+ N)/(SIG+ TO PIO P)
A+0            +0.04      0.11          CORK      60 CNTR    SIG+ FROM PI+P
A+0           (+0.20)    (0.24)         TRIPP     62 HBC  +  REPLAC.BY BANGER
A+0 O 3500    (-.014)    (0.052)        BANGERTER 66 HBC  +  SIG+ FROM K-P     9/66
A+0 O 2600    (-.047)    (.07)          BERLEY    66 HBC  +  SIG+ FROM K-P     9/66
A+0 O         OLD RESULTS,HAVE BEEN REPLACED . SEE BELOW -

A+        ALPHA SIGMA++(SIG+ TO PI+ N)
A+    35000    0.069     0.017          BANGERTER 69 HBC     K-P AT 400 MEV/C 11/69
A+     4101    0.037     0.049          BERLEY    70 HBC                      12/70
A+            . . . . . . . . .
A+   AVG       0.066     0.016   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
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Stable Particles — Data Card Listings

Σ^+, Σ^-

For notation, see key at front of Listings.

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AO      ALPHA SIGMAO (SIG+ INTO PIO PROTON)
AO  -        -0.80     0.16            BEALL     62 CNTR
AO          (-0.90)   (0.25)           TRIPP     62 HBC     REPLAC. BY BANGE
AO  O 5200  (-0.986)  (0.072)          BANGERTER 66 HBC     K-P TO SIG+ PI-    7/66
AO   32000   -0.999    0.022           BANGERTER 69 HBC                       10/69
AO H  1335   -0.98     0.05     0.02   HARRIS    70 OSPK    PI+P TO SIG+ K+    5/70
AO     16K   -0.940    0.045           BELLAMY   72 ASPK    PI+P TO SIG+ K+   11/72*
AO H  DECAY PROTONS SCATTERED OFF CARBON
AO          . . . . . . . . . .
AO  AVG      -0.984    0.017   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

F+       PHI+ ANGLE (SIG+ INTO N PI)  SIN(PHI)/COS(PHI)=BETA/GAMMA  (DEGREE)
F+  O  370 (180.)    (30.)             BERLEY    66 HBC  +  NEUTRON RESCATT.  9/66
F+     560  143.      29.              BANGERT1  69 HBC                       10/69
F+   C1054  184.      24.              BERLEY    70 HBC     K-P AT 400 MEV/C 11/69
F+   C  CHANGED FROM 176 TO 184 TO AGREE WITH SIGN CONVENTION.
F+          . . . . . . . . . .
F+  AVG     167.3     20.1     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.1)

AG       ALPHA SIGMAG (SIG+ INTO PROTON GAMMA)
AG       61   -1.03    0.52     0.42   GERSHWIN  69 HBC     K-P TO SIG PI     11/69

FO      PHIO ANGLE (SIG+ INTO PIO PROTON) SIN(PHI)/COS(PHI)=BETA/GAMMA (DEG)
FO H          22.0     90.0            HARRIS    70 OSPK PI+P TO SIG+ K+       5/70
FO H    DECAY PROTONS SCATTERED OFF CARBON.

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REFERENCES FOR SIGMA+


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CORK      60 PR 120 1000         CORK,KERTH,WENZEL,CRONIN,COOL(LRL+PRIN+BNL)
EVANS     60 NC 15 873           BRIST+BRUSS+IAS-U.COL-DUBLIN+LON+MILAN+PAD
FREDEN    60 NC 16 611           S FREDEN,H KORNBLUM,R WHITE            (LRL)
KAPLON    60 ANP 9 139           M KAPLON,A MELISSINOS,YAMANOUCHI      (ROCH)
PUSCHEL   60 NP 20 254           W PUSCHEL                 (MAX PLANCK INST)

BARKAS    61 PR 124 1209         BARKAS,DYER,MASON,NICHOLS,SMITH        (LRL)
BERTHELO  61 NC 21 693           BERTHELOT,DAUDIN,GOUSSU +     (SACLAY+ORSAY)
CHIESA    61 NC 19 1171          CHIESA,QUASSIATI,RINAUDO        (INFN-TURIN)

BEALL     62 PRL 8 75            BEALL,CORK,KEEFE,MURPHY,WENZEL         (LRL)
GRARD     62 PR 127 607          F GRARD,G A SMITH                      (LRL)
GALTIERI  62 PRL 9 26            GALTIERI,BARKAS,HECKMAN,PATRICK,SMITH  (LRL)
HUMPHREY  62 PR 127 1305         W E HUMPHREY,R R ROSS                  (LRL)
TRIPP     62 PRL 9 66            R D TRIPP,M B WATSON,M FERRO-LUZZI     (LRL)

BARKAS    63 PRL 11 26           W H BARKAS,J N DYER,H H HECKMANN       (LRL)
   ALSO   61 UCRL 9450           JOHN DYER (THESIS, BERKELEY)           (LRL)

BHOWMIK   64 NP 53 22            B BHOWMIK,P JAIN,P MATHUR,LAKSHMI    (DELHI)
CARRARA   64 PL 12 72            CARRARA,CRESTI,GRIGOLETTO,PERUZZO+  (PADOVA)
COURANT   64 PR 136 B 1791       COURANT,FILTHUTH+    (CERN+HEID+UMD+NRL+BNL)
MURPHY    64 PR 134 B 188        C THORNTON MURPHY                (WISCONSIN)
NAUENBER  64 PRL 12 679          NAUENBERG,MARATECK,+          (COLU+RUTG+PRIN)
WILLIS    64 PRL 13 291          WILLIS,COURANT,ENGELMAN+(BNL,CERN,HEID,UMD)

BALTAY    65 PR 140 B 1027       BALTAY,SANDWEISS,CULWICK,KOPP +  (YALE+BNL)
BAZIN     65 PRL 14 154          BAZIN,BLUMENFELD,NAUENBERG +      (PRIN+COLU)
BAZIN2    65 PR 140  B1358       BAZIN,PLANO,SCHMIDT+          (PRIN,RUTG,COLU)
CARAYAN   65 PR 138 B 433        CARAYANNOPOULOS,TAUTFEST,WILLMANN  (PURDUE)
QUARENI   65 NC 40 A 928         QUARENI,CARTACCI +    (BGNA,FIRZ,GENO,PARMA)
SCHMIDT   65 PR 140 B 1328       P SCHMIDT                         (COLUMBIA)

BANGERTE  66 PRL  17  495        BANGERTER,GALTIERI,BERGE,MURRAY+       (LRL)
BERLEY    66 PRL 17 1071         +HERZBACH,KOFLER,YAMAMOTO + (BNL+MASA+YALE)
CHANG     66 PR  151  1081       CHUNG YUN CHANG                   (COLUMBIA)
   ALSO   65 NEVIS 145  THESIS   CHUNG YUN CHANG                   (COLUMBIA)
CHIEN     66 PR  152  1171       +LACH,SANDWEISS,TAFT,YEH,OREN +   (YALE+BNL)
COOK      66 PRL  17  223        V COOK,EWART,MASEK,ORR,PLATNER (WASHINGTON)

BAGGETT   67 PRL 19 1458         BAGGETT,DAY,GLASSER,KEHOE,KNOP+   (MARYLAND)
   ALSO   68 VIENNA ABS. 374     BAGGETT,KEHOE                     (MARYLAND)
   ALSO   68 PRIVATE COMM.       N. BAGGETT                        (MARYLAND)

BARASH    67 PRL 19  181         BARASH,DAY,GLASSER,KEHOE,KNOP +   (MARYLAND)
EISELE    67 ZPHYS 205 409       +ENGELMANN,FILTHUTH,FOLISH,HEPP+      (HEID)
HYMAN     67 PL 25 B 376         +LOKEN,PEWITT,MCKENZIE,+      (ANL+CARN+NWES)
KOTELCHU  67 PRL 18 1166         KOTELCHUCK,GOZA,SULLIVAN,ROSS  (VANDERBILT)
SULLIVAN  67 PRL 18 1163         SULLIVAN,MCINTURFF,KOTELCHUCH  (VANDERBILT)
   ALSO   64 PRL 13 246          A D MC INTURFF,C E ROOS        (VANDERBILT)

BIERMAN   68 PRL 20 1459         BIERMAN,KOUNOSU,NAUENBERG +      (PRINCETON)
COMBE     68 NC 57A 54           CERN-BRISTOL-LAUSANNE-MUNICH-ROME-COLLABOR
MAST      68 PRL 20 1312         MAST,GERSHWIN,ALSTON-GARNJOST +        (LRL)

ANG       69 ZPHYS 228 151       +EBENHOH,EISELE,ENGELMANN,FILTHUTH+   (HEID)
BAGGETT   69 MDDP-TR-973         N V BAGGETT (THESIS)                   (UMD)
BALTAY    69 PRL 22 615          BALTAY,FRANZINI,NEWMAN,NORTON+  (COLU,STON)
BANGERTE  69 UCRL-19244          ROGER ODELL BANGERTER (THESIS)         (LRL)
BANGERT1  69 PR 187 1821         BANGERTER,GARNJOST,GALTIERI,GERSHWIN+ (LRL)
BARLOUTA  69 NP B14 153          BARLOUTAUD,BELLEFON,GRANET+(SACL+CERN+HEID)
EISELE1   69 ZPHYS 221 1         +ENGELMANN,FILTHUTH,FOHLISCH,HEPP+    (HEID)
EISELE2   69 ZPHYS 221 401       +ENGELMANN,FILTHUTH,FOHLISCH,HEPP+    (HEID)
GERSHWIN  69 PR 188 2077         +ALSTON-GARNJOST,BANGERTER +           (LRL)
   ALSO      UCRL 19246 THESIS   LAWRENCE K GERSHWIN                    (LRL)
NORTON    69 NEVIS 175 (THESIS)  HERBERT NORTON                    (COLUMBIA)

BERLEY    70 PR D1 2015          +YAMIN,HERTZBACH,KOFLER +   (BNL,MASA,YALE)
EBENHOH   70 KIEV CONF           +EISELE,ENGELMANN,FILTHUTH,FOHLISCH+ (HEID)
   ALSO   70 ZPHY 228 151        ANG,EISELE,ENGELMANN,FILTHUTH +       (HEID)
EISELE    70 ZPHY 238 372        +FILTHUTH,HEPP,PRESSER,ZECH     (HEIDELBERG)
HARRIS    70 PRL 24 165          +OVERSETH,PONDROM,DETTMANN       (MICH,WISC)

ALLEY     71 PR  D3  75          +BENBROOK,COOK,GLASS,GREEN,HAGUE +    (WASH)
BAKKER    71 LNC 1 37            +,SABRE COLLAB.  (ZEEM+SACL+BGNA+REHO+EPOL)
COLE      71 PR D4 631           +LEE-FRANZINI,LOVELESS,BALTAY+   (STON,COLU)
TOVEE     71 NP B33 493          LOUC,BELGRADE,BERL,BRUX,DUBLIN,WARS COLLAB
BELLAMY   72 PL 39B 299          +ANDERSON,CRAWFORD,OSMON+   (LOWC+RHEL+SUSS)
BOHM      72 NP B48 1            BERLIN+BELGRADE+BRUX+DUBLIN+LOUC+WARSAW
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PAPERS NOT REFERRED TO IN DATA CARDS

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GLASER    58 CERN CONF 270       GLASER,GOOD,MORRISON             (MICH+LRL)
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QUANTUM NUMBER DETERMINATIONS NOT REFERRED TO IN THE DATA CARDS

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TRIPP     62 PRL 8 175           R TRIPP,M WATSON,M FERRO-LUZZI     (LRL) P
ALFF      63 SIENA CONF 1 205    ALFF,NAUENBERG,KIRSCH,+       (COLU+RUTG+BNL)
   ALSO   65 PR 137 B 1105       ALFF,GELFAND,BRUGGER,BERLEY+(COLU+RUTG+BNL)
COURANT   63 SIENA CONF 1 73     COURANT,FILTHUTH,BURNSTEIN,DAY+  (CERN+UMD)
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              20  SIGMA- (1198,JP=1/2+) I=1

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              20  SIGMA- MASS (MEV)

M   N   SEE NOTE PRECEDING LAMBDA MASS LISTINGS

M    3000 1197.47    0.11          SCHMIDT   65 HBC  SEE NOTE N          6/68
M         . . . . . . . . . .
M   FIT   1197.34    0.07   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.2)  1/73*

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              20  (SIGMA-) - (SIGMA+) MASS DIFFERENCE (MEV)

D      87    8.25    0.40          BARKAS    63 EMUL  -
D    2500    8.25    0.25          DOSCH     65 HBC
D      86    7.91    0.23          BOHM      72 EMUL                     1/73*
D         . . . . . . . . . .
D   AVG      8.09    0.16   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
D   FIT      7.94    0.09   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.2)  1/73*

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              20  (SIGMA-) - (LAMBDA) MASS DIFFERENCE (MEV)

DL  N   SEE NOTE PRECEDING LAMBDA MASS LISTINGS.

DL          81.70    0.19          BURNSTEIN 64 HBC                      9/66
DL     85   81.80    0.24          SCHMIDT   65 HBC  SEE NOTE N          6/68
DL   2279   81.64    0.09          HEPP      68 HBC                      8/68
DL        . . . . . . . . . .
DL  AVG     81.666   0.077   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
DL  FIT     81.749   0.067  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)  1/73*

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              20  SIGMA- MEAN LIFE (UNITS 10**-10)

T            1.67    0.40     0.28 BROWN     58 HLBC
T            1.89    0.33     0.25 EISLER    58 HLBC
T       45   1.35    0.32     0.17 CHIESA    61 EMUL
T       41   1.75    0.39     0.30 BARKAS    61 EMUL
T     1208   1.58    0.06     0.06 HUMPHREY  62 HBC     STOP. K-
T  C  3267   1.666   0.075         CHANG     66 HBC     STOP. K-             6/66
T   S   61  (2.08)  (0.22)         CHIEN     66 HBC  -  6.9 PBAR P           9/67
T   S   64  (1.46)  (0.31)         CHIEN     66 HBC  +  6.9 PBAR P,ANTI      9/67
T      506   1.38    0.07          WHITESIDE 68 HBC     STOP. K-             6/68
T    10253   1.472   0.016         BARLOUTAU 69 HBC     K-P .4-1.2 GEV/C    11/69
T      .1M   1.485   0.022         EISELE    70 HBC     K-P AT REST          2/71
T     1383   1.42    0.05          BAKKER    71 DBC   - K-N TO SIG- 2PI     10/71
T            1.41    0.09     0.08 TOVEE     71 EMUL                        12/71
T  C    CHANG ERROR 0.018 RAISED BY US.  SEE 1970 EDITION, RMP 42,123(1970)  1/73*
T   S   ERROR PURELY STATISTICAL.
T         . . . . . . . . . .
T   AVG      1.484   0.019    0.018  AVERAGE (ERROR INCL. SCALE FACTOR OF 1.6)
                     (SEE IDEOGRAM BELOW )
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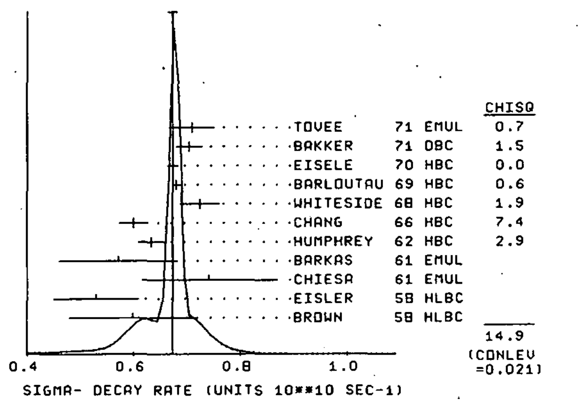
WEIGHTED AVERAGE = 0.6738 ± 0.0085
ERROR SCALED BY 1.6

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              20  SIGMA- PARTIAL DECAY MODES

                                                         DECAY MASSES
P1       SIGMA- INTO NEUTRON PI-                         939+ 139
P2       SIGMA- INTO NEUTRON PI- GAMMA                   939+ 139+   0
P3       SIGMA- INTO NEUTRON MU- NEUTRINO                939+ 105+   0
P4       SIGMA- INTO NEUTRON E- NEUTRINO                 939+  .5+   0
P5       SIGMA- INTO LAMBDA E- NEUTRINO                 1115+  .5+   0

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              20  SIGMA- BRANCHING RATIOS

R1       SIGMA- INTO (N MU- NEU)/(N PI-) (UNITS 10**-3)   (P3)/(P1)
R1      22    0.66    0.15          COURANT   64 HBC
R1      11    0.56    0.20          BAZIN     65 HBC     FROM STOP. K-     6/66
R1      56    0.43    0.09          BAGGETT   69 HBC     STOP. K-         10/69
R1      72    0.43    0.06          ANG 1     69 HBC     STOP K-          10/69
R1      13    0.38    0.11          COLE      71 HBC     STOP K-          10/71
R1          . . . . . . . . . .
R1  AVG       0.447   0.043   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
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Data Card Listings

For notation, see key at front of Listings.

Stable Particles

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R2      SIGMA- INTO (N E- NEU)/(N PI-) (UNITS 10**-3)      (P4)/(P1)
R2        9    1.0      0.4       0.3  MURPHY     64 HLBC
R2       16    1.37     0.34           NAUENBERG  64 HBC
R2       16    1.15     0.4            MILLER     64 FBC
R2       31    1.4      0.3            COURANT    64 HBC
R2      180    1.11     0.09           BIERMAN    68 HBC                     6/68
R2            (1.11)   (0.15)          SECHIZOR   68 HBC   PRELIMINARY      10/68
R2   A  331   (1.02)   (0.08)          ANG 1      69 HBC  - STOP K-         10/69
R2      601    1.09     0.06           EBENHOH    70 HBC   STOP K-          12/70
R2       57    0.97     0.15           COLE       71 HBC   STOP K-          10/71
R2   A   ANG1 REPLACED BY EBENHOH 70.                                        2/71
R2             . . . . . . . . .
R2   AVG       1.096    0.046   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

R3      SIGMA- INTO (LAMBDA E- NEU)/(N PI-) (UNITS 10**-4)
R3                                                  (P5)/(P1)
R3       11    0.75     0.28           COURANT    64 HBC   STOP. K-
R3       35    0.64     0.12           BARASH     67 HBC   STOP K-           8/67
R3       31    0.69     0.12           EISELE1    69 HBC   STOP K-          10/69
R3       31    0.52     0.09           BALTAY     69 HBC   STOP K-           4/69
R3             . . . . . . . . .
R3   AVG       0.604    0.060   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

R4      SIGMA- INTO (N PI- GAMMA)/(N PI-) (UNITS 10**-3) (P2)/(P1)
R4            (1.1)APPROXIM.           BAZIN      65 HBC   PI- LT 166 MEV/C  8/67
R4       23    0.10     .02            ANG 2      69 HBC   P(PI-) LT 110    10/69
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20 SIGMA- DECAY PARAMETERS

RELATED TEXT SECTION IV H AND APPENDIX III

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A-      ALPHA SIGMA-
A-           (-0.16)   (0.21)          TRIPP      62 HBC   REPL.BY BANGERTE
A-   O 6500  (-0.010)  (0.043)         BANGERTER  66 HBC   K-P TO SIG- PI+   7/66
A-   O 6068  (-0.104)  (0.04)          BERLEY     67 HBC   K-P TO SIG- PI+  11/67
A-     51000  -0.071    0.012          BANGERTER  69 HBC                    10/69
A-   B 5978  (-0.134)  (0.034)         BERLEY     70 HBC   K-P AT 400 MEV/C  2/71
A-     60000  -0.067    0.011          BOGERT     70 HBC   K-P AT 400 MEV/C 12/70
A-   O   OLD RESULTS.  HAVE BEEN REPLACED.
A-   B   BERLEY 70 REPLACED BY BOGERT 70                                     2/71
A-             . . . . . . . . .
A-   AVG      -0.0688   0.0081  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

F-      PHI ANGLE (SIN(PHI)/COS(PHI)=BETA/GAMMA)  (DEGREES)
F-   O 1006 (+22.)     (30.)           BERLEY     67 HBC   K-P TO SIG- PI+  11/67
F-     1385  14.       19.             BANGERT1   69 HBC                    10/69
F-    C1092  + 5.      23.             BERLEY     70 HBC   NEUTRON RESCATT. 11/69
F-   C   CHANGED FROM -5 TO +5 TO AGREE WITH SIGN CONVENTION
F-             . . . . . . . . .
F-   AVG       10.3     14.6    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

AV      GV/GA FOR SIGMA TO LAMBDA BETA DECAY (TEXT SEC IV H.1 FOR SIGN CONV)
AV       PREDICTED TO BE ZERO BY CONSERVED VECTOR CURRENT THEORY
AV   FB  45    (0.31)   (0.30)         BARASH     67 HBC                    11/67
AV   FS  51    (0.7)    (0.4)          BALTAY     69 HBC   USING SIG+-       4/69
AV   FS  81    (+0.22)  (0.28)         EISELE1    69 HBC                    10/68
AV F S 186      0.37     0.20          FRANZINI   72 HBC   USING SIG+-       1/73*
AV   B   BARASH 67 MEASURED ABSOLUTE VALUE.
AV   S   SIGN CHANGED TO AGREE WITH OUR CONVENTION.
AV F     FRANZINI 72 INCLUDES EVENTS OF BARASH 67, EISELE1 69, BALTAY 69.    1/73*

AV1     GA/GV FOR SIGMA TO NEUTRON BETA DECAY(TEXT SEC IV H.1 FOR SIGN CONV)
AV1      57    (0.05)   (0.23)   (0.32) GERSHWIN  68 HBC   REPLACED BY GER.69  6/68
AV1  C   49     0.23     0.16           COLLERAIN 69 HBC   NEUTRON SCATTER.  10/69
AV1  C   33     0.37     0.26     0.19  EISELE2   69 HBC   NEUTRON SCATTER.  10/69
AV1      61    +0.19     0.20     0.17  GERSHWIN  69 HBC   POLARIZED SIGMAS  10/69
AV1      63    -0.33     0.30     0.85  BOGERT    70 HBC   K-P AT 400 MEV/C  10/70
AV1  S         -0.20     0.28           EBENHOH   70 HBC   E- SPECTRUM        3/72
AV1  C   36     0.29     0.28     0.29  BALTAY    72 HBC   NEUTRON SCATTER    6/72*
AV1      43    -0.4      0.52     1.5   ELLIS     72 ASPK  POLARIZED SIGMAS  10/71
AV1  E        (+0.10)   (0.11)          ELLIS     72 RVUE  SUM LIKEL.(+SOL)  10/71
AV1  E        (-0.27)   (0.13)   (0.17) ELLIS     72 RVUE  SUM LIKEL.(-SOL)  10/71
AV1  C   COLLERAINE,EISELE,BALTAY MEASURE ABSOLUTE VALUE OF GA/GV.          6/72*
AV1      GERSHWIN 69, BOGERT 70, EBENHOH 70, AND ELLIS 72 MEASURE THE SIGN.
AV1      BUT NEITHER HAS A DEFINITE SIGN DETERMINATION. SINCE THE SIGN IS
AV1      UNDETERMINED THE AVERAGE OF THE SIX VALUES IS MEANINGLESS.
AV1  E   ELLIS 72 HAS COMBINED THE MAXIMUM LIKELIHOODS OF COLLERAINE 69,     3/72
AV1  E   EISELE2 69, GERSHWIN 69, ELLIS 72, AND GETS TWO POSSIBLE VALUES.    3/72
AV1  S   SIGN CHANGED TO AGREE WITH OUR CONVE. INCLUDES BIERMAN 68 EVENTS.   3/72
AV1            . . . . . . . . .
AV1 AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)
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REFERENCES FOR SIGMA-


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BROWN     58 CERN CONF 270      BROWN,GLASER,GRAVES,PERL,CRONIN +      (MICH)
EISLER    58 NC SER10 10 150    EISLER,BASSI,CONVERSI+ (COLU,BNL,BGNA,PISA)

BARKAS    61 PR 124 1209        BARKAS,DYER,MASON,NICKOLS,SMITH         (LRL)
CHIESA    61 NC 19 1171         A M CHIESA,B QUASSIATI,G RINAUDO      (TURIN)
HUMPHREY  62 PR 127 1305        W E HUMPHREY,R R ROSS                   (LRL)
TRIPP     62 PRL 9 66           R D TRIPP,M WATSON,M FERRO-LUZZI        (LRL)

BARKAS    63 PRL 11 26          W H BARKAS,J N DYER,H H HECKMAN         (LRL)
BURNSTEI  64 PRL 13 66          BURNSTEIN,DAY,KEHOE,SECHI ZORN,SNOW     (UMD)
COURANT   64 PR 136 B 1791      COURANT,FILTHUTH+    (CERN+HEID+UMD+NRL+BNL)
MILLER    64 PL 11 262          MILLER,STANNARD,BEZAGUET+  (LOUC,EPOL+BERG)
MURPHY    64 PR 134 B 188       C THORNTON MURPHY                 (WISCONSIN)
NAUENBER  64 PRL 12 679         NAUENBERG,SCHMIDT,MARATECK+(COLU+RUTG+PRIN)

BAZIN     65 PR 140 B 1358      BAZIN,PLANO,SCHMIDT +        (PRIN+RUTG+COLU)
DOSCH     65 PL 14 239          DOSCH,ENGELMANN,FILTHUTH,HEPP,KLUGE+ (HEID)
    ALSO  66 PR  151 1081       CHUNG YUN CHANG                    (COLUMBIA)
SCHMIDT   65 PR 140 B 1328      P SCHMIDT                          (COLUMBIA)
BANGERTE  66 PRL 17 495         BANGERTER,GALTIERI,BERGE,MURRAY+        (LRL)
CHANG     66 PR  151 1081       CHUNG YUN CHANG                    (COLUMBIA)
CHIEN     66 PR  152 1171       +LACH,SANDWEISS,TAFT,YEH,OREN +    (YALE+BNL)

BARASH    67 PRL 19  181        BARASH,DAY,GLASSER,KEHOE,KNOP +    (MARYLAND)
BERLEY    67 PRL  19  979       BERLEY,HERTZBACH,KOFLER +    (BNL,MASA,YALE)
BIERMAN   68 PRL 20 1459        BIERMAN,KOUNOSU,NAUENBERG +       (PRINCETON)
GERSHWIN  68 PRL 20 1270        GERSHWIN,ALSTON-GARNJOST,BANGERTER+    (LRL)
HEPP      68 ZPHY          214 71 V.HEPP,H. SCHLEICH            (HEIDELBERG)
SECHIZOR  68  TO BE PUBL.       DAY,GLASSER,KNOP+ VIENNA 375       (MARYLAND)
WHITESID  68 NC  54A  537       H. WHITESIDE,J. GOLLUB              (OBERLIN)

ANG 1     69 ZPHY 223 103       ANG,EISELE,ENGELMANN,FILTHUTH +        (HEID)
ANG 2     69 ZPHY 228 151       +EBENHOR,EISELE,ENGELMANN,FILTHUTH+    (HEID)
BAGGETT   69 PRL 23 249         BAGGETT,KEHOE,SNOW           (UNIV MARYLAND)
BALTAY    69 PRL 22 615         BALTAY,FRANZINI,NEWMAN,NORTON+   (COLU,STON)
BANGERTE  69 UCRL-19244         ROGER ODELL BANGERTER (THESIS)          (LRL)
BANGERT1  69 PR 187 1821        BANGERTER,GARNJOST,GALTIERI,GERSHWIN+  (LRL)

BARLOUTA  69 NP B14 153         BARLOUTAUD,BELLEFON,GRANET+(SACL+CERN+HEID)
COLLERAI  69 PRL 23 198         COLLERAINE,DAY,GLASSER,KNOP+(UNIV MARYLAND)
EISELE1   69 ZPHY 221 1         +ENGELMANN,FILTHUTH,FOHLISCH,HEPP+     (HEID)
EISELE2   69 ZPHY 223 487       EISELE,ENGELMANN,FILTHUTH,FOHLISCH+    (HEID)
GERSHWIN  69 UCRL-19246         LAWRENCE KENNETH GERSHWIN (THESIS)      (LRL)

BERLEY    70 PR D1 2015         +YAMIN,HERTZBACH,KOFLER +    (BNL,MASA,YALE)
BOGERT    70 PR D2 6            +LUCAS,TAFT,WILLIS,BERLEY + (BNL,MASA,YALE)
EBENHOH   70 KIEV CONF          +EISELE,ENGELMANN,FILTHUTH,FOHLISCH+ (HEID)
EISELE    70 ZPHY 238 372       +FILTHUTH,HEPP,PRESSER,ZECH      (HEIDELBERG)

BAKKER    71 LNC 1 37           +,SABRE COLLAB.  (ZEEM+SACL+BGNA+REHO+EPOL)
COLE      71 PR D4 631          +LEE-FRANZINI,LOVELESS,BALTAY+   (STON,COLU)
    ALSO  69 NEVIS-175 THESIS   HERBERT NORTON                     (COLUMBIA)
TOVEE     71 NP B33 493         LOUC,BELGRADE,BERL,BRUX,DUBLIN,WARS COLLAB
BALTAY    72 PR D5 1569         +FEINMAN,FRANZINI,NEWMAN,YEH+     (COLU+STON)
BOHM      72 NP B48 1           BERLIN+BELGRADE+BRUX+DUBLIN+LOUC+WARSAW
ELLIS     72 NP B39 77          OXF+AERE+RHEL+LOQM+LYON+NWES+ITEP COLLABOR
FRANZINI  72 PR D6 2417         COLUMBIA+HEIDELBERG+MARYLAND+STONY BROOK

                                PAPERS NOT REFERRED TO IN DATA CARDS

BROWN     57 PR 108 1036        J BROWN, D GLASER, M PERL          (MICH+BNL)
NIETO     68 RMP 40 140         M NIETO                                (STON)
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21 SIGMAO (1193,JP=1/2+) I=1

21 (SIGMA-) - (SIGMAO) MASS DIFFERENCE (MEV)

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D1   N   SEE NOTE PRECEDING LAMBDA MASS LISTINGS.

D1       18    4.75     0.1            BURNSTEIN 64 HBC
D1       37    4.87     0.12           DOSCH     65 HBC
D1       12    4.99     0.13           SCHMIDT   65 HBC   SEE NOTE N          6/68
D1             . . . . . . . . .
D1   AVG       4.849    0.069   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
D1   FIT       4.863    0.064   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0) 1/73*
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21 (SIGMAO) - (LAMBDA) MASS DIFFERENCE (MEV)

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DL   N   SEE NOTE PRECEDING LAMBDA MASS LISTINGS.

DL      208   76.63     0.28           SCHMIDT   65 HBC   SEE NOTE N          6/68
DL             . . . . . . . . .
DL   FIT      76.89     0.09    FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1) 1/73*
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21 SIGMAO MEAN LIFE (UNITS 10**-14)

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T             (1.0)  OR LESS           DAVIS     62 EMUL
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21 SIGMAO PARTIAL DECAY MODES

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                                                     DECAY MASSES
P1      SIGMAO INTO LAMBDA GAMMA                     1115+  0
P2      SIGMAO INTO LAMBDA E+ E-                     1115+  .5+  .5
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21 SIGMAO BRANCHING RATIOS

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R1      SIGMAO INTO(LAMBDA E+ E-)/TOTAL                  (P2)/(P1+P2)
R1            (0.00545)   THEORET. CAL. FEINBERG  58     QUANTUM ELECT.       9/66
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REFERENCES FOR SIGMAO


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FEINBERG  58 PR 109 1019        G.FEINBERG                              (BNL)
DAVIS     62 PR 127 605         D DAVIS,R SETTI,M RAYMOND,G TOMASIN     (EFI)
BURNSTEI  64 PRL 13 66          BURNSTEIN,DAY,KEHOE,SECHI ZORN,SNOW     (UMD)
DOSCH     65 PL 14 239          DOSCH,ENGELMANN,FILTHUTH,HEPP,KLUGE+ (HEID)
SCHMIDT   65 PR 140 B 1328      P SCHMIDT                          (COLUMBIA)

                                PAPERS NOT REFERRED TO IN DATA CARDS.

COURANT   63 PRL 10 409         COURANT,FILTHUTH,FRANZINI+     (CERN+UMD+NRL)

          QUANTUM NUMBER DETERMINATIONS NOT REFERRED TO IN THE DATA CARDS

ALFF      65 PR 137 B1105       ALFF,GELFAND,NAUENBERG+ (COLUMBIA+RUTG+BNL)P
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Stable Particles

Ξ^-, Ξ^0

Data Card Listings.

For notation, see key at front of Listings.

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                    22  XI- (1321,JP=1/2 ) I=1/2
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                    22  XI- MASS (MEV)

M   H    11(1317.0)    (2.2)         WANG        61 HLBC
M   H    18(1317.9)    (1.9)         FOWLER      61 HLBC
M   H    (OLD DATA AND LOW STATISTICS DROPPED ON SUGGESTION OF J R HUBBARD)
M       517 1321.4      0.4          JAUNEAU     63 FBC
M        62 1321.1      0.65         SCHNEIDER   63 HBC
M       241 1321.1      0.3          BADIERI     64 HBC
M        ALL MASSES ABOVE WERE RAISED 0.09 MEV BECAUSE LAMBDA MASS RAISED
M       149 1321.3      0.4          PJERROU     65 HBC                    11/67
M         6 1321.67     0.52         CHIEN       66 HBC   - 6.9 PBAR P     9/67
M       299 1321.4      1.1          LONDON      66 HBC                    6/66
M  G    195 1321.87     0.51         GOLDWASSE   70 HBC     5.5 K-P        8/70
M   G   USES LAMBDA MASS OF 1115.589-M(XI) IS 1322.18 IF M(LAMBDA) IS 1115. 4/68
M       268 1321.12     0.41         WILQUET     72 HLBC                   1/73*
M            . . . . . . . . .
M  AVG      1321.31     0.16    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
M  FIT      1321.29     0.14   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)  1/73*

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                    22  ANTI-XI+ MASS (MEV)

M1        1(1322.0)    (1.3)         BROWN       62 HBC     ANTI-XI-       7/66
M1        5 1320.69     0.93         CHIEN       66 HBC   + 6.9 PBAR P,ANTI 9/67
M1  S    12(1321.7)    (0.6)         SHEN        67 HBC     ANTI-XI-       10/67
M1       34 1321.2      0.4          STONE       70 HBC                    10/70
M1       35 1321.6      0.8          VOTRUBA     72 HBC     10 GEV/C K+ P  11/72*
M1  S   THE ERROR IS STATISTICAL ONLY
M1           . . . . . . . . .
M1 AVG      1321.20     0.33    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
M1 FIT      1321.29     0.14   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)  1/73*

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                    22  (XI-) - (ANTI-XI+) MASS DIFFERENCE (MEV)

DM            1.0       1.1          CHIEN       66 HBC     6.9 PBAR P     9/67

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                    22  XI- MAGNETIC MOMENT (MAGNETONS,938.26 MEV)

MM     2724   -0.1      2.1          BINGHAM     70 OSPK  - 1.8 GEV/C K-P  2/71
MM     1134   -2.2      0.8          COOL        72 OSPK  - 1.8 GEV/C K-P  1/73*
MM           . . . . . . . . .
MM AVG        -1.93     0.75    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

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                    22  XI- MEAN LIFE (UNITS 10**-10)

T   H    11    (3.5)   (3.4)    (1.23) WANG      61 HLBC
T   H    18    (1.28)  (0.41)   (0.25) FOWLER    61 HLBC
T   H    (OLD DATA AND LOW STATISTICS DROPPED ON SUGGESTION OF J R HUBBARD)
T       517     1.86    0.15     0.14  JAUNEAU   63 FBC
T        62     1.55    0.31     0.31  SCHNEIDER 63 HBC
T       356    (1.77)  (0.12)          CARMONY   64 HBC     REP BY PJERROU 65
T       794     1.69    0.07           HUBBARD   64 HBC
T       246     1.70    0.12           PJERROU   65 HBC                    11/67
T   S     6    (1.37)  (0.51)          CHIEN     66 HBC   -  6.9 PBAR P    9/67
T       299     1.80    0.16           LONDON    66 HBC                    6/66
T   S          (1.67)  (0.07)          BURGUN    68 HBC     K-P AT 1.3-1.8  2/71
T      2610     1.61    0.04           DAUBER    69 HBC                    6/68
T   S 2436     (1.637) (0.050)         COOL      72 OSPK    1.8 GEV/C K-P  1/73*
T       680     1.73    0.08     0.07  MAYEUR    72 HLBC    2.1 GEV/C K-   1/73*
T   S   THE ERROR IS STATISTICAL ONLY
T            . . . . . . . . .
T  AVG          1.672   0.032    0.031  AVERAGE (ERROR INCL. SCALE FACTOR OF 1.1)

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                    22  ANTI-XI+ MEAN LIFE (UNITS 10**-10)

T1  S     5    (1.51)  (0.55)          CHIEN     66 HBC   +  6.9 PBAR P,ANTI 9/67
T1  S    12    (1.9)   (0.7)    (0.5)  SHEN      67 HBC     ANTI-XI-       10/67
T1       34     1.6     0.3            STONE     70 HBC                    10/70
T1  S    35    (1.55)  (0.35)   (0.20) VOTRUBA   72 HBC     10 GEV/C K+ P  11/72*
T1  S   THE ERROR IS STATISTICAL ONLY

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                    22  XI- PARTIAL DECAY MODES

                                                        DECAY MASSES
P1        XI- INTO LAMBDA PI-                          1115+ 139
P2        XI- INTO LAMBDA E- NEUTRINO                  1115+  .5+   0
P3        XI- INTO NEUTRON PI-                          939+ 139
P4        XI- INTO LAMBDA MU- NEUTRINO                 1115+ 105+   0
P5        XI- INTO SIGMAO E- NEUTRINO                  1192+  .5+   0
P6        XI- INTO SIGMAO MU- NEUTRINO                 1192+ 105+   0
P7        XI- INTO NEUTRON E- NEUTRINO                  939+  .5+   0

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                    22  XI- BRANCHING RATIOS

R1        XI- INTO (LAMBDA E- NEU)/(LAMBDA PI-) (UNITS 10**-3)
R1                                                   (P2)/(P1)
R1          1       (155)EFFECTIVE DENOM.  CARMONY   63 HBC                11/67
R1          0       (260)EFFECTIVE DENOM.  JAUNEAU   63 HBC                11/67
R1          0       (220)EFFECTIVE DENOM.  BERGE     66 HBC                11/67
R1          1       (155)EFFECTIVE DENOM.  LONDON    66 HBC                11/67
R1          0       (717)EFFECTIVE DENOM.  TRIPPE    67 HBC                11/67
R1          2      (1976)EFFECTIVE DENOM.  HUBBARD   68 HBC                6/68
R1          4        1.15     0.90   0.55  HUBBARD   68 RVUE
R1        HUBBARD 68 (RVUE) INCLUDES ALL ABOVE EVENTS                      6/68

R2        XI- INTO (NEUTRON PI-)/(LAMBDA PI-) (UNITS 10**-3)
R2                                                   (P3)/(P1)
R2              5.0  OR LESS               FERRO-LUZ 63 HBC                6/68
R2              1.1  OR LESS               DAUBER    69 HBC                6/68

R3        XI- INTO (LAMBDA MU- NEUTRINO)/TOTAL (UNITS 10**-3)
R3                                                     (P4)
R3             12.0  OR LESS               BERGE     66 HBC                6/68
R3              1.3  OR LESS               DAUBER    69 HBC                6/68

R4        XI- INTO (SIGMAO E- NEUTRINO)/TOTAL (UNITS 10**-3)
R4                                                     (P5)
R4              3.0  OR LESS               BERGE     66 HBC                6/68
R4              0.5  OR LESS               DAUBER    69 HBC                6/68

R5        XI- INTO (SIGMAO MU- NEUTRINO)/TOTAL             (P6)
R5              0.005 OR LESS              BERGE     66 HBC                7/66

R6        XI- INTO (N E- NEUTRINO)/(LAMBDA PI-)            (P7)/(P1)
R6              0.01  OR LESS  CL=.90      BINGHAM   65 RVUE               9/66

R7        XI- INTO (SIGMAO E- NEU + LAMBDA E- NEU)/TOTAL (10**-3)
R7                                                     (P2+P5)
R7          17     0.68      0.22          DUCLOS    71 OSPK   SEE NOTE D  10/71
R7  D     THIS EXPERIMENT CANNOT DISTINGUISH SIGMAO FROM LAMBDA. THE CABIBBO
R7  D     THEORY PREDICTS SIGMAO RATE ABOUT A FACTOR 6 SMALLER THAN THE
R7  D     LAMBDA.  TO GET A VALUE FOR THE TABLE R7 HAS BEEN AVERAGED WITH R1.

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                    22  XI- DECAY PARAMETERS

          RELATED TEXT SECTION IV H AND APPENDIX III

A         ALPHA XI-
A   O          (-0.44)   (0.12)         JAUNEAU    63 FBC    SEE NOTE D BELOW  6/68
A   O     62   (-0.73)   (0.23)         SCHNEIDER  63 HBC    SEE NOTE D BELOW  6/68
A        240    -0.5      0.38          BADIERI    64 HBC    SEE NOTE D BELOW  6/68
A        356    -0.62     0.13          CARMONY    64 HBC    SEE NOTE D BELOW  6/68
A       1004    -0.365    0.068         BERGE      66 HBC    SEE NOTE D BELOW  6/68
A   L    364    -0.47     0.13          LONDON     66 HBC    SEE NOTE D BELOW  6/68
A              (-0.391)  (0.032)        BERGE 2    66 RVUE  INCLUDES ALL ABOVE 9/66
A     M 2529   (-0.375)  (0.051)        MERRILL    68 HBC                      6/68
A       2781    -0.391    0.045         DAUBER     69 HBC    SEE NOTE A BELOW
A       2724    -0.383    0.065         BINGHAM    70 OSPK                     10/70
A        820    -0.42     0.11          MAYEUR     72 HLBC   2.1 GEV/C K-      1/73*
A   A     USED ALPHA LAMBDA = 0.647 +- 0.020.
A   D     ERRORS MULTIPLIED BY 1.1 DUE TO APPROXIMATIONS USED FOR XI
A   D     POLARIZATION. (SEE DAUBER 69 FOR DETAILED DISCUSSION)               6/68
A   L     LONDON 66 USES ALPHA-LAMBDA = 0.62
A   M     DATA OF MERRILL 68 INCLUDED IN DAUBER 68.
A   O     OLD DATA NOT INCLUDED IN AVERAGE.
A              . . . . . . . . .
A   AVG         -0.403    0.029   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

F         PHI ANGLE (SIN(PHI)/COS(PHI)=BETA/GAMMA) (DEGREES)
F   O          (-16.0)   (45.0)         JAUNEAU    63 FBC    SEE NOTE D BELOW  6/68
F   O     62   (45.0)    (36.0)         SCHNEIDER  63 HBC    SEE NOTE D BELOW  6/68
F        356    54.0      30.0          CARMONY    64 HBC    SEE NOTE D BELOW  6/68
F       1004    0.        12.           BERGE      66 HBC    SEE NOTE D BELOW  6/68
F   L    364    0.0       20.4          LONDON     66 HBC    SEE NOTE D BELOW  6/68
F     M 2529   (9.8)     (11.6)         MERRILL    68 HBC                      6/68
F       2781   -14.       11.           DAUBER     69 HBC    SEE NOTE A BELOW
F       2724   -26.0      30.0          BINGHAM    70 OSPK                     10/70
F   A     USED ALPHA LAMBDA = 0.647 +- 0.020.
F   D     ERRORS MULTIPLIED BY 1.2 DUE TO APPROXIMATIONS USED FOR XI
F   D     POLARIZATION. (SEE DAUBER 68 FOR DETAILED DISCUSSION)
F   L     LONDON 66 USES ALPHA-LAMBDA = 0.62
F   M     DATA OF MERRILL 68 INCLUDED IN DAUBER 68.
F   O     OLD DATA NOT INCLUDED IN AVERAGE.
F              . . . . . . . . .
F   AVG         -4.3      8.1       AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.1)

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                    REFERENCES FOR XI-

FOWLER    61 PRL 6 134          FOWLER,BIRGE,EBERHARD,ELY,GOOD,POWELL+(LRL)
WANG      61 JETP 13 512        K WANG,T WANG,VIRYASOV,TING,SOLOVEV+ (JINR)
BROWN     62 PRL 8 255          BROWN,CULWICK,FOWLER,GAILLOUD +  (BNL+YALE)

CARMONY   63 PRL  10  381       CARMONY,PJERROU                      (UCLA)
FERRO-LU  63 PR 130 1568        FERRO-LUZZI,ALSTON,ROSENFELD,WOJCICKI (LRL)
JAUNEAU   63 SIENA CONF 4       JAUNEAU+       (EPOL+CERN+LOUC+RHEL+BERGEN)
  ALSO    63 PL  5  261         JAUNEAU,+      (EPOL,CERN,LOUC,RHEL,BERGEN)
SCHNEIDE  63 PL 4 360           H SCHNEIDER                          (CERN)

CARMONY   64 PRL 12 482         CARMONY,PJERROU,SCHLEIN,SLATER,STORK+(UCLA) J
BADIERI   64 DUBNA CONF I 593   BADIER,DEMOULIN,BARLOUTAUD+(EPOL,SACL,ZEEM)
HUBBARD   64 PR 135 B 183       HUBBARD,BERGE,KALBFLEISCH,SHAFER +    (LRL)
BINGHAM   65 PRSL  285  202     H H BINGHAM                          (CERN)
PJERROU   65 PRL 14 275         + SCHLEIN,SLATER,SMITH,STORK,TICHO   (UCLA)
PJERROU   65 THESIS             G M PJERROU                          (UCLA)

BERGE     66 PR  147  945       BERGE,EBERHARD,HUBBARD,MERRILL +      (LRL)
BERGE 2   66 BERKELEY CONF 46   BERGE,CABIBBO               (LRL,CERN(RVUE))
LONDON    66 PR 143 1034        LONDON,RAU,GOLDBERG,LICHTMAN+(BNL+SYRACUSE)
CHIEN     66 PR  152  1171      +LACH,SANDWEISS,TAFT,YEH,OREN +  (YALE+BNL)
SHEN      67 PL 25 B 443        B.C.SHEN,A.FIRESTONE,G.GOLDHABER (UCB+LRL)
TRIPPE    67 PRIV. COMM.        T. TRIPPE                            (UCLA)

BURGUN    68 NP B8 447          +MEYER,PAULI,TALLINI, +    (SACL+CDEF+RHEL)
HUBBARD   68 PRL 20 465         HUBBARD,BERGE,DAUBER                  (LRL)
MERRILL   68 PR 167 1202        MERRILL,SHAFER                        (LRL)J

DAUBER    69 PR  179 1272       +BERGE,HUBBARD,MERRILL,MILLER         (LRL)J
BINGHAM   70 PR D1 3010         +COOK,HUMPHREY,SANDER,WILLIAMS+ (UCSD,WASH)
GOLDWASS  70 PR D1 1960         GOLDWASSER, SCHULTZ                   (ILL)
STONE     70 PL 32B 515         +BERLINGHIERI,BROMBERG,COHEN,FERBEL +(ROCH)

DUCLOS    71 NP B32 493         +FREYTAG,HEINTZE,HEINZELMAN,JONES+   (CERN)
COOL      72 PRL 29 1630        +GIACOMELLI,JENKINS,KYCIA,LEONTIC,LI+ (BNL)
MAYEUR    72 NP B47 333         +VAN BINST,WILQUET+   (BRUX+CERN+TUFT+LOUC)
VOTRUBA   72 NP B45 77          VOTRUBA,SAFDER,RATCLIFFE       (BIRM+EDIN)
WILQUET   72 PL 42B 372         +FLIAGINE,GUY,KNIGHT+ (BRUX+CERN+TUFT+LOUC)

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                    23  XIO (1314,JP=1/2 ) I=1/2
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                    23  XIO MASS (MEV)

M         1 1313.4      1.8          PALMER      68 HBC                    3/68
M        49 1315.2      0.92         WILQUET     72 HLBC                   1/73*
M            . . . . . . . . .
M  AVG      1314.83     0.82    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
M  FIT      1314.90     0.55   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)  1/73*

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Data Card Listings

For notation, see key at front of Listings.

Stable Particles

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                    23  (XI-) - (XIO) MASS DIFFERENCE (MEV)

D       23    6.8       1.6                JAUNEAU   63 FBC
D       45   (6.1)     (1.6)               CARMONY   64 HBC    REP BY PJERROU 65
D       88    6.1       0.9                PJERROU   65 HBC                           11/67
D       29    6.9       2.2                LONDON    66 HBC                            6/66
D            . . . . . . . . . .
D    AVG      6.34      0.74      AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
D    FIT      6.40      0.55     FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)   1/73*

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                    23  XIO MEAN LIFE (UNITS 10**-10)

T       24    3.9       1.4        0.80  JAUNEAU   63 FBC
T       45   (3.5)     (1.0)      (0.8)  CARMONY   64 HBC    REP BY PJERROU 65
T      101    2.5       0.4        0.3   HUBBARD   64 HBC
T       80    3.0       0.5              PJERROU   65 HBC                           11/67
T      340    3.07      0.22       0.20  DAUBER    69 HBC                            6/68
T      469    2.85      0.20       0.18  BRIDGEWAT 72 HBC     1.75 GEV/C K-P         1/73*
T      157    3.04      0.26       0.23  MAYEUR    72 HLBC    2.1 GEV/C K-           1/73*
T            . . . . . . . . . .
T    AVG      2.98      0.12       0.11   AVERAGE (ERROR INCL. SCALE FACTOR OF 1.0)

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                    23  XIO PARTIAL DECAY MODES

                                                            DECAY MASSES
P1      XIO INTO LAMBDA PIO                               1115+ 134
P2      XIO INTO PROTON PI-                                938+ 139
P3      XIO INTO PROTON E- NEU                             938+  .5+   0
P4      XIO INTO SIGMA+ E- NEU                            1189+  .5+   0
P5      XIO INTO SIGMA- E+ NEU                            1197+  .5+   0
P6      XIO INTO SIGMA+ MU- NEUTRINO                      1189+ 105+   0
P7      XIO INTO SIGMA- MU+ NEUTRINO                      1197+ 105+   0
P8      XIO INTO PROTON MU- NEUTRINO                       938+ 105+   0

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                    23  XIO BRANCHING RATIOS

R1      XIO INTO (PROTON PI-)/(LAMBDA PIO) (UNITS 10**-3)
R1                                                       (P2)/(P1)
R1            27.0   OR LESS           TICHO     63 HBC                             6/68
R1             5.0   OR LESS           HUBBARD   66 HBC                             6/68
R1             0.9   OR LESS           DAUBER    69 HBC                             6/68

R2      XIO INTO (PROTON E- NEU)/(LAMBDA PIO) (UNITS 10**-3)
R2                                                       (P3)/(P1)
R2            27.0   OR LESS           TICHO     63 HBC                             6/68
R2             6.0   OR LESS           HUBBARD   66 HBC                             6/68
R2             1.3   OR LESS           DAUBER    69 HBC                             6/68

R3      XIO INTO (SIGMA+ E- NEU)/(LAMBDA PIO) (UNITS 10**-3)
R3                                                       (P4)/(P1)
R3            13.0   OR LESS           TICHO     63 HBC                             6/68
R3             7.0   OR LESS           HUBBARD   66 HBC                             6/68
R3             1.5   OR LESS           DAUBER    69 HBC                             6/68

R4      XIO INTO (SIGMA- E+ NEU)/(LAMBDA PIO) (UNITS 10**-3)
R4                                                       (P5)/(P1)
R4             6.0   OR LESS           HUBBARD   66 HBC                             6/68
R4             1.5   OR LESS           DAUBER    69 HBC                             6/68

R5      XIO INTO (SIGMA+ MU- NEU)/TOTAL (UNITS 10**-3)   (P6)
R5             7.0   OR LESS           HUBBARD   66 HBC                             6/68
R5             1.5   OR LESS           DAUBER    69 HBC                             6/68

R6      XIO INTO (SIGMA- MU+ NEU)/TOTAL (UNITS 10**-3)   (P7)
R6             6.0   OR LESS           HUBBARD   66 HBC                             6/68
R6             1.5   OR LESS           DAUBER    69 HBC                             6/68

R7      XIO INTO (PROTON MU- NEU)/TOTAL (UNITS 10**-3)   (P8)
R7             6.0   OR LESS           HUBBARD   66 HBC                             6/68
R7             1.3   OR LESS           DAUBER    69 HBC                             6/63

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                    23  XIO DECAY PARAMETER

     RELATED TEXT SECTION IV H AND APPENDIX III

A       ALPHA XI O
A            -0.09     0.46            PJERROU   65 HBC    SEE NOTE D BELOW  6/68
A       146  -0.13     0.17            BERGE     66 HBC    SEE NOTE D BELOW  6/68
A  L     46  -0.2      0.4             LONDON    66 HBC    SEE NOTE D BELOW  6/68
A   M   490 (-0.33)   (0.11)           MERRILL   66 HBC    SEE NOTE D BELOW  6/68
A  A    739  -0.43     0.09            DAUBER    69        SEE NOTE A BELOW
A   B   507 (-0.52)   (0.09)           BRIDGEWAT 72 HBC    1.75 GEV/C K-P    1/73*
A       130  -0.84     0.27            MAYEUR    72 HLBC   2.1 GEV/C K-      1/73*
A   A   USED ALPHA LAMBDA = 0.647 +- 0.020.
A   D   ERRORS MULTIPLIED BY 1.1 DUE TO APPROXIMATIONS USED FOR XI
A   D   POLARIZATION. (SEE DAUBER 69 FOR DETAILED DISCUSSION)
A   L   LONDON 66 USES ALPHA-LAMBDA = 0.62
A   M   MERRILL 66 REPLACED BY DAUBER 69
A   B   ERROR PURELY STATISTICAL                                                 1/73*
A            . . . . . . . . . .
A    AVG     -0.387    0.090   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.2)
                              (SEE IDEOGRAM BELOW )

F       PHI ANGLE  (SIN(PHI)/COS(PHI)=BETA/GAMMA)  (DEGREES)
F       146   -8.       30.            BERGE     66 HBC    SEE NOTE D BELOW  6/68
F   M   490 (107.0)    (46.0)          MERRILL   66 HBC    SEE NOTE D BELOW  6/68
F  A    739   38.       19.            DAUBER    69 HBC    SEE NOTE A BELOW
F   B   507  (11.2)    (14.4)          BRIDGEWAT 72 HBC    1.75 GEV/C K-P    1/73*
F   A   USED ALPHA LAMBDA = 0.647 +- 0.020.
F   D   ERRORS MULTIPLIED BY 1.2 DUE TO APPROXIMATIONS USED FOR XI
F   D   POLARIZATION. (SEE DAUBER 69 FOR DETAILED DISCUSSION)
F   M   MERRILL 66 REPLACED BY DAUBER 69
F   B   ERROR PURELY STATISTICAL                                                 1/73*
F            . . . . . . . . . .
F    AVG      24.8      20.8     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.3)
                              (SEE IDEOGRAM BELOW )
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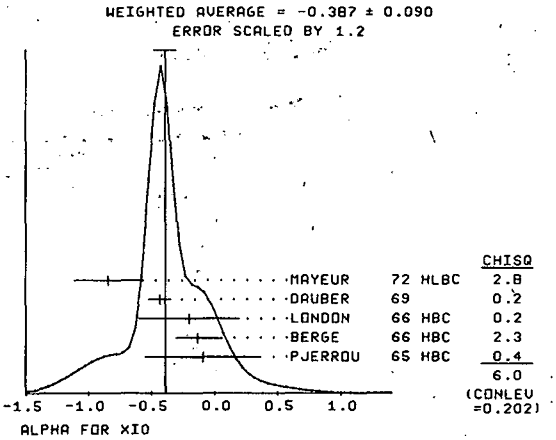

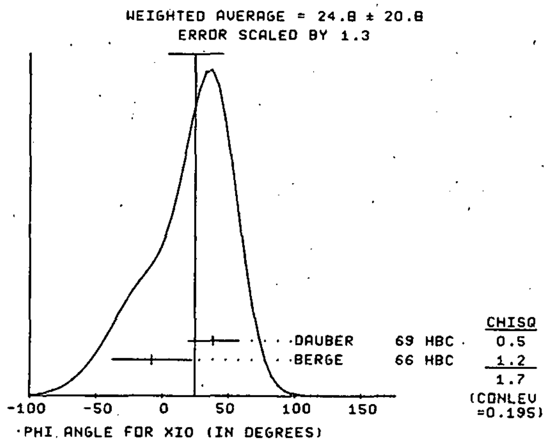

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REFERENCES FOR XIO

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ALVAREZ  59 PRL 2 215          ALVAREZ,EBERHARD,GOOD,GRAZIANO,TICHO+ (LRL)
JAUNEAU  63 SIENA CONF 1 1     JAUNEAU+         (EPOL+CERN+LOUC+RHEL+BERGEN)
    ALSO 63 PL 4 49            JAUNEAU+         (EPOL+CERN+LOUC+RHEL+BERGEN)
TICHO    63 BNL CONF 410       HAROLD K TICHO                           (UCLA)

CARMONY  64 PRL 12 482         CARMONY,PJERROU,SCHLEIN,SLATER,STORK+(UCLA)
HUBBARD  64 PR 135 B 183       HUBBARD,BERGE,KALBFLEISCH,SHAFER +       (LRL)
PJERROU  65 PRL 14 275         + SCHLEIN,SLATER,SMITH,STORK,TICHO      (UCLA)
PJERROU  65 THESIS             G M PJERROU                              (UCLA)

BERGE    66 PR  147  945       BERGE,EBERHARD,HUBBARD,MERRILL +         (LRL)
HUBBARD  66 UCRL 11510         J RICHARD HUBBARD (THESIS,BERKELEY)      (LRL)
LONDON   66 PR 143 1034        LONDON,RAU,GOLDBERG,LICHTMAN+(BNL+SYRACUSE)
MERRILL  66  BERKELEY CONF     MERRILL,SHAFER,BERGE                     (LRL)
    ALSO 66 UCRL 16455         DEANE MERRILL (THESIS, BERKELEY)         (LRL)

PALMER   68 PL 26B  323        PALMER,RADOJICIC,RAU,RICHARDSON+ (BNL,SYRA)
DAUBER   69 PR  179 1262       +BERGE,HUBBARD,MERRILL,MILLER            (LRL)

BRIDGEWA 72 NEVIS 195(THESIS) ALBERT BRIDGEWATER                 (COLUMBIA)
MAYEUR   72 NP B47 333         +VAN BINST,WILQUET+   (BRUX+CERN+TUFT+LOUC)
WILQUET  72 PL 42B 372         +FLIAGINE,GUY,KNIGHT+ (BRUX+CERN+TUFT+LOUC)
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Stable Particles

Ω^-

Data Card Listings

For notation, see key at front of Listings.

Ω^-

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                    24  OMEGA- (1675,JP=3/2+) I=0
                 QUANTUM NUMBERS ASSIGNED FROM SU3

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                    24  OMEGA- MASS (MEV)

M        1(1620.0)   (25.0)     (10.0) EISENBERG 54 EMUL
M        1 1673.0      8.0             ABRAMS    64 HBC    INTO XI- PIO
M        3 1673.3      1.0             PALMER    68 HBC    K-P 4.6,5. GEV/C 11/69
M        3 1671.8      0.8             SCHULTZ   68 HBC    K-P 5.5 GEV/C    11/69
M        5 1674.2      1.6             SCOTTER   68 HBC    K-P 6.  GEV/C    11/69
M        6 1671.9      1.2             SPETH     69 HBC    K-P 10. GEV/C    11/69
M          . . . . . . . . .
M   AVG    1672.49     0.52     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

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                    24  ANTI-OMEGA+ MASS (MEV)

MB       1 1673.1      1.0             FIRESTONE 71 HBC    12 GEV/C K+D     3/71

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                    24  OMEGA- MEAN LIFE (UNITS 10**-10 SEC)

T    A    1   (1.63)                   ABRAMS    64 HBC                      7/66
T    A    1   (0.7)                    BARNES 1  64 HBC                      7/66
T    A    1   (1.4)                    BARNES 2  64 HBC                      7/66
T    A    1   (1.85)                   COLLEY    65 HBC                      7/66
T    A    1   (1.5)                    RICHARDSO 65 HBC                      7/66
T    A    1   (0.93)                   ABCLV COL 68 HBC                     11/67
T    A    1   (2.6)                    ABCLV COL 68 HBC                     11/67
T    A    1   (1.6)                    ABCLV COL 68 HBC                     11/67
T    A    1   (0.21)                   ABCLV COL 68 HBC                     11/67
T    A    1   (1.20)                   SCHULTZ   68 HBC                     11/67
T    A    1   (0.06)                   SCHULTZ   68 HBC                     11/67
T    A    1   (0.63)                   SCHULTZ   68 HBC                     11/67
T    A    1   (0.25)                   SCOTTER   68 HBC                      6/68
T    A    1   (0.30)                   SCOTTER   68 HBC                      6/68
T    A    1   (0.71)                   SCOTTER   68 HBC                      6/68
T    A    1   (0.08)                   SCOTTER   68 HBC                      6/68
T    A    1   (1.04)                   SCOTTER   68 HBC                      6/68
T    A    1   (2.38)                   SCOTTER   68 HBC                      6/68
T    A   ALLISON INCLUDES ALL ABOVE + 3 MORE BNL EVENTS, UNPUBLISHED.        6/68
T        21     1.31     0.37     0.24 ALLISON   68 RVUE                     6/68
T         1 (2.3)                      SPETH     69 HBC                     10/69
T         1 (0.31)                     SPETH     69 HBC                     10/69

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                    24  OMEGA- PARTIAL DECAY MODES

                                                            DECAY MASSES
P1      OMEGA- INTO LAMBDA K-                             1115+ 493
P2      OMEGA- INTO XIO PI-                               1314+ 139
P3      OMEGA- INTO XI- PIO                               1321+ 134

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                    24  OMEGA- BRANCHING RATIOS

R1      OMEGA- INTO LAMBDA K-                            (P1)
R1        2   EVENTS                  PALMER    68 HBC                     11/69
R1        3   EVENTS                  SCHULTZ   68 HBC                     11/69
R1        5   EVENTS  1 AMBIG. XIO PI- SCOTTER  68 HBC                     11/69
R1        6   EVENTS                  SPETH     69 HBC                     11/69

R2      OMEGA- INTO XIO PI-                              (P2)
R2        1   EVENTS                  ABRAMS    64 HBC                     11/69
R2        4   EVENTS                  PALMER    68 HBC                     11/69
R2        3   EVENTS                  SCOTTER   68 HBC                     11/69
R2        1   EVENT                   SPETH     69. HBC                    11/69

R3      OMEGA- INTO XI- PIO                              (P3)
R3        1   EVENT                   PALMER    68 HBC                     11/69
R3        1   EVENT                   SCOTTER   68 HBC                     11/69

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REFERENCES FOR OMEGA-


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EISENBER 54 PR 96 541          Y EISENBERG                          (CORNELL)
ABRAMS   64 PRL 13 670         + BURNSTEIN,GLASSER +                (UMD+NRL)
BARNES 1 64 PRL  12  204       V E BARNES,CONNOLLY,CRENNELL,CULWICK+ (BNL)
BARNES 2 64 PL 12 134          V E BARNES,CONNOLLY,CRENNELL,CULWICK+ (BNL)
COLLEY   65 PL 19 152          COLLEY,DODD +(BIRM+GLAS+LOIC+MPIM+OXF+RHEL)
RICHARDS 65 BAPS 10 115        RICHARDSON,BARNES,CRENNEL+   (BNL+SYRACUSE)
SAMIOS   65 ARGONNE CONF 189   N P SAMIOS                        ((RVUE) BNL)

ABCLV CO 68 NUC PHYS B4 326    AACHEN+BERLIN+CERN+LONDON IMP.COLL.+VIENNA
ALLISON  68 PRIV. COMM.        JOHN ALLISON                       (LANCASTER)
PALMER   68 PL 26B 323         PALMER,RADOJICIC,RAU,RICHARDSON+ (BNL,SYRA)
SCHULTZ  68 PR  168  1509      SCHULTZ+    (ILL,ARGONNE,NORTHWESTERN,WISC)
SCOTTER  68 PL 26B 474         SCOTTER+       (BIRM,GLASGOW,LOIC,MUNICH,OXF)
SPETH    69 PL  29B 252        SPETH+         (AACHEN,BERLIN,CERN,LOIC,VIEN)
FIRESTON 71 PRL 26 410         +GOLDHABER,LISSAUER,SHELDON,TRILLING  (LRL)

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Data Card Listings

For notation, see key at front of Listings.

Mesons

$\pi^{\pm}$, π^0, η, ϵ

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CODE EVENTS QUANTITY  ERROR+  ERROR-  REFERENCE YR TECN SIGN COMMENTS  DATE
     ABOVE                                                            PUNCHED
   BACKGROUND

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$\pi^{\pm}$

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8  CHARGED PION (140,JPG=0--) I=1
SEE STABLE PARTICLE DATA CARD LISTINGS

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π^0

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9  NEUTRAL PION (135,JPG=0--) I=1
SEE STABLE PARTICLE DATA CARD LISTINGS

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η

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14  ETA (549,JPG=0-+) I=0
SEE STABLE PARTICLE DATA CARD LISTINGS

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ϵ

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14  PI PI S WAVE, CALLED EPSILON
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S-wave ππ Interactions in the Region 280-1400 MeV

In this note we first discuss the experimental results on the I = 0 ππ S-wave, and thereafter we comment on the possible interpretation.

At threshold, ππ interactions in the $I^G(J^P)C = 0^+(0^+)+$ wave are characterized by a scattering length which still is poorly known (EBEL 71, BASDEVANT 72).

No structure or resonant behavior is indicated near threshold in data from the reaction $\pi N \rightarrow \pi\pi N$. In fact, the only structures claimed in this region are due to reactions involving the nuclei d, H^3, or He^3 (BOOTH 63, HALL 69, BRODY 70, BANAIGS 71), for which the background may be difficult to assess (BRODY 72), and where kinematic reflections from low-mass baryons may contribute (DUBAL 71).

In the region from the ππ threshold (~280 MeV) up to the region near $K\bar{K}$ threshold (~990 MeV), ππ scattering is nearly elastic (BATON 70, CARROLL 72, GRAYER 72, PROTOPOPESCU 72). Up to the ρ meson mass region, δ_0^0 is (qualitatively) uniquely determined; it rises monotonically and reaches a value of 60° to 70° near 700 MeV (SONDEREGGER 69, BATON 70, BAILLON 72, CARROLL 72, FRENKIEL 72, GAIDOS 72, GRAYER 72, PROTOPOPESCU 72).

In the mass region of 700 to 900 MeV, all energy-independent analyses find two solutions ("up-down ambiguity"), with the exception of CARROLL 72 who claim to find only the lower ("down") solution. A possibility of resolving the up-down ambiguity arises from the observation by FLATTE 72, GAIDOS 72, and GRAYER 72 of a very rapid decrease in the S-wave amplitude between 950 and 980 MeV. The size of the observed drop corresponds to a change from nearly the unitarity limit to zero, i.e. to a phase shift change from ~90° to ~180°. This is easily compatible with the "down" solution, which is in the 70° to 90° range between 800 and 900 MeV; in contrast the "up" solution is already near 150° at 900 MeV, and it appears unlikely that it could be smoothly connected with a 90° phase shift at 950 MeV.

In accordance with this, an energy-dependent phase-shift analysis by PROTOPOPESCU 72 using a 2-channel (ππ and $K\bar{K}$) effective range parametrization, gives a (qualitatively) unique I = 0 S-wave phase-shift solution from 550 to 1150 MeV. After having reached 180° near the $K\bar{K}$ threshold, inelasticity sets in and the phase continues to rise slowly. A preliminary analysis by GRAYER 72, as well as the analysis by CARROLL 72, suggests that δ_0^0 may slowly go through 270° somewhere between 1200 and 1400 MeV. (This energy region is however very complicated because the 4π, ρππ, etc. channels are no longer negligible.)

Independent evidence for the correctness of this ("down") solution comes from experiments on $\pi^0\pi^0$ scattering (APEL 72, SKUJA 72). They observe a wide $\pi^0\pi^0$ enhancement at ~800 MeV which is much better described by the "down" solution than by the "up" solution. Futhermore, indirect information from elastic ππ scattering in the crossed channel (NIELSEN 70, ELVEKJAER 71 and 72, HAMILTON 71) is compatible with the "down" but not the "up" solution.

It is clear that the behavior of δ_0^0 is much too complicated to allow a description in terms of one or several Breit-Wigner resonances. We therefore list the positions of the poles of the T matrix, found by searching in the complex energy plane, using the best-fit parameters of the K-matrix or M-matrix. The best fit of PROTOPOPESCU 72 obtains two poles on the second sheet, the $S^*(990)$ and the $\epsilon(600)$. The $S^*(990)$ is connected with the rapid variation of δ_0^0 near the $K\bar{K}$ threshold discussed above, and is also responsible for the large $K\bar{K}$ I = 0 S-wave scattering length. The $\epsilon(600)$ pole is very far from the real axis and therefore much less certain; it is inferred from the large size and slow variation of the S-wave amplitude between 600 and 900 MeV, but PROTOPOPESCU 72 can fit this

Mesons

ε, ρ(770)

Data Card Listings

For notation, see key at front of Listings.

behavior also without an ε pole. Finally, BASDEVANT 72 present a set of ππ amplitudes consistent with crossing, unitarity, and analyticity, and with the ππ phase shifts up to 1100 MeV; their amplitude has a very wide (Γ > 650 MeV) ε.

We list the S* parameters separately under S-wave I = 0 $K\bar{K}$ Interactions.

For a recent review see DIEBOLD 72.

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                 14  REAL PART OF POLE POSITION (MEV)

M          (650.0)  OR LESS          BASDEVANT 72 RVUE    SHEET 2           1/73*
M           660.0   100.0            PROTOPOPE 72 HBC     SHEET 2  7. PI+P  1/73*

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                 14  NEGATIVE IMAG. PART OF POLE POSITION (MEV)
                 CORRESPONDS TO HALF WIDTH, NOT FULL WIDTH.

W          (325.0)  OR MORE          BASDEVANT 72 RVUE                      1/73*
W           320.0    70.0            PROTOPOPE 72 HBC     7. PI+ P          1/73*

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REFERENCES FOR EPSILON


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SAMIOS    62 PRL 9 139             +BACHMAN,LEA+             (BNL+CUNY+COLU+KNTY)

BLOKHINT 63 JETP 17 80             BLOKHINTSEVA,GREIBINNIK,ZHUKOV +      (DUBNA)
BOOTH    63 PR 132 2314            + ABASHIAN                              (LRL)
KIRZ     63 PR 130 2481            +SCHWARTZ + TRIPP                       (LRL)

BARISH   64 PR 135 B 416           BARISH,KURZ,PEREZ-MENDEZ,SOLOMON        (LRL)
CRAWFORD 64 PRL 13 421             +GROSSMAN,LLOYD,PRICE,FOWLER            (LRL)
DEL FABR 64 PRL 12 674             DEL FABRO,DE PRETIS,JONES+         (FRASCATI)
KALMUS   64 PRL 13  99             +KERNAN,PU,POWELL,DOWD       (LRL+WISCONSIN)

BATON    65 NC 36 1149             J.P.BATON, J.REGNIER                 (SACLAY)
BIRGE    65 PR 139 B 1600          +ELY+GIDAL+KALMUS+CAMERINI+        (LRL+WISC)
BROWN    65 CORAL GABLES 219       BROWN+FAIER                    (NORTHWESTERN)
DURAND   65 PRL 14 329             L. DURAND AND Y.T. CHIU                (YALE)

JACOBS   66 PRL 16 669             +SELOVE                                 (LRL)
KOPELMAN 66 PL  22  118            +ALLEN,GODDEN,MARSHALL +      (COLORADO+IOWA)
LOVELACE 66 PL  22  332            LOVELACE,HEINZ,DONNACHIE               (CERN)

ANDERSON 67 PRL 18 89              +FUKUI+KESSLER+ (CHIC+ANL+CNRC+MCGILL+LOQM)
CLEGG    67 PR 163 1664            A.B.CLEGG                         (LANCASTER)
CORBETT  67 PR 156 1451            +DAMERELL+MIDDLEMAS+NEWTON         (OXF+RHEL)
GUTAY    67 PRL 18 142             +JOHNSON+LOEFFLER+MCILWAIN+      (PURDUE+LRL)
JOHNSON  67 PR 163 1497            +GUTAY,EISNER,KLEIN,PETERS,SAHNI,YEN+(PURD)
MALAMUD  67 PRL 19 1056            E.MALAMUD + P.E.SCHLEIN                (UCLA)
WALKER   67 RMP 39 695             W.D.WALKER                        (WISCONSIN)
WALKER   67 PRL 18 630             +CARROLL,GARFINKEL,OH             (WISCONSIN)

BANDER   68 PR 168 1679            +SHAW,FULCO             (UC IRVINE+S.BARBARA)
BISWAS   68 PL 27 B 513            +CASON,JOHNSON,KENNEY,POIRIER+         (NDAM)
BRAUN    68 PRL 21 1275            BRAUN,CLINE,SCHERER               (WISCONSIN)
DUTTA-RO 68 PR 169 1357            B. DUTTA-ROY, I.R. LAPIDUS             (STEV)
EISENHAN 68 PRL 20 758             EISENHANDLER,MISTRY,MOSTEK +        (CORNELL)
FOSTER   68 NP B 6 107             +GAVILLET+LABROSSE+MONTANET+      (CERN+CDEF)
HYAMS    68 NP 87 1                +KOCH,POTTER,..VON LINDERN,LOREN(CERN+MPIM)
JONES    68 PR 166 1405            +CALDWELL+ZACHAROV+HARTING+BLEULER+  (CERN)
JOHNSON  68 PR 176 1651            +POIRIER,BISWAS,GUTAY+        (NDAM+PURD+SLAC)
LOVELACE 68 PL 28 B 264            C.LOVELACE                             (CERN)
MARATECK 68 PRL 21 1613            +HAGOPIAN,+  (PENN+LRL+COLO+PURD+TNTO+WISC)

BIZZARRI 69 NP B14 169(SEE P.190)+FOSTER,GAVILLET,GHESQUIERE+ (CERN+CDEF)
DAVISON  69 PR 180 1333            +BACASTOW,BARKAS,+                  (UCR+UCB)
DEINET   69 PL 30 B 359            +MENZIONE,MULLER,STAUDENMAIER,+ (KARL+CERN)
ELY      69 PR 180 1319            +GIDAL,HAGOPIAN,+              (UCB+LOUC+WISC)
FELDMAN  69 PRL 22 316             +FRATI,GLEESON,HALPERN,NUSSBAUM,+      (PENN)
GUTAY    69 NP B 12 31             +CARMONY,CSONKA,LOEFFLER,MEIERE      (PURDUE)
HALL     69 NP B 12 573            +MURRAY,RIDDIFORD                (BIRMINGHAM)
HOPKINSO 69 NC 59 A 181            J.HOPKINSON,R.G.ROBERTS                (CERN)
MALAMUD  69 ARGONNE CONF.P.93 E.MALAMUD, P.SCHLEIN                       (UCLA)
MORGAN   69 NP B 10 261            D.MORGAN,G.SHAW                        (RHEL)
ROBERTS  69 PL 29 B 368            R.G. ROBERTS, F. WAGNER                (CERN)
SCHAREN1 69 ARGONNE CONF.306       SCHARENGUIVEL                        (PURDUE)
SCHAREN2 69 PR 186 1387            SCHARENGUIVEL(PURD+LRL+CERN+COLO+PENN+TNTO)
SMITH    69 PRL 23 335             G.A.SMITH, R.J.MANNING              (MSU+LRL)
SONDEREG 69  SEE BASDEVANT 72 SONDEREGGER,BONAMY                         (SACL)
STRUGALS 69 PL 29 B 518            +CHUVILO,FENYVES,+           (WARS+JINR+BUDA)
    ALSO 70 NP B 24 358            STRUGALSKI,CHUVILO,FENYVES,GEMESY,+ (DUBNA)
WAGNER   69 NC 64 A 189            F.WAGNER                               (CERN)

BARTSCH  70 NP B 22 1              +KEPPEL,GENSCH,MORRISON,+  (AACH+BERL+CERN)
BATON    70 PL 33 B 528            +LAURENS,REIGNIER                    (SACLAY)
BRODY    70 PRL 24 948             +GROVES,VANBERG,MAGLIC+(PENN+RUTG+UPNJ+ANL)
DIAZ     70 NP B 16 239            +GAVILLET,LABROSSE,MONTANET+      (CERN+CDEF)
HYAMS    70 PHILAD.CONF.P.41  +SCHLEIN,BEUSCH,+(CERN+MPIM+ETHZ+LOIC+HAWA)
MAUNG    70 PL 33 B 521            +MASEK,MILLER,RUDERMAN,VERNON,+  (UCSD+LRL)
MORGAN1  70 SPRINGER TRACTS MOD.PHYS.,VOL.55,P.1. MORGAN,PISUT(RHEL+CERN)
MORGAN 2 70 PR D 2 520             D.MORGAN,G.SHAW                        (RHEL)
NIELSEN  70 NP B 22 525            +LYNG-PETERSEN,PIETARINEN           (NORDITA)
SCHARENG 70 NP B 22 16             SCHARENGUIVEL,GUTAY,MILLER,+     (PURD+PENN)
OH       70 PR D 1 2494            +GARFINKEL,MORSE,WALKER,PRENTICE(WISC+TNTO)
SHIBATA  70 PRL 25 1227            +FRISCH,WAHLIG                          (MIT)

ALSTON-G 71 PL 36 B 152            ALSTON-GARNJOST,BARBARO-GALTIERI,+      (LBL)
BANAIGS  71 NP B 28 509            +BERGER,DUFLO,GOLDZAHL,COTTEREA+(SACL+CAEN)
BEAUPRE  71 NP B 28 77             +DEUTSCHMANN,GRAESSLER,+   (AACH+BERL+CERN)
BENSINGE 71 PL 36 B 134            BENSINGER,ERWIN,THOMPSON,W.D.WALKER  (WISC)
DUBAL    71 NP B 32 535            L.DUBAL,D.J.BROWN                 (CNRC+CARL)
EBEL     71 NP B 33 317            +MULLENSIEFEN+     (KARL+CERN+LOUC+RHEL+NIJM)
ELVEKJAE 71  PREPRINT RPP/C22 F.ELVEKJAER,H.NIELSEN               (NORDITA+RHEL)
GUTAY    71 NP B 27 486            +SCHARENGUIVEL,FUCHS,GAIDOS,MILLER,+ (PURD)
HAMILTON 71 SPRINGER TRACTS MOD.PHYS.,VOL. 57,P.41 J.HAMILTON    (NORDITA)
KIM      71 PR D 4 265             +BANDER                                 (UCI)
LYNG PET 71 PHYS.REPRTS 2 155 J.LYNG PETERSEN (REVIEW)                   (CERN)
MORGAN   71  PREPRINT RPP/C30 D.MORGAN                                   (RHEL)

APEL     72 PL 41 B 542            +AUSLANDER,MULLER,BERTOLUCCI,+  (KARL+PISA)
BAILLON  72 PL 38 B 555            +CARNEGIE,KLUGE,LEITH,LYNCH,RATCLIFF+(SLAC)
BASDEVAN 72 PL 41 B 178            BASDEVANT,FROGGATT,PETERSEN            (CERN)
BRODY    72 PRL 28 1217            H.BRODY                        (PENNSYLVANIA)
BRODY    72 PRL 28 1215            +GROVES,MAGLICH,NOREM,+     (PENN+RUTG+UPNJ)
CARROLL  72 PRL 28 318             +DIAMOND,FIREBAUGH,MATTHEWS,+   (WISC+TNTO)
DIEBOLD  72  BATAV.CONF.           R.DIEBOLD  RAPPORTEUR TALK              (ANL)
ELVEKJAE 72 NP B 43 445            F.ELVEKJAER                          (AARHUS)
FLATTE   72 PL 38 B 232            +ALSTON-GARNJOST,BARBARO-GALTIERI,      (LBL)
FRENKIEL 72 NP B 47 61             +GHESQUIERE,LILLESTOL,CHUNG,+   (CDEF+CERN)
GAIDOS   72 NP B 46 449            +MCILWAIN,THOMPSON,WILLMANN          (PURDUE)
GRAYER   72 PHIL.CONF.PROC. 5 +HYAMS,JONES,SCHLEIN,BLUM,DIETL+(CERN+MPIM)
ODORICO  72  PREP.ANL/HEP7204 R.ODORICO                                   (ANL)
PRASAD   72 PR D 6 3216            +BREHM               (UNIV.OF MASSACHUSETTS)
PROTOPOP 72 PHIL.CONF.PROC.17 +ALSTON,BARBARO-,FLATTE,FRIEDMAN,+         (LBL)
PROTOPOP 72  LBL 970 SUBM.PR       +LASINSKI,LYNCH,RABIN,SOLMITZ           (LBL)
RISSER   72  PREP.DPH T/72/50 T.RISSER,M.D.SHUSTER                       (SACL)
SKUJA    72  BATAV.CONF.PAPER +WAHLIG,RISSER,PRIPSTEIN,NELSON,+          (LBL)
WHITEHEA 72 NP B 48 365            WHITEHEAD,AULD,+        (AERE+RHEL+SHMP+LOUC)
WILLIAMS 72 PR D 6 3178            P.K.WILLIAMS                            (FSU)
ZYLBERSZ 72 PL 38 B 457            ZYLBERSZTEJN,BASILE,BOURQUIN,+  (GEVA+SACL)

FUJII    73 NC 13 A 311            Y.FUJII,M.KATO                        (TOKYO)
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ρ(770)

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9  RHO (770, JPG = 1-+) I=1

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                 9  RHO MASS (MEV)

M        WE DO NOT LIST ALL VALUES PUBLISHED.WE AVERAGE ONLY                2/73*
M        THE MOST SIGNIFICANT DETERMINATIONS OF MASS AND WIDTH.             2/73*
M        SOME OF THE RHO 0 DATA MAY BE INFLUENCED BY RHO-OMEGA INTERFERENCE.

M    MIXED CHARGES
M       240 (752.0)                     ALITTI    63 HBC   -0 1.6 PI-P
M       290 (755.0)                     CHADWICK  63 HBC  +-0 0.0 PBAR P

M        CHARGED ONLY
M           (748.0)                     KENNEY    62 HBC   -  1.2 PI-P
M       130 (775.0)                     GUIRAGOSS 63 HBC   -  3.3 PI-P
M    R      (760.0)   (9.0)             CARMONY   64 HBC   +  3.5 PI+P,TCUT 4
M    S      (760.)    (10.)             ARMENISE  65 HBC   +  2.8 PI+P
M    R      (768.0)   (5.0)             BLIEDEN   65 MMSP  -  3-5 PI- P      6/66
M    R      (765.0)   (5.0)             ALFF-STEI 66 HBC   +  2-3 PI+ P      6/66
M    R      (760.0)   (5.0)             HAGOPIAN1 66 HBC   -  3.0 PI- P      6/66
M    R      (765.0)   (5.0)             HAGOPIAN2 66 HBC   -  2.14 PI-,TCUT12 9/67
M    R 2775 (753.5)   (10.5)            JACOBS    66 HBC   -  2-3PI-,T CUT 20 6/68
M    R      (758.0)   (10.0)            JAMES     66 HBC   +  2.1 PI+,TCUT2.5 8/66
M    R      (749.0)   (3.0)             WEST      66 HBC   -  2.1 PI- P     10/66
M    B      (755.)    (10.)             ALLES-BOR 67 HBC   +- 5.7 PBAR P    12/66
M    C 7666 (755.0)   (5.0)             BATON     67 HBC   -  2.8 PI- P     10/67
M    Z  900  767.      6.               EISNER    67 HBC   -  4.2 PI-,T CUT10 1/73*
M    R      (768.0)   (5.0)             MILLER    67 HBC   -  2.7 PI-,T CUT20 9/66
M    S      (777.0)   (7.0)             ABC COLL. 68 HBC   +  8 PI+P TO P+3PI 5/68
M    R      (773.0)   (2.0)             BATON     68 HBC   -  2.8 PI-,T CUT13 7/69
M      1700 (782.)    (5.)              FOSTER    68 HBC   +- PBAR P AT REST  1/73*
M      9650  764.3     1.9       1.8    PISUT     68 RVUE  -  1.7-3.2PI-,CT10 6/68
M    A 9650 (764.3)   (19.2)    (3.3)   PISUT     68 RVUE  -  1.7-3.2PI-,CT10 6/68
M    A   ERRORS ARE 2 STD AND INCLUDE SYSTEMATIC UNCERTAINTIES FROM THEORY
M   X  1300  777.0     5.0              REYNOLDS  69 HBC   -  2.26 PI- P      1/73*
M   X    SYSTEMATIC ERRORS ADDED CORRESP. TO SPREAD OF DIFFERENT FITS.
M          . . . . . . . . . .
M    AVG     765.9     2.8     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.7)

MO   NEUTRAL ONLY
MO      190 (750.0)   (20.0)            SAMIOS    62 HBC    0 4.7 PI-P
MO   R  300 (760.0)   (10.0)            ABOLINS   63 HBC    0 3.5 PI+P
MO      160 (775.0)                     GUIRAGOSS 63 HBC    0 3.3 PI-P
MO   R  500 (770.0)   (10.0)            GOLDHABER 64 HBC    0 3.7 PI+P
MO          (750.0)                     CLARK     65 OSPK   0 1.5 PI-P
MO   R      (750.0)   (5.0)             ALFF-STEI 66 HBC    0 2-3 PI+ P       6/66
MO   R      (775.0)   (5.0)             HAGOPIAN1 66 HBC    0 3.0 PI- P       6/66
MO   R      (770.)    (5.)              HAGOPIAN2 66 HBC    0 2.1 PI-,TCUT 12 2/67
MO   R 4207 (758.0)   (7.5)             JACOBS    66 HBC    0 2-3PI-,T CUT 20 6/68
MO   R      (765.0)   (8.0)             JAMES     66 HBC    0 2.1 PI+ P       6/66
MO   R      (760.0)   (3.0)             WEST      66 HBC    0 2.1 PI- P      10/66
MO   P 4000 (765.)    (5.0)             ASBURY 2  67 CNTR   0 GAMMA + PB      1/73*
MO   R      (768.0)   (2.0)             BACON     67 HBC    0 1.7 PI-P        9/67
MO   B  327 (750.)    (10.)             DANYSZ    67 HBC    0 3.0 PB P,6 PI   7/67
MO   R      (761.)    (3.)              HUWE      67 HBC    0 2.4 PI- P       7/67
MO   R      (770.0)   (4.0)             MILLER    67 HBC    0 2.7 PI-,T CUT20 9/66
MO   S      (770.0)   (3.0)             ABC COLL. 68 HBC    0 8 PI+P TO P+3PI 5/68
MO   R      (775.0)   (2.0)             ARMENISE  68 DBC    0 5.1 PI+D        6/68
MO   B      (745.0)   (5.0)             DONALD    68 HBC    0 1.2 PB P,4 PR.  9/68
MO     1900 (776.)    (5.)              FOSTER    68 HBC    0 PBAR P AT REST  1/73*
MO     2250  775.0     3.0              HYAMS     68 OSPK   011.2 PI- P       9/68
MO   S      (765.0)   (6.0)             JONES     68 OSPK   0 12PI-, T LT 2.5 5/68
MO   S      (745.0)   (13.0)            JONES     68 OSPK   0 18PI-, T LT 2.5 5/68
MO   S      (760.0)   (5.0)             KEY       68 HBC    0 3.0 PI- P       5/68
MO    13300  766.7     2.8              PISUT     68 RVUE   0 1.7-3.2PI-,CT10 1/73*
MO   E      (754.0)   (9.0)             AUSLENDER 69 OSPK   0 E+E- COLL.BEAMS 6/68
MO   E        SEE ALSO HAISSINSKI 69, WHO FITS AUSLENDER 69 DATA
MO E         768.      10.              HAISSINSK 69 RVUE   0 E+E- COLL.BEAMS 12/72*
MO   R      (768.4)   (2.4)             MALAMUD   69 RVUE   0 2-4 PI-P        1/73*
MO   S      (755.0)   (15.0)            MOTT      69 HBC    0 4.1-5.5 K- P    7/69
MO X   1700  772.0     5.0              REYNOLDS  69 HBC    0 2.26 PI- P      1/73*
MO X     SYSTEMATIC ERRORS ADDED CORRESP. TO SPREAD OF DIFFERENT FITS.
MO C         759.0     7.0              SCHAREN   69 HBC    0 2-4. PI- P      1/73*
MO   P      (765.0)   (10.0)            ALVENSLEB 70 CNTR   0 GAMMA A,TCUT.01 1/73*
MO   C12630 (760.0)    4                BATON     70 HBC    0 2.8 PI- P       1/71
MO     140K  767.7     1.9              BIGGS     70 CNTR   0PHOTOPRODUCTION  1/73*
MO   S      (765.0)   (6.0)             GALLOWAY  70 HBC    0 5.97 PI- P      1/71
MO C         761.0     5.0              BAILLON   72 ASPK   0 15. PI- P       1/73*
MO     1930  767.0     4.0              BALLAM    72 HBC    0 2.8 GAMMA P     1/73*
MO     2430  770.0     4.0              BALLAM    72 HBC    0 4.7 GAMMA P     1/73*
MO           775.4     7.3              BENAKSAS  72 OSPK   0 E+E- COLL.BEAMS 2/72
MO Z 11200   773.5     1.7              JACOBS    72 HBC    0 2.8 PI- P       1/73*
MO C 32000   775.0     4.0              PROTOPOPE 72 HBC    0 7.1 PI+P,TCUT.4 1/73*
MO Z    900  764.0     5.0              RATCLIFF  72 ASPK   0 15. PI- P       1/73*
MO      880  787.0     10.0             TAKAHASHI 72 HBC    0 8.0 PI- P       1/73*
MO         . . . . . . . . . .
MO   AVG     770.3     1.2      AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.3)
                        (SEE IDEOGRAM BELOW )
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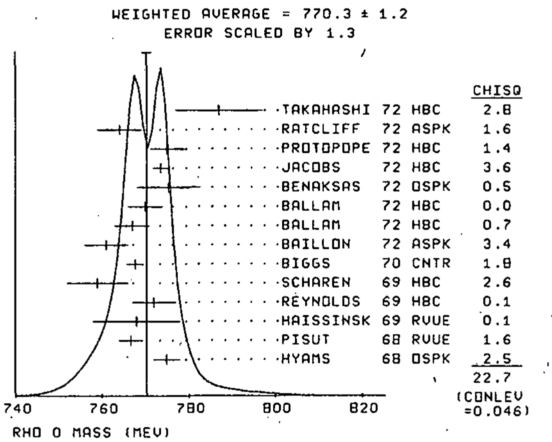
0 0 0 0 3 6 0 4 0 0 3

Data Card Listings
For notation, see key at front of Listings.

Mesons
$\rho(770)$

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M         ----------NOTES----------

M    C    FROM POLE EXTRAPOLATION
M    R    INCLUDED IN PISUT 68 RVUE
M    S    S-WAVE BREIT-WIGNER FIT, CANNOT BE COMBINED WITH OTHER VALUES
M    B    HIGH COMBINATORIAL BACKGROUND
M    P    FROM PHOTOPRODUCTION, MODEL DEPENDENT.
M   Z     ERRORS INCREASED BY US. SEE TYPED NOTE ON K* MASS.

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                  9  (RHO0) - (RHO+-) MASS DIFFERENCE (MEV)

D              2.4      2.1                PISUT      68 RVUE      PI N TO RHO N    6/68

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                  9  RHO WIDTH (MEV)

W         SEE NOTE ON RHO MASS ABOVE

W    MIXED CHARGES
W       290 (110.0)                        CHADWICK  63 HBC  +-0 0.0 PBAR P

W         CHARGED ONLY
W       130 (125.0)                        GUIRAGOSS 63 HBC   -  3.3 PI-P
W            (90.0)    (10.0)              SACLAY    63 HBC   +  2.8 PI+P
W        98 (180.0)                        BONDAR    64 HBC   -  4.1 PI-P
W    R       (77.0)    (20.0)              CARMONY   64 HBC   +  3.5 PI+P,TCUT 4
W    S      (160.)     (10.)               ARMENISE  65 HBC   +  2.8 PI+P
W    R      (100.0)                        ALFF-STEI 66 HBC   +  2-3 PI+ P       6/66
W    R      (127.0)     (5.0)              BLIEDEN   66 MMSP  -  3-5 PI- P       6/66
W    R      (150.0)    (20.0)              HAGOPIAN1 66 HBC   -  3.0 PI- P       6/66
W    R      (135.0)    (20.0)              HAGOPIAN2 66 HBC   -  2.14 PI-,TCUT12  9/67
W    R 2775 (137.1)    (20.0)              JACOBS    66 HBC   -  2-3PI-,T CUT 20  6/68
W    R      (147.0)    (19.0)              JAMES     66 HBC   +  2.1 PI+,TCUT2.5  8/66
W    R      (149.0)     (13.0)             WEST      66 HBC   -  2.1 PI- P      10/66
W    B      (146.)     (31.)               ALLES-BOR 67 HBC  +-  5.7 PBAR P     12/66
W    C 7666 (110.0)     (9.0)              BATON     67 HBC   -  2.8 PI- P      10/67
W       900  146.       13.                EISNER    67 HBC   -  4.2 PI-,T CUT10  9/67
W    R      (153.0)    (13.0)              MILLER    67 HBC   -  2.7 PI-,T CUT20  9/66
W    S      (149.0)    (22.0)              ABC COLL. 68 HBC   +  8 PI+P TO P+3PI  5/68
W    R      (150.0)     (5.0)              BATON     68 HBC   -  2.8 PI- P       7/69
W      1700 (145.0)    (10.0)              FOSTER    68 HBC  +-  PBAR P AT REST  1/73*
W      9650  147.3      4.0       3.9      PISUT     68 RVUE  -  1.7-3.2PI-,CT10  6/68
W   X  1300  154.0      13.0               REYNOLDS  69 HBC   -  2.26 PI- P      1/73*
W   X     SYSTEMATIC ERRORS ADDED CORRESP. TO SPREAD OF DIFFERENT FITS.
W            . . . . . . . . . .
W    AVG     147.7      3.6     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

WO   NEUTRAL ONLY
WO      190 (150.0)    (20.0)              SAMIOS    62 HBC   .0 4.7 PI-P
WO   R  300  (90.0)    (10.0)              ABOLINS   63 HBC    0 3.5 PI+P
WO      160 (175.0)                        GUIRAGOSS 63 HBC    0 3.3 PI-P
WO   R  500 (130.0)                        GOLDHABER 64 HBC    0 3.7 PI+P
WO          (130.0)                        CLARK     65 OSPK   0 1.5 PI-P
WO   R      (100.0)                        ALFF-STEI 66 HBC    0 2-3 PI+ P       6/66
WO   R      (120.0)    (10.0)              HAGOPIAN1 66 HBC    0 3.0 PI- P       6/66
WO   R      (135.0)    (20.0)              HAGOPIAN2 66 HBC    0 2.14 PI-P,LOW T  9/67
WO   R 4207 (122.2)    (15.0)              JACOBS    66 HBC    0 2-3PI-,T CUT 20  6/68
WO   R      (103.0)    (13.0)              JAMES     66 HBC    0 2.1 PI+ P       6/66
WO   R      (173.0)    (13.0)              WEST      66 HBC    0 2.1 PI- P      10/66
WO   P 4000 (130.)      (5.)               ASBURY 2  67 CNTR   0 GAMMA + PB      1/73*
WO   R      (148.0)     (8.0)              BACON     67 HBC    0 1.7 PI-P        9/67
WO   S  327 (135.)     (25.)               DANYSZ    67 HBC    0 3.0 PB P,6 PI   1/73*
WO   R      (152.)     (15.)               HUWE      67 HBC    0 2.4 PI- P       7/67
WO   R      (160.0)    (15.0)              MILLER    67 HBC    0 2.7 PI-,T CUT20  9/66
WO   S      (165.0)    (10.0)              ABC COLL. 68 HBC    0 8 PI+P TO P+3PI  5/68
WO   R      (167.0)     (6.0)              ARMENISE  68 DBC    0 5.1 PI+D        6/68
WO   B      (150.0)    (13.0)              DONALD    68 HBC    0 1.2 PB P,4 PR.  9/68
WO     1900 (132.)     (10.)               FOSTER    68 HBC    0 PBAR P AT REST  1/73*
WO Z   2250  145.0      12.0               HYAMS     68 OSPK  011.2 PI- P       1/73*
WO   S      (129.0)    (19.0)              JONES     68 OSPK   0 12PI-, T LT 2.5  5/68
WO   S      (169.0)    (41.0)              JONES     68 OSPK   0 18PI-, T LT 2.5  5/68
WO   S      (113.0)    (16.0)              KEY       68 HBC    0 3.0 PI- P       5/68
WO   P      (160.0)    (10.0)              LANZEROTT 68 CNTR   0 GAMMA P         1/73*
WO   C14890 (105.0)    (15.0)              MARATECK  68 HBC    0 1.9-3.0 PI- P   9/68
WO   E      (105.0)    (20.0)              AUSLENDER 69 OSPK   0 E+E- COLL.BEAMS  6/68
WO   E        SEE ALSO HAISSINSKI 69, WHO FITS AUSLENDER 69 DATA
WO E          140.      14.                HAISSINSK 69 RVUE   0 E+E- COLL.BEAMS 12/72*
WO   R      (132.0)    (13.0)              MALAMUD   69 RVUE   0 2-4 PI-P        1/73*
WO   S      (130.0)    (40.0)              MOTT      69 HBC    0 4.1-5.5 K- P    7/69
WO X   1700  135.0      16.0               REYNOLDS  69 HBC    0 2.26 PI- P      1/73*
WO X      SYSTEMATIC ERRORS ADDED CORRESP. TO SPREAD OF DIFFERENT FITS.
WO C          119.0     20.0               SCHAREN   69 HBC    0 2-4 PI- P       1/73*
WO  P        (140.0)    (5.0)              ALVENSLEB 70 CNTR   0 GAMMA A,TCUT.01 1/73*
WO  C12630  (131.0)                        BATON     70 HBC    0 2.8 PI- P       1/71
WO     140K  146.1       2.9               BIGGS     70 CNTR   0PHOTOPRODUCTION  1/73*
WO  S        (120.0)    (7.0)              GALLOWAY  70 HBC    0 5.97 PI- P      1/71
WO C          108.0     20.0               BAILLON   72 ASPK   0 15. PI- P       1/73*
WO Z  2430    155.0     12.0               BALLAM    72 HBC    0 4.7 GAMMA P     1/73*
WO Z  1930    145.0     13.0               BALLAM    72 HBC    0 2.8 GAMMA P     1/73*
WO            149.6     23.2               BENAKSAS  72 OSPK   0 E+E- COLL.BEAMS 12/72*
WO    11200 (178.35)   (2.5)               JACOBS    72 HBC    0 2.8 PI- P       1/73*
WO C 32000    160.0     10.0               PROTOPOPE 72 HBC    0 7.1 PI+P,TCUT.4 1/73*
WO Z   900    157.0     21.0               RATCLIFF  72 ASPK   0 15. PI- P       1/73*
WO Z   880    144.0     19.0               TAKAHASHI 72 HBC    0 8.0 PI- P       1/73*
WO            . . . . . . . . . .
WO   AVG      146.0      2.4     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

W         ----------NOTES----------

W    C    FROM POLE EXTRAPOLATION
W    R    INCLUDED IN PISUT 68 RVUE
W    S    S-WAVE BREIT-WIGNER FIT, CANNOT BE COMBINED WITH OTHER VALUES
W    B    HIGH COMBINATORIAL BACKGROUND
W    P    FROM PHOTOPRODUCTION, MODEL DEPENDENT.
W   Z     ERRORS INCREASED BY US. SEE TYPED NOTE ON K* MASS.

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                  9  RHO PARTIAL DECAY MODES

                                                           DECAY MASSES
P1      RHO INTO 2PI                                       139+ 139
P2      RHO INTO 4PI                                       139+ 139+ 139+ 139
P3      RHO INTO PI GAMMA                                  139+   0
P4      RHO INTO E+ E-                                      .5+  .5
P5      RHO INTO PI ETA (VIOLATES G)                       139+ 548
P6      RHO INTO MU+ MU-                                   105+ 105
P7      RHO0 INTO PI+ PI- PI0 (VIOLATES G)                 139+ 139+ 134

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                  9  RHO BRANCHING RATIOS

R1      RHO INTO 4PI/2PI                                  (P2)/(P1)

R1      RHO+- INTO (PI+- PI+ PI- PI0) / (PI+- PI0)
R1          (0.026)OR LESS            BLIEDEN   66 MMSP  -   3-5 PI- P        6/66
R1          (0.01) OR LESS            DEUTSCHMA 66 HBC   +   8.0 PI+ P        6/66
R1          (0.002)OR LESS            FERBEL    66 HBC   +- PI+- P ABOVE 2.5 10/66
R1           0.0035    0.004          JAMES     66 HBC   +   2.1 PI+P        11/66

R1      RHO0 INTO (PI+ PI- PI+ PI-) / (PI+ PI-)
R1          (0.008)OR LESS            JAMES     66 HBC     0 2.1 PI+P         6/66
R1          (0.002)OR LESS            CHUNG     68 HBC     0 3.2,4.2 PI-P     7/67
R1          (0.002)OR LESS  CL=.90    HUSON     68 HLBC    0 16.0 PI- P       1/71
R1          (0.0015)OR LESS CL=.90    GERMAN CO 69 HBC     0 2.5-5.8 GAMMA P 10/67

R2      RHO INTO PI GAMMA/2PI                              (P3)/(P1)
R2   M      (0.02) OR LESS            LANZEROTT 65 CNTR      GAMMA P(BREMS)  11/66
R2          (0.005)OR LESS  CL=.97    FIDECARO  66 OSPK  -                   10/66
R2          (0.007)OR LESS            HUSON     66 HLBC  -   15 PI-PB         6/66
R2   M      (0.002)OR LESS  CL=.90    GERMAN CO 69 HBC
R2   M       ONE PION EXCHANGE MODEL USED IN THIS ESTIMATION
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Note on $\rho^0 \to e^+e^-$

Extraction of a ratio for $\rho^0 \to e^+e^-$ is complicated by interference with ω^0 decay. In photoproduction, $\gamma A \to e^+e^-A$, there is substantial interference between the allowed $(\rho^0, \omega) \to e^+e^-$ decays. The interference in the colliding-beam reaction $e^+e^- \to \pi^+\pi^-$ is due to G parity violating mixing of the overlapping ρ^0 and ω resonances; it alters the results for the rate $\Gamma(\rho^0 \to e^+e^-)$ only by a small amount. Therefore we use at present, for the average, only the values from the $e^+e^- \to \pi^+\pi^-$ experiments.

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R3      RHO INTO(E+ E-)/(PI+PI-) (UNITS 10**-4)            (P4)/(P1)
R3   P   94  (0.65)   (0.14)            ASBURY 1  67 CNTR     PHOTOPRODUCTION  9/67
R3   P         POSSIBLY LARGE RHO-OMEGA INTERFERENCE
R3   H       (0.65)   (1.1)    (0.5)    HERTZBACH 67 OSPK ASSUME SU(3)+MIXING.10/66
R3   H         NOT SEPARATED FROM OMEGA DECAY.
R3   A   33  (0.53)   (0.11)            ASTVACATU 68 OSPK ASSUME SU(3)+MIXING  6/68
R3   A         NOT SEPARATED FROM OMEGA DECAY. ERROR STATISTICAL ONLY.
R3    E      (0.663)  (0.085)           AUGUSTI1  69 OSPK     E+E- COLLID.BEAM  4/69
R3    E        ASSUMING RHO WIDTH 111 MEV
R3             0.50     0.10            AUSLENDER 69 OSPK     E+E- COLLID.BEAM  9/68
R3   F       (0.49)   (0.12)   (0.15)   BIGGS     70 CNTR     PHOTOPRODUCTION   6/70
R3   F         ASSUMING RHO WIDTH 140 MEV. ERROR STATISTICAL ONLY.
R3             0.41     0.05            BENAKSAS  72 OSPK     E+E- COLL.BEAMS 12/72*
R3           . . . . . . . . . .
R3   AVG       0.428    0.045     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

R4      RHO INTO (PI ETA)/(2PI)                             (P5)/(P1)
R4           (0.03) OR LESS             DEUTSCHMA 66 HBC   +    8.0 PI+ P       6/66
R4           (0.008)OR LESS             FERBEL    66 HBC   +- PI+- P ABOVE 2.5 11/66
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Mesons

$\rho(770)$, $\omega(784)$

Data Card Listings

For notation, see key at front of Listings.

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R5     RHO INTO (MU+ MU-)/(PI+ PI-) (UNITS 10**-4)        (P6)/(P1)
R5
R5            SEE NOTE UNDER RHO INTO E+E- ABOVE
R5
R5   H        0.97     0.31     0.33  HYAMS      67 OSPK    11 PI- LI H      6/67
R5   H        HYAMS MASS RESOL. IS 20 MEV. THE OMEGA REGION WAS EXCLUDED.
R5   R        0.82     0.16     0.36  ROTHWELL   69 CNTR    PHOTOPRODUCTION . 4/70
R5   R        POSSIBLY LARGE RHO-OMEGA INTERFERENCE LEADS US TO INCREASE
R5   R        THE MINUS ERROR
R5            0.56     0.15           WEHMANN    69 OSPK    12 PI- ON C,FE   7/69
R5   W        RESULT CONTAINS (11 +- 11) PER CENT CORRECTION USING SU(3)
R5   W        FOR CENTRAL VALUE. THE ERROR ON THE CORRECTION TAKES ACCOUNT
R5   W        OF POSSIBLE RHO-OMEGA INTERFERENCE AND THE UPPER LIMIT AGREES
R5   W        WITH THE UPPER LIMIT OF (OMEGA INTO MU+ MU-) FROM THIS EXPT.
R5           . . . . . . . . . .
R5   AVG      0.67     0.12    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

R6     RHO 0 INTO (PI+ PI- PI0)/(PI+ PI-)                  (P7)/(P1)
R6   G        (0.01) OR LESS  CL=.84   ABRAMS     71 HBC     0 3.7 PI+ P      11/71
R6   G      MODEL DEPENDENT,ASSUMES I = 1,2,OR 3 FOR THE 3PI SYSTEM           11/71

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REFERENCES FOR RHO


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ANDERSON 61 PRL 6 365           ANDERSON,BANG,BURKE,CARMONY,SCHMITZ   (LRL)
ERWIN    61 PR 6 628            A.R.,R.MARCH,W.D.WALKER,E.WEST       (WISC)
KENNEY   62 PR 126 736          V P KENNEY,W D SHEPHARD,C D GALL (KENTUCKY)
SAMIOS   62 PRL 9 139           SAMIOS,BACHMAN,LEA+    (BNL+CUNY+COLU+KNTY)
XUONG    62 PR 128 1849         NGUYEN HUU XUONG,GERALD R LYNCH       (LRL)

ABOLINS  63 PRL 11 381          ABOLINS,LANDER,MEHLHOP,NGUYEN,YAGER  (UCSD)
ALITTI   63 NC 29 515           ALITTI,BATON,ARMENISE+(SACL+ORSA+BARI+BGNA)
CHADWICK 63 PRL 10 62           CHADWICK,DAVIES,DERRICK,CRESTI + (OXF+PADO)
GUIRAGOS 63 PRL 11 85           ZAVEN GUIRAGOSSIAN                    (LRL)
SACLAY   63 SIENA CONF 1 239    SACLAY+ORSAY+BARI + BOLOGNA- COLLABORATION

BONDAR   64 NC 31 729           BONDAR+    (AACHEN+BIRM+BONN+DESY+LOIC+MPIM)
CARMONY  64 DUBNA CONF 1 486    CARMONY,HOA,LANDER,NG.H.XUONG,YAGER  (UCSD)
GOLDHABE 64 PRL 12 336          GOLDHABER,BROWN,KADYK,SHEN+       (LRL+UCB)

ALYEA    65 PL 15 82            ALYEA,CRITTENDEN,MARTIN,RHODE +   (INDIANA)
ARMENISE 65 NC 37 361           SACLAY+ORSAY+BARI+BOLOGNA    COLLABORATION
BLIEDEN  65 PL 19 444           CERN MISSING MASS SPECTROMETER GROUP (CERN)
CLARK    65 PR 139 B 1556       A CLARK,CHRISTENSON,CRONIN,TURLAY(PRINCETO)
GUTAY    65 NC 39 381           GUTAY,LANNUTTI,TULI                   (FSU)
LANZEROT 65 PRL 15 210          LANZEROTTI,BLUMENTHAL,EHN,FAISSLER + (HARV)
ZDANIS   65 PRL 14 721          ZDANIS,MADANSKY,KRAEMER +         (JHU+BNL)

ACCENSI  66 PL 20 557           ACCENSI,ALLES-BORELLI,FRENCH,FRISK+  (CERN)
ALFF-STE 66 PR 145 1072         ALFF-STEINBERGER,BERLEY,BRUGGER+(COLU+RUTG)
BALTAY   66 PR 145 1103         +FRANZINI,LUTJENS,SEVERINS,TYCKO+(COLUMBIA)
BLIEDEN  66 NC 43 71            CERN MISSING MASS SPECTROMETER GROUP (CERN)
CAMBRIDG 66 PR  146  994        CAMBRIDGE BUBBLE CHAMBER GROUP  (MIT+HARV+)
CASON    66 PR  148  1282       N M CASON                       (WISCONSIN)
DEUTSCHM 66 PL 20 82            DEUTSCHMANN,STEINBERG + (AACH+BERLIN+ CERN)
FERBEL   66 PL 21 111           FERBEL                          (ROCHESTER)
FIDECARO 66 PL  23  163         G+M FIDECARO,J POIRIER,P SCHIAVON    (CERN)
HAGOPIAN166 PR 145 1128         HAGOPIAN,SELOVE,ALITTI,BATON+ (PENN+SACLAY)
HAGOPIAN266 PR  152  1183       HAGOPIAN,PAN    (PENNSYLVANIA,LRL-BERKELEY)
HUSON    66 PL 20 91            HUSON,ALLARD,DRIJARD,HENNESSY+ (ORSAY+EPOL)
JACOBS   66 UCRL-16877          L.D.JACOBS                            (LRL)
JAMES    66 PR 142 896          F E JAMES,KRAYBILL        (YALE+BROOKHAVEN)
WEST     66 PR 149 1089         WEST,BOYD,ERWIN,WALKER          (WISCONSIN)

ALLES-BO 67 NC 50 A 776         ALLES-BORELLI,FRENCH,FRISK,+    (CERN+BONN)
ASBURY 1 67 PRL 19 869          +BECKER+BERTRAM+JOOS+JORDAN+    (DESY+COLU)
ASBURY 2 67 PRL 19 865          +BECKER+BERTRAM+JOOS+JORDAN+    (DESY+COLU)
BACON    67 PR 157 1263         +FICKINGER,HILL,HOPKINS,ROBINSON+     (BNL)
BANNER   67 PL  25 B  300       +FAYOUX,HAMEL,ZSEMBERY,CHEZE+ (SACLAY+CAEN)
BARLOW   67 NC 50A 701          +LILLESTOL+MONTANET+  (CERN+COEF+IRAD+LIVP)
BATON    67 PL 25 B 419         J.BATON,G.LAURENS,J.REIGNIER       (SACLAY)
    ALSO 67 NP B 3  349         J.BATON,G.LAURENS,J.REIGNIER       (SACLAY)
CLEAR    67 NC 49A 399          +JOHNSTON+COOPER+MANNER+     (TNTO+ANL+WISC)
DANYSZ   67 NC 51 A 801         DANYSZ+FRENCH+SIMAK                  (CERN)
EISNER   67 PR 164 1699         +JOHNSON+KLEIN+PETERS+SAHNI+YEN+   (PURDUE)
FRENCH   67 NC 52A 442          +KINSON+MCDONALD+RIDDIFORD+     (CERN+BIRM)
HERTZBAC 67 PR 155  1461        HERTZBACH,KRAEMER,MADANSKI,ZDANIS+(JHU+BNL)
    ALSO 65 ZDANIS
HUWE     67 PL 24B 252          +MARQUIT+OPPENHEIMER+SCHULTZ+WILSON  (COLU)
HYAMS    67 PL 24B 634          +KOCH+PELLETT+POTTER+VONLINDERN+(CERN+MPIM)
MILLER   67 PR 153 1423         MILLER,GUTAY,JOHNSON,LOEFFLER +    (PURDUE)
POIRIER  67 PR 163 1462         +BISWAS,CASON,DERADO,KENNEY+    (NDAM+PENN)

ABC COLL 68 NP B4 501                  AACHEN+BERLIN+CERN COLLABORATION
ARMENISE 68 NC 54A 999          +GHIDINI,FORINO+      (BARI+BGNA+FIRZ+ORSAY)
ASTVACAT 68 PL 27 B  45         ASTVACATUROV,AZIMOV,BALDIN+  (JINR+MOSCOW)
BATON    68 PR 176 1574         J.P. BATON, G. LAURENS             (SACLAY)
BLECHSCH 68 NC   53 A  1045     BLECHSCHMIDT,DOWD,ELSNER,+      (DESY+MCHS)
    ALSO 67 NC   52 A  1348
CHUNG    68 PR 165 1491         S.U.CHUNG,O.I.DAHL,J.KIRZ,D.H.MILLER  (LRL)
DONALD   68 NP B 6 174          +EDWARDS,FRODESEN,BETTINI+ (LIVP+OSLO+PADO)
FOSTER   68 NP B 6 107          +GAVILLET+LABROSSE+MONTANET+    (CERN+CDEF)
HUSON    68 PL 28B 208          +LUBATTI,SIX,VEILLET,+     (ORSA+MILA+UCLA)
HYAMS    68 NP B 7 1            +KOCH,POTTER,WILSON,VON LINDERN+(CERN+MPIM)
JONES    68 PR 166 1405         +BLEULER,CALDWELL,ELSNER,HARTING+    (CERN)
JOHNSON  68 PR 176 1651         +POIRIER,BISWAS,GUTAY+     (NDAM+PURD+SLAC)
KEY      68 PR 166 1430         +PRENTICE+COOPER+MANNER+     (TNTO+ANL+WISC)
LAMSA    68 PR 166 1395         +CASON+BISWAS+DERADO+GROVES+    (NOTREDAME)
LANZEROT 68 PR 166 1365         LANZEROTTI,BLUMENTHAL,EHN,FAISSLER + (HARV)
MARATECK 68 PRL 21 1613         +HAGOPIAN,+  (PENN+LRL+COLO+PURD+TNTO+WISC)
PISUT    68 NP B 6 325          J.PISUT,M.ROOS                       (CERN)

AUGUSTI1 69 PL 28 B 508         +BIZOT+BUON+HAISSINSKI+LALANNE+     (ORSAY)
AUGUSTI2 69 LNC 2 214           +LEFRANCOIS,LEHMANN,MARIN,+         (ORSAY)
AUSLENDE 69 SJNP 9  69          AUSLENDER,BUDKER,PANTUSOVA,PESTOV+   (NOVO)
GERMAN C 69 PR 188  2060        GERMAN BUBBLE CHAMBER COLL.          (DESY)
HAISSINS 69 ARGONNE CONF. 373   J.HAISSINSKI                        (ORSAY)
JUHALA   69 PR 184  1461        +LEACOCK,RHODE,KOPELMAN,LIBBY,+  (ISU+COLO)
MALAMUD  69 ARGONNE CONF.P.93   E.MALAMUD, P.SCHLEIN                 (UCLA)
MILLER   69 PR 178 2061         R.MILLER,LICHTMAN,WILLMANN         (PURDUE)
MOTT     69 PR 177 1966         +AMMAR,DAVIS,KROPAC,SLATE,DAGAN+ (NWES+ANL)
REYNOLDS 69 PR 184 1424         +ALBRIGHT,BRADLEY,BRUCKER,HARMS+      (FSU)
ROOS     69 NP B 10 563         M.ROOS,J.PISUT           (CERN+BRATISLAVA)
ROTHWELL 69 PRL 23 1521         +CHASE,EARLES,GETTNER,GLASS,WEINSTEI+(NEAS)
SCHAREN  69 ARGONNE CONF.306    SCHARENGUIVEL                      (PURDUE)
WEHMANN  69 PR 178  2095        +ENGELS,WILSON,+ (HARV+CASE+SLAC+CORN+MCGI)

ALVENSLE 70 PRL 24 786          ALVENSLEBEN,BECKER,BERTRAM,CHEN,COHEN(DESY)
BATON    70 PL 33 B 528         +LAURENS,REIGNIER                  (SACLAY)
BIGGS    70 PRL 24 1197         +BRABEN,CLIFFT,GABATHULER,KITCHING+  (DARE)
BINGHAM  70 PRL 24 955          +FRETTER,MOFFEIT,BALLAM+    (LRL+SLAC+TUFT)
GALLOWAY 70 PR D 1 3077         +MOTT,ALYA,LEE,MARTIN,PRICKETT        (IND)

ABRAMS   71 PR D 4 653          +BARNHAM,BUTLER,COYNE,GOLDHABER,HALL,+(LBL)
BLOODWOR 71  PREPRINT           BLOODWORTH,JACKSON,PRENTICE,YOON  (TORONTO)
DEERY    71 PR D 3 635          +BISWAS,CASON,GROVES,JOHNSON,+ (NOTRE DAME)
DRIVER   71  DESY 71/56         +HEINLOTH,HOHNE,HOFMANN,JANATA,KAROW+(DESY)
EISENBER 71  SLAC-PUB-933       EISENBERG,HABER,BALLAM,CHADWICK+(REHO+STAN)

BAILLON  72 PL 38 B 555         +CARNEGIE,KLUGE,LEITH,LYNCH,RATCLIFF+(SLAC)
BALLAM   72 PR D 5 545          +CHADWICK,BINGHAM,MILBURN,+ (SLAC+LBL+TUFT)
BASDEVAN 72 PL 41 B 178         BASDEVANT,FROGGATT,PETERSEN          (CERN)
BENAKSAS 72 PL 39 B 289         +COSME,JEAN-MARIE,JULLIAN,LAPLANCHE,+(ORSA)
DRIVER   72 NP B 38 1           +HEINLOTH,HOHNE,HOFMANN,RATHJE,+(DESY+HAMB)
EISENBER 72 PR D 5 15           EISENBERG,BALLAM,DAGAN,+    (REHO+SLAC+TELA)
GRAYER   72 PHIL.CONF.PROC. 5   +HYAMS,JONES,SCHLEIN,BLUM,DIETL+(CERN+MPIM)
GRAYER   72 NP B 50 29          +HYAMS,JONES,WEILHAMMER,BLUM,+  (CERN+MPIM)
JACOBS   72 PR D 6 1291         L.D.JACOBS                         (SACLAY)
RATCLIFF 72 PL 38 B 345         +BULOS,CARNEGIE,KLUGE,LEITH,LYNCH,+  (SLAC)
PROTOPOP 72  PREPRINT LBL-970   PROTOPOPESCU,ALSTON,BARBARO,FLATTE,+  (LBL)
TAKAHASH 72 PR D 6 1266         TAKAHASHI,BARISH,+     (TOHO+PENN+NDAM+ANL)
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$\omega(784)$

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      1  OMEGA (784,JPG=1--) I=0
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                  1  OMEGA MASS (MEV)

           HERE WE LIST ONLY EXPERIMENTS IN WHICH THE EFFECTS
           OF MASS RESOLUTION HAVE BEEN EVALUATED.

M       FROM FINAL STATE K1 K1 OMEGA
M       64  779.4      1.4             ARMENTERO 62 HBC     0.0 PBAR P K1K1
M      155  779.5      1.5             BARASH    67 HBC     0.0 PBAR P K1K1 11/71
M      510  781.0      0.6             BIZZARRI  71 HBC     0.0 P PBAR K1K1 11/71
M           . . . . . . . . . .
M   AVG     780.60     0.52    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

M       FROM OTHER FINAL STATES
M      400  782.0      1.0             ALFF      62 HBC     2.3-2.9 PI+P
M       34  784.0      1.0             ARMENTERO 63 HBC     0.0 PBAR P
M      220  781.0      2.0             KRAEMER   64 DBC     1.2 PI+D
M           785.6      1.2             MILLER D  65 HBC    SEEN WITH K+K-
M      666  786.0      1.0             JAMES     66 HBC     2.1 PI+P         6/66
M     2198  783.4      0.7             BALTAY    67 HBC    0.0 PBAR P        9/66
M           784.8      1.1             KEY       68 HBC     3 PI-P          11/67
M     2400  782.4      0.5             BIZZARRI  69 HBC     0 PBAR P         9/69
M      250  784.       1.              DANBURG   70 DBC     1.2 PI+ D       11/71
M      500  786.       1.              DANBURG   70 DBC     1.4 PI+ D       11/71
M      600  784.       1.              DANBURG   70 DBC     1.7 PI+ D       11/71
M      500  786.       1.              DANBURG   70 DBC     1.9 PI+ D       11/71
M      400  785.       1.              DANBURG   70 DBC     2.1 PI+ D       11/71
M      200  785.       2.              DANBURG   70 DBC     2.3 PI+ D       11/71
M      750  784.1      1.2             ABRAMOVIC 70 HBC     3.9 PI- P        6/70
M           784.0      0.7             ATHERTON  70 HBC    3.6 PBAR P, 7 PI  5/70
M           783.2      1.6             BIGGS     70 CNTR   PHOTOPRODUCTION   6/70
M      260  781.0      2.0             CASON     70 HBC     8.0 PI-P,4PI
M      248  783.4      1.0             BIZZARRI  71 HBC     0.0 P PBAR K+K- 11/71
M   C 4270 (784.1)    (0.3)            COYNE     71 HBC    3.7 PI+ P        11/71
M   C       FROM TOTAL SAMPLE OF COYNE 71                                   11/71
M  D        783.7      1.0             COYNE     71 HBC    3.7 PI+ P        11/71
M  D        FROM BEST-RESOLUTION SAMPLE OF COYNE 71                         11/71
M      369  784.0      1.4             MATTHEWS  71 DBC     6.95 PI+ D       2/71
M      418  782.5      0.8             AGUILAR   72 HBC    3.9,4.6 K- P     12/72*
M           . . . . . . . . . .
M   AVG     783.76     0.28    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.3)
                      (SEE IDEOGRAM BELOW )
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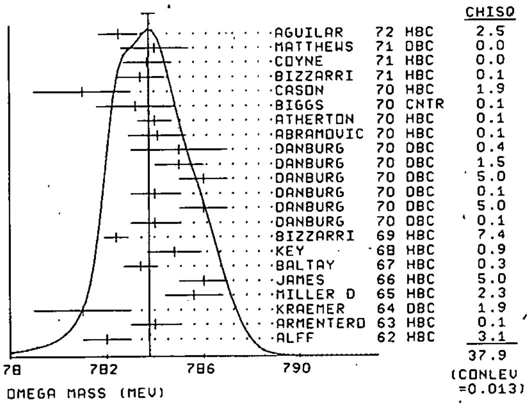
WEIGHTED AVERAGE = 783.76 ± 0.28
ERROR SCALED BY 1.3



0 0 0 0 3 6 0 4 0 0 6

Data Card Listings

For notation, see key at front of Listings.

Mesons
ω(784)

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                    1  OMEGA FULL WIDTH (MEV)

W        34    9.0      3.0          ARMENTERO 63 HBC      0.0 PBAR P
W              13.4.    2.0          MILLER D  65 HBC     SEEN WITH K+ K-
W       155   (12.3)   (2.0)         BARASH    67 HBC     SEEN WITH K1 K1 . 6/66
W    B  171    (5.8)   (2.8)         BARASH    67 HBC     0.0 PBAR P,K1 K1 11/71
W    B         UNFOLDED BY COYNE 71                                       11/71
W       750    8.8      3.0          ABRAMOVIC 70 HBC      3.9 PI- P        6/70
W              11.2     2.7          ATHERTON  70 HBC     3.6 PBAR P, 7 PI  5/70
W       510    10.3     1.4          BIZZARRI  71 HBC     0.0 P PBAR K1K1 11/71
W       248    12.8     3.0          BIZZARRI  71 HBC     0.0 P PBAR K+K- 11/71
W      4270    9.5      1.0          COYNE     71 HBC     3.7 PI+ P        11/71
W       418    13.3     2.           AGUILAR   72 HBC     3.9,4.6 K- P    12/72*
W              9.1      0.8          BENAKSAS1 72 OSPK    E+E- COLL.BEAMS  2/73*
W    E  940    7.70     1.65         BROWN     72 MMS     2.5 PI- P,N MMS 12/72*
W    E    ERROR TAKES ACCOUNT OF SYSTEMATICS ADDED LINEARLY
W              . . . . . . . . . .
W   AVG        9.84     0.51     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.1)
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                    1  OMEGA PARTIAL DECAY MODES

                                                           DECAY MASSES
P1     OMEGA INTO PI+ PI- PIO                              139+ 139+ 134
P2     OMEGA INTO PI+ PI- (VIOLATES G)                     139+ 139
P3     OMEGA INTO PIO GAMMA (ONLY NEUTRAL INPUT TO FIT)    134+   0
P4     OMEGA INTO PI+ PI- GAMMA                            139+ 139+   0
P5     OMEGA INTO 2PIO GAMMA                               134+ 134+   0
P6     OMEGA INTO ETA GAMMA                                548+   0
P7     OMEGA INTO E+ E-                                    .5+  .5
P8     OMEGA INTO MU+ MU-                                  105+ 105
P9     OMEGA INTO ETA PIO (VIOLATES C)                     548+ 134
P10    OMEGA INTO 3 GAMMA                                  0+   0+   0
P11    OMEGA INTO PIO MU+ MU-                              134+ 105+ 105
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FITTED PARTIAL DECAY MODE BRANCHING FRACTIONS

The matrix below is derived from the error matrix for the fitted partial decay mode branching fractions, P_i, as follows: The diagonal elements are $P_i \pm \delta P_i$, where $\delta P_i = \sqrt{(\delta P_i \delta P_i)}$, while the off-diagonal elements are the normalized correlation coefficients $\langle \delta P_i \delta P_j \rangle / (\delta P_i \cdot \delta P_j)$. For the definitions of the individual P_i, see the listings above; only those P_i appearing in the matrix are assumed in the fit to be nonzero and are thus constrained to add to 1.

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         P 1         P 2         P 3
 P 1  .8961+-.0058
 P 2   -.3543   .0130+-.0027
 P 3   -.9269     -.0226  .0909+-.0050

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                    1  OMEGA BRANCHING RATIOS

R1      OMEGA INTO NEUTRAL/(PI+ PI- PIO)                 (P3+...)/(P1)
R1              0.17      0.04          ARMENTERO 63 HBC      0.0 PBAR P
R1        20    0.11      0.02          BUSCHBECK 63 HBC      1.5 K-P
R1        35    0.08      0.03          KRAEMER   64 DBC      1.2 PI+D
R1        65    0.10      0.04          ALFF-STEI 66 HBC CORR.BY SCHULTZ(COL)  9/66
R1       850    0.134     0.026         DIGIUGNO  66 CNTR     1.4 PI-P        9/66
R1       348    0.097     0.016         FLATTE    66 HBC      1.8 K-P         9/66
R1              0.06      0.05    0.02  JAMES     66 HBC      2.1 PI+P        6/66
R1        19    0.10      0.03          BARASH    67 HBC      0.0 PBAR P      7/67
R1        46    0.15      0.04          AGUILAR   72 HBC     3.9,4.6 K- P    12/72*
R1              . . . . . . . . . .
R1   AVG        0.1065    0.0088   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R1   FIT        0.1015    0.0067 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)

R2      OMEGA INTO (PI+ PI-)/(PI+ PI- PIO). SEE ALSO R15 (P2)/(P1)
R2 R            (0.011)OR MORE  CL=.95  ABRAMOVIC 70 HBC      3.9 PI- P     . 6/70
R2 R            (0.035)OR LESS  CL=.95  BIZZARRI  70 DBC      PBAR N AT REST 11/71
R2              (0.019)OR MORE  CL=.95  CHAPMAN   70 HBC    . 1.6-2.2 P PBAR  6/70
R2   F          (.002)OR MORE   CL=.90  FLATTE    70 HBC      1.5    K- P     8/69
R2   F          FLATTE 70 SEES NO SIGNAL AT 1.7, 2.1, 2.6 GEV/C.
R2              (0.0026)OR MORE CL=.84  HAGOPIAN  70 HBC      2.3 PI- P       1/71
R2              (0.040)OR LESS  CL=.84  HAGOPIAN  70 HBC      2.3 PI- P.      1/71
R2 R            0.022     0.009   0.01  ROOS      70 RVUE                     6/70
R2 R            ROOS 70 COMBINES ABRAMOVICH 70 AND BIZZARRI 70
R2              0.028     0.006         BEHREND   71 ASPK     PHOTOPRODUCTION 11/71
R2              (0.0015)OR MORE CL=.95  HAGOPIAN  71 HBC      2.3 PI- P       1/71
R2 S            0.021     0.028   0.009 RATCLIFF  72 ASPK    15.PI- P,N 2PI  12/72*
R2 S     SIGNIFICANT INTERFERENCE EFFECT OBSERVED.NB OF OMEGA INTO 3PI       12/72*
R2 S     COMES FROM AN EXTRAPOLATION.                                        12/72*
R2              . . . . . . . . . .
R2   AVG        0.0259    0.0049   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R2   FIT        0.0145    0.0031 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.5)

R3      OMEGA INTO (PIO GAMMA) / (PI+ PI- PIO)           (P3)/(P1)
R3              (0.125)  (0.025)OR GRTR. BARMIN   64 PXBC     2.8 PI-P
R3              0.13      0.04          JACQUET   69 HLBC                    10/67
R3              0.081     0.020         BALDIN    71 HLBC     2.9 PI+ P      11/71
R3              0.109     0.025         BENAKSAS2 72 OSPK     E+E- COLL.BEAMS  2/73*
R3              . . . . . . . . . .
R3   AVG        0.097     0.015    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R3   FIT        0.1015    0.0067 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)

R4      OMEGA INTO (PI+ PI- GAMMA)/(PI+ PI- PIO)         (P4)/(P1)
R4              (0.05)  OR LESS         FLATTE    66 HBC      1.8 K-P         9/66

R6      OMEGA INTO (MU+ MU-)/(PI+ PI- PIO)(UNITS 10**-3) (P8)/(P1)
R6              (1.2)   OR LESS         GALTIERI  65 HBC      2.7 K-P
R6              (1.7)   OR LESS         FLATTE    66 HBC      1.8 K-P         9/66
R6              (0.2)   OR LESS         WILSON    69 OSPK    12 PI- ON C,FE   9/69

R7      OMEGA INTO (2PIO GAMM)/(PIO GAMMA)               (P5)/(P3)
R7              (0.1)   OR LESS         BARMIN    64 PXBC     1.3-2.8 PI-P
R7              (0.45)   (0.33)         STRUGALSK 69 HLBC     2.34 PI+ N      8/69
R7              (0.14)  OR LESS         BALDIN    71 HLBC     2.9 PI+ P      11/71
R7              (0.15)  OR LESS  CL=.90 BENAKSAS2 72 OSPK     E+E- COLL. BEAMS  2/73*

R8      OMEGA INTO (ETA PIO + ETA GAMMA)/(PI+ PI- PIO)   (P9+P6)/(P1)
R8              (0.017)OR LESS          FLATTE    66 HBC      1.8 K-P         9/66
R8              (0.045)OR LESS  CL=.95  JACQUET   69 HLBC                     4/70

R9      OMEGA INTO (NEUTRALS) / (CHARGED)                (P3+...)/(P1+P2...)
R9              0.124     0.021         FELDMAN   67 OSPK     1.2 PI- P       3/67
R9              . . . . . . . . . .
R9   FIT        0.1000    0.0067 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)

R10     OMEGA INTO (2PIO GAMMA)/(PI+PI-PIO)              (P5)/(P1)
R10             (0.08) OR LESS  CL=.95  JACQUET   69 HLBC                     4/70

R11     OMEGA INTO (ETA GAMMA)/(PIO GAMMA)               (P6)/(P3)
R11             (0.58)   (0.30)         STRUGALSK 69 HLBC     2.34 PI+ N      8/69
R11             (0.40) OR LESS          BALDIN    71 HLBC     2.9 PI+ P      11/71
R11             0.010     0.045         APEL      72 OSPK    4-8 PI- P,N 3GAM  2/73*
R11             (0.27) OR LESS  CL=.90  BENAKSAS2 72 OSPK     E+E- COLL. BEAMS  2/73*

R12     OMEGA INTO (PIO MU+ MU-) / TOTAL (UNITS 10**-3)  (P11)
R12             (2.)   OR LESS          WEHMANN   68 OSPK    12 PI- FE        6/68

R13     OMEGA INTO (E+ E-)/TOTAL (UNITS 10**-4)          (P7)
R13        3    2.        1.2           BINNIE    65 OSPK     PI-P NEAR THLD.  6/66
R13 B           MASS RESOLUTION OF BINNIE 65 IS ABOUT 15 MEV.
R13 H           (1.0)     (1.7)    (0.75) HERTZBACH 67 OSPK ASSUME SU(3)+MIXING.10/66
R13 H           NOT RESOLVED  FROM RHO DECAY.
R13 A     33    (0.65)    (0.13)        ASTVACATU 68 OSPK ASSUME SU(3)+MIXING  6/68
R13 A           NOT RESOLVED  FROM  RHO  DECAY. ERROR STATISTICAL ONLY.
R13             0.40      0.21          BOLLINI1  68 CNTR     1.7PI-P,NOTE Z   9/68
R13 Z           MASS RESOLUTION OF BOLLINI 1 IS +-10 MEV.HIS ERROR IS +-.15
R13 Z           WITHOUT RHO-OMEGA INTERFERENCE. COMPLETE INTERFERENCE WOULD
R13 Z           CHANGE VALUE BY +-35 PER CENT. THEREFORE WE INCREASED ERROR.
R13 E           (0.76)    (0.14)        AUGUSTI1  69 OSPK     SEE NOTE E       2/72
R13 E    FROM E+ E- COLLIDING BEAMS, ASSUMING OMEGA WIDTH 12.2+-1.3 MEV        4/69
R13             0.83      0.10          BENAKSAS1 72 OSPK     E+E- COLL.BEAMS  2/73*
R13             . . . . . . . . . .
R13 AVG         0.76      0.17     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.9)

R14     OMEGA INTO NEUTRALS / TOTAL                      (P3+...)
R14             0.084     0.015         BOLLINI   68 CNTR     2.1 PI- P        6/68
R14             0.079     0.019         DEINET    69 OSPK     1.5 PI- P        9/69
R14             0.075     0.025         BIZZARRI  71 HBC      0.0 P PBAR      11/71
R14       42    0.073     0.018         BASILE    72 CNTR     1.67 PI- P       2/73*
R14             . . . . . . . . . .
R14 AVG         0.0788    0.0092   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R14 FIT         0.0909    0.0055 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)

R15     OMEGA INTO (PI PI)/(TOTAL). SEE ALSO R2          (P2)
R15             0.032     0.028    0.019 AUGUSTI2 69 OSPK      E+E- COLL.BEAMS  8/69
R15             (0.003)OR MORE  CL=.95  GOLDHABER 69 HBC       3.7-4.0 PI+P   11/69
R15             (0.014)OR MORE  CL=.95  ALLISON   70 HBC      1.3-1.7 PBAR P  . 6/70
R15             0.0080    0.0028   0.0022BIGGS    70 CNTR     PHOTOPRODUCTION  6/70
R15             0.0122    0.0030        ALVENSLEB 71 CNTR     PHOTOPRODUCTION 11/71
R15             0.013     0.012    0.009 MOFFEIT  71 HBC      2.8,4.7 GAMMA P 11/71
R15             0.036     0.024    0.018 BENAKSAS 72 OSPK      E+E- COLL.BEAMS 12/72*
R15             . . . . . . . . . .
R15 AVG         0.0102    0.0019   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R15 FIT         0.0130    0.0027 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.5)

R16     OMEGA INTO (ETA GAMMA) / (ALL NEUTRALS)          (P6)/(P3+...) .
R16             (0.24) OR LESS  CL=.90  DEINET    69 OSPK                      9/69
R16             (0.36) OR LESS  CL=.90  DAKIN     72 OSPK     1.4 PI- P,N MMO 12/72*

R17     OMEGA INTO (2 PIO GAMMA) / (ALL NEUTRALS)        (P5)/(P3+...)
R17             (0.19) OR LESS  CL=.90  DEINET    69 OSPK                      9/69
R17 D           (0.22)    (0.07)        DAKIN     72 OSPK     1.4 PI- P,N MMO 12/72*
R17 D           SEE R18

R18     OMEGA INTO (PIO GAMMA) / (ALL NEUTRALS)          (P3)/(P3+...)
R18             (0.81) OR MORE  CL=.90  DEINET    69 OSPK                      9/69
R18 D           (0.78)    (0.07)        DAKIN     72 OSPK     1.4 PI- P,N MMO 12/72*
R18 D        ERROR STATISTICAL ONLY.AUTHORS OBTAIN GOOD FIT ALSO ASSUMING     11/71
R18 D        PIO GAMMA AS THE ONLY NEUTRAL DECAY.                             11/71
****** ********* ********* ********* ********* ********* ********* *********
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REFERENCES FOR OMEGA


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MAGLIC    61 PRL 7 178         B MAGLIC,ALVAREZ,ROSENFELD,STEVENSON  (LRL)
PEVSNER   61 PRL 7 421         PEVSNER,KRAEMER,NUSSBAUM,RICHARD+(JHU+NWES)
XUONG     61 PRL 7 327         NGUYEN HUU XUONG,GERALD R LYNCH        (LRL)

ALFF      62 PRL 9 325         ALFF,BERLEY,COLLEY,GELFAND + (COLU+RUTGERS)
ARMENTER  62 CERN CONF 90      R ARMENTEROS,R BUDDE +       (CERN+CDEF+EPOL)
STEVENSO  62 PR 125 687        STEVENSON,ALVAREZ,MAGLIC,ROSENFELD     (LRL)

ARMENTER  63 SIENA CONF 1 296  ARMENTEROS,EDWARDS,JACOBSEN+    (CERN+CDEF)
BARMIN    63 SIENA CONF 1 207  BARMIN,DOLGOLENKO,KRESTNIKOV+        (ITEP)
BUSCHBEC  63 SIENA CONF 1 166  BUSCHBECK,CZAPP+    (VIENNA+CERN+AMSTERDAM)
GELFAND   63 PRL 11 436        GELFAND,MILLER,NUSSBAUM,RATAU+   (COLU+RUTG)
MURRAY    63 PL 7 358          MURRAY,FERROLUZZI,HUWE,SHAFER,SOLMITZ+(LRL)

BARMIN    64 JETP 18 1289      BARMIN,DOLGOLENKO,KRESTNIKOV +       (ITEP)
KRAEMER   64 PR 136 B 496      KRAEMER,MADANSKY,MEER+        (JHU+NWES+WOOD)

BINNIE    65 PL 18 348         BINNIE,DUANE,JANE,W JONES+       (LOIC+MCHS)
GALTIERI  65 PRL 14,279        A BARBARO GALTIERI,R D TRIPP           (LRL)
MILLER D  65 CU-237(NEVIS 131) DAVID C MILLER  (THESIS)          (COLUMBIA)
    INCLUDES DATA OF GELFAND 63 ABOVE
ALFF-STE  66 PR 145 1072       ALFF-STEINBERGER,BERLEY,BRUGGER+(COLU+RUTG)
ZDANIS    65 PRL 14 721        ZDANIS,MADANSKY,KRAEMER,HERTZBACH+(JHU+BNL)

DIGIUGNO  66 NC 44A 1272       DI GIUGNO,PERUZZI,TROISE+  (NAPL+FRAS+TRST)
FLATTE    66 PR  145  1050     +HUWE,MURRAY,BUTTON-SHAFER,SOLMITZ+    (LRL)
JAMES     66 PR 142 896        F E JAMES,KRAYBILL          (YALE+BROOKHAVEN)

BALTAY    67 PRL  18  93       +FRANZINI,SEVERIENS,YEH,ZANELLO  (COLUMBIA)
BARASH    67 PR  156  1399     BARASH,KIRSCH,MILLER,TAN         (COLUMBIA)
FELDMAN   67 PR 159 1219       +FRATI,GLEESON,HALPERN,NUSSBAUM+     (PENN)
HERTZBAC  67 PR 155, 1461      HERTZBACH,KRAEMER,MADANSKI,ZDANIS+(JHU+BNL)
    ALSO 65 ZDANIS

ASTVACAT  68 PL 27 B  45       ASTVACATUROV,AZIMOV,BALDIN+   (JINR+MOSCOW)
BOLLINI   68 NC 56 A 531       +BUHLER,DALPIAZ,MASSAM+      (CERN+BGNA+STRB)
BOLLINI1  68 NC 57 A 404       +BUHLER,DALPIAZ,MASSAM+      (CERN+BGNA+STRB)
KEY       68 PR 166 1430       +PRENTICE+COOPER+MANNER       (TNTO+ANL+WISC)
PISUT     68 NP B 6 325        J.PISUT,M.ROOS                        (CERN)
WEHMANN   68 PRL 20 748        +ENGELS+ (HARVARD+CASE+SLAC+CORNELL+MCGILL)

AUGUSTI1  69 PL 28 B 513       +BENAKSAS,BUON,GRACCO,HAISSINSKI,+  (ORSAY)
AUGUSTI2  69 LNC 2 214         +LEFRANCOIS,LEHMANN,MARIN,+         (ORSAY)
BIZZARRI  69 NP B 14 169       +FOSTER,GAVILLET,MONTANET,+     (CERN+CDEF)
DANBURG   69 UCRL-19275        JEROME S. DANBURG, THESIS             (LRL)
    ALSO DANBURG 70
```

Mesons
ω(784), M(940), M(953), η'(958)

Data Card Listings
For notation, see key at front of Listings.


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DEINET   69 PL 30 B 426        +MENZIONE,MULLER,BUNIATOV+        (KARL+CERN)
ERWIN    69 NP B 9 364         +WALKER,GOSHAW,WEINBERG      (WISC+PRIN+VAND)
GOLDHABE 69 PRL 23,1351        +BUTLER,COYNE,HALL,MACNAUGHTON,TRILING(LRL)
JACQUET  69 NC 63 A 743        +NGUYEN-KHAC,HAATUFT,HALSTEINSLI(EPOL+BERG)
MILLER   69 PR 178 2061        R.MILLER,LICHTMAN,WILLMANN           (PURDUE)
STRUGALS 69 PL 29 B 532        +CHUVILO,FENYVES,+           (WARS+JINR+BUDA)
WILSON   69 PRIVATE COMM.      RICHARD WILSON (SEE ALSO PR 178 2095)(HARV)

ABRAMOVI 70 NP B 20 209        ABRAMOVICH,BLUMENFELD,BRUYANT,+        (CERN)
BIZZARRI 70 PRL 25 1385        +CIAPETTI,DORE,GASPERO,GUIDONI,+(ROMA+SYRA)
ALLISON  70 PRL 24 618         +COOPER,FIELDS,RHINES                   (ANL)
ATHERTON 70 NP B 18 221        +BLAIR,CELNIKER,DOMINGO,FRENCH+  (CERN+IPN)
BIGGS    70 PRL 24 1201        +CLIFFT,GABATHULER,KITCHING,RAND       (DARE)
CASON    70 PR D 1 851         +ANDREWS,BISWAS,GROVES,HARRINGTON,+  (NDAM)
CHAPMAN  70 NP B 24 445        +DAVIDSON,GREEN,LYS,ROE,VANDER VELDE (MICH)
DANBURG  70 PR D 2 2564        +ABOLINS,DAHL,DAVIES,HOCH,KIRZ,MILLER+(LRL)
FLATTE   70 PR D 1 1           STANLEY M. FLATTE                       (LRL)
GOLDHABE 70 PHILA.CONF.P.59    GERSON GOLDHABER,REVIEW                 (LRL)
HAGOPIAN 70 PRL 25 1050        S. AND V.HAGOPIAN,BOGART,SELOVE  (FSU+PENN)
ROOS     70 DNPL/R7 P.173      PROC. DARESBURY STUDY WEEKEND NO 1.  (CERN)

ABRAMS   71 PR D 4 653         +BARNHAM,BUTLER,COYNE,GOLDHABER,HALL,+(LBL)
ALVENSLE 71 PRL 27 888         ALVENSLEBEN,BECKER,BUSZA,CHEN,COHEN,+(DESY)
ANGELOW  71 SJNP 12 427        +GRAMENITSKY,KANASIRSKY,KERATSCHEW,+ (JINR)
BALDIN   71 SJNP 13 758        +YERGAKOV,TREBUKHOVSKY,SHISHOV         (ITEP)
BARDADIN 71 PR D4 2711         BARDADIN-OTWINOWSKA,HOFMOKL,MICHEJDA+(WARS)
BEHREND  71 PRL 27 61          +LEE,NORDBERG,WEHMAN,+       (ROCH+CORN+NAL)
BIZZARRI 71 NP B 27 140        +MONTANET,NILSSON,D-ANDLAU,+    (CERN+CDEF)
BLOODWOR 71 NP B 35 133        BLOODWORTH,JACKSON,PRENTICE,YOON  (TORONTO)
CHAPMAN  71 PR D 3 38          +FORTNEY,FOWLER                        (DUKE)
COYNE    71 NP B 32 333        +BUTLER,FANG-LANDAU,MACNAUGHTON         (LRL)
FIELDS   71 PRL 27 1749        +COOPER,RHINES,ALLISON              (ANL+OXF)
HAGOPIAN 71  BAPS 16           S.HAGOPIAN                        (FSU+PENN)
LEFRANCO 71  PREPRINT LAL1256 J.LEFRANCOIS                         (ORSAY)
MATTHEWS 71 PRL 26 400         +PRENTICE,YOON,CARROLL,WALKER,+ (TNTO+WISC)
MOFFEIT  71 NP B 29 349        +BINGHAM,FRETTER,BALLAM+(LRL+UCB+SLAC+TUFT)

AGUILAR  72 PR D 6 29          AGUILAR-BENITEZ,CHUNG,EISNER,SAMIOS   (BNL)
APEL     72 PL 41 B 234        +AUSLANDER,MULLER,BERTOLUCCI,+  (KARL+PISA)
BASILE   72 PHIL.CONF.PROC153 +BOLLINI,BROGLIN,DALPIAZ,FRABETTI,+  (CERN)
BENAKSAS 72 PL 39 B 289        +COSME,JEAN-MARIE,JULLIAN,LAPLANCHE,+(ORSA)
BENAKSAS172 PL 42 B 507        +COSME,JEAN-MARIE,JULLIAN,LAPLANCHE+(ORSAY)
BENAKSAS272 PL 42 B 511        +COSME,JEAN-MARIE,JULLIAN,LAPLANCHE+(ORSAY)
BROWN    72 PL 42 B 117        +DOWNING,HOLLOWAY,HULD,BERNSTEIN+(ILL+ILLC)
DAKIN    72 PR D 6 2321        +HAUSER,KREISLER,MISCHKE         (PRINCETON)
EISENBER 72 PR D 5 15          EISENBERG,BALLAM,DAGAN,+   (REHO+SLAC+TELA)
RATCLIFF 72 PL 38 B 345        +BULOS,CARNEGIE,KLUGE,LEITH,LYNCH,+  (SLAC)
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M(940) →MM

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                    66  M(940)

                    EVIDENCE NOT COMPELLING.OMITTED FROM TABLE.

                    66  M(940) MASS  (MEV)

M  N   55  940.5      1.7            CHESHIRE  72 MMS   0 2.4 PI- P,N MM   12/72*
M  N   NOT SEEN BY BINNIE 72 AT THRESHOLD.

                    66  M(940) WIDTH  (MEV)

W  N   55  (10.4)  OR LESS  CL=.90   CHESHIRE  72 MMS   0 2.4 PI- P,N MM   12/72*

                    66  M(940) BRANCHING RATIOS

R1     M(940) INTO (NEUTRAL)/(TWO-CHARGE)/(FOUR-CHARGE)
R1             0.12      0.86     0.02 CHESHIRE  72 MMS   0 2.4 PI- P,N MM   12/72*
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REFERENCES FOR M(940)


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CHESHIRE 72 PRL 28 520         +HOFFMAN,GARFINKEL,+          (IOWA+ANL+PURD)
BINNIE   72 PL 39 B 275        +CAMILLERI,DUANE,GARBUTT,BURTON+(LOIC+SHMP)
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M(953) $\to \gamma\pi^+\pi^-$ $\not\to \gamma\rho^0$

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                    59  M (953,JPG=  +)

                    WHILE MASS AND WIDTH ARE CONSISTENT WITH THOSE OF
                    THE ETA PRIME(958), THE (PI+ PI- GAMMA) DECAY DOES
NOT SHOW A RHOO SIGNAL, UNLIKE THE ETA PRIME. THIS IS TAKEN AS EVIDENCE
FOR A NEW PARTICLE. WHILE THIS DIFFERENCE IN DALITZ PLOT DISTRIBUTIONS
APPEARS SIGNIFICANT, IT STILL NEEDS FURTHER CONFIRMATION TO BE REGARDED
AS WELL ESTABLISHED. POSSIBLY SEEN IN MMS .
                    OMITTED FROM TABLE.

                    59  M MASS (MEV)

M       68  953.0      2.0                AGUILAR   70 HBC    3.9-4.6K-P,P K-M  1/71
M   M      (953.4)    (1.5)     (3.8)     MAGLICH   71 MMS    3.8 P D,HE3 XO    2/72
M   M   MISSING MASS SPECTRUM SHOWED THIS PEAK AT 953.4 INSTEAD OF
M   M   ETA PRIME (958).  PEAK LISTED UNDER M BECAUSE OF MASS
M   M   COINCIDENCE.  THE 1.5 MEV ERROR MAY BE UNDERESTIMATED BY
M   M   A FACTOR OF 2 (SEE BRODY 72, TABLE III).  OBSERVED PEAK COULD
M   M   THEN WELL CORRESPOND TO ETA PRIME.

                    59  M WIDTH (MEV)

W       68  (10.0)  OR LESS  CL=.95   AGUILAR   70 HBC    3.9-4.6K-P,P K-M  1/71
W   M       (15.)   OR LESS           MAGLICH   71 MMS    3.8 P D,HE3 XO    2/72

                    59  M PARTIAL DECAY MODES

                                                          DECAY MASSES
P1     M INTO PI+ PI- GAMMA                               139+ 139+   0
P2     M INTO RHOO GAMMA                                  770+   0
P3     M INTO PI+ PI- ETA                                 139+ 139+ 548
P4     M INTO PIO ETA                                     134+ 548
P5     M INTO PI+ PI- PIO                                 139+ 139+ 134

                    59  M BRANCHING RATIOS

R1     M INTO (RHOO GAMMA)/(ALL PI+ PI- GAMMA)            (P2)/(P1)
R1      58     0.05      0.1          AGUILAR   70 HBC    3.9-4.6K-P,P K-M  1/71

R2     M INTO (PI+ PI- GAMMA)/(PI+ PI- ETA NEUTR.)        (P1)/(P3N)
R2      58     1.2       0.3          AGUILAR   70 HBC    3.9-4.6K-P,P K-M  1/71

R3     M INTO (PI+ PI- PIO)/TOTAL                         (P5)
R3      58     NOT OBSERVED           AGUILAR   70 HBC    3.9-4.6K-P,P K-M  1/71

R4     M INTO (PIO ETA NEUTR.)/TOTAL                      (P4N)
R4      58     NOT OBSERVED           AGUILAR   70 HBC    3.9-4.6K-P,P K-M  1/71
```

REFERENCES FOR M


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AGUILAR  70 PRL 25 1635        AGUILAR-BENITEZ,BASSANO,SAMIOS,BARNES+(BNL)

MAGLICH  71 PRL 27 1479        +OOSTENS,BRODY,CVIJANOVICH (RUTG+PENN+UPNJ)
ROSNER   71 PRL 26 933         J.L.ROSNER,E.W.COLGLAZIER          (MINN+CIT)

AGUILAR  72 PR D 6 29          AGUILAR-BENITEZ,CHUNG,EISNER,SAMIOS   (BNL)
BRODY    72 UPR-3E.SUBM.TO PR +GROVES,NOREM,CVIJANOVICH,+(PENN+RUTG+UPNJ)
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η'(958)

```
        2  ETA PRIME (958,JPG=0-+) I=0

           KNOWN ALSO AS XO
```

Note on the J^P Assignment of η' (958)

From the Dalitz plot analyses of the $\eta' \to \pi\pi\eta$ and $\eta' \to \pi^+\pi^-\gamma$ decays, and from the observation of a $\eta' \to \gamma\gamma$ decay mode, all assignments except $J^{PC} = 0^{-+}$ and 2^{-+} are excluded. The Dalitz plot analyses favor spin 0 but cannot rule out spin 2. However, various attempts to find evidence for a spin different from zero, by searching for anisotropies in η' decay, were unsuccessful. The most complete study was made by DANBURG 72 with about 1000 η' decays from the reaction $K^-p \to \eta'\Lambda$ at 2.2 GeV/c. This number of events was sufficient to make cuts on momentum transfer and Λ polarization angle. No η' decay anisotropies or correlations were found. This is rather suggestive evidence that the η' spin is indeed zero. Presumably an Adair-type analysis could be used to settle this question unambiguously.

```
                    2  ETA PRIME MASS (MEV)

M   O   ONLY EXPERIMENTS GIVING ERROR LESS THAN 3 MEV KEPT FOR AVERAGING    12/72*
M       85 (957.0)                   DAUBER    64 HBC     1.95 K-P
M   K      (958.0)    (1.0)          KALBFLEIS 64 HBC     2.7 K-P            6/66
M   K      KALBFLEISCH 64 SUPERSEDED BY RITTENBERG 69
M   O      (957.0)    (3.0)          BADIER    65 HBC     3.0 K-P
M        8  960.0      2.0           TRILLING  65 HBC     3.65 PI+ P         9/66
M   O    7 (955.0)   (10.0)          COHN      66 DBC     3.3 PI+D           6/66
M   O      (959.0)    (3.0)          LONDON    66 HBC     2.2 K-P            6/66
M   O      (960.0)    (5.0)          MOTT      69 HBC     4.1-5.5 K- P       7/69
M           957.       1.            RITTENBER 69 HBC     1.7-2.7 K- P       9/69
M           956.0      2.0           AGUILAR   70 HBC     3.9-4.6K-P         1/71
M     3415  956.1      1.1           BASILE1   71 CNTR    1.6 PI- P,N XO    11/71
M      535  957.4      1.4           BASILE1   71 CNTR    1.6 PI- P,N XO    11/71
M           958.4      0.3           DANBURG   72 HBC     2.2 K- P,L XO     12/72*
M          . . . . . . . . . .
M   AVG     958.11     0.37    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.4)
                       (SEE IDEOGRAM BELOW )
```

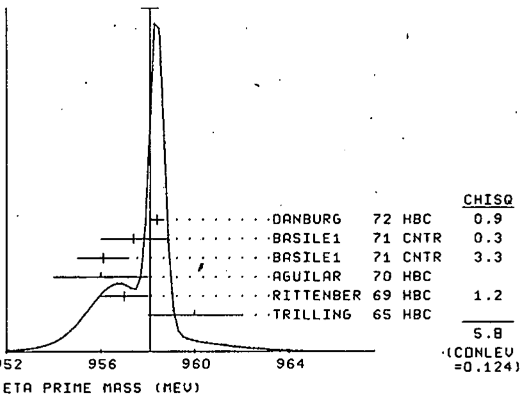
Data Card Listings

For notation, see key at front of Listings.

Mesons

$\eta'(958)$

WEIGHTED AVERAGE = 958.11 ± 0.37
ERROR SCALED BY 1.4




```
2  ETA PRIME WIDTH (MEV)

W       85   (4.0)   OR LESS            DAUBER    64 HBC    1.95 K-P
W   K        (7.0)   OR LESS            KALBFLEIS 64 HBC    2.7 K-P            6/66
W   K        KALBFLEISCH 64 SUPERSEDED BY RITTENBERG 69
W            (30.0)  OR LESS            BADIER    65 HBC    3.0 K-P
W            (15.0)  OR LESS            LONDON    66 HBC    2.2 K-P            6/66
W            (10.)   OR LESS            RITTENBER 69 HBC    1.7-2.7 K- P
W            (20.0)  OR LESS            AGUILAR   70 HBC    3.9-4.6K-P         1/71
W     3415   (8.)    OR LESS  CL=.90    BASILE1   71 CNTR   1.6 PI- P,N XO    11/71
W            (3.8)   OR LESS  CL=.90    DANBURG   72 HBC    2.2 K- P,L XO     12/72*
```

```
2  ETA PRIME PARTIAL DECAY MODES

                                                        DECAY MASSES
P1     ETA PRIME INTO PI+ PI- ETA                      139+ 139+ 548
                      P1(N)  ETAS DECAY INTO ALL NEUTRALS
                      P1(C)  ETAS DECAY CHARGED
P2     ETA PRIME INTO PIO PIO ETA                      134+ 134+ 548
                      P2(N)  ETAS DECAY INTO ALL NEUTRALS
                      P2(C)  ETAS DECAY CHARGED
P3     ETA PRIME INTO PI+ PI- GAMMA                    139+ 139+   0
                      (INCLUDING RHO GAMMA)
P4     ETA PRIME INTO GAMMA GAMMA                        0+   0
P6     ETA PRIME INTO RHOO GAMMA                         0+ 770
P10    ETA PRIME INTO PI+ PI- E+ E-                    139+ 139+  .5+  .5
P11    ETA PRIME INTO 2 PI                             139+ 139
P12    ETA PRIME INTO 3 PI                             139+ 139+ 134
P13    ETA PRIME INTO 4 PI                             139+ 139+ 139+ 139
P14    ETA PRIME INTO 5 PI
P15    ETA PRIME INTO 6 PI
P16    ETA PRIME INTO PIO E+ E- (VIOLATES C IN         134+  .5+  .5
                                      BORN APPROX.)
P17    ETA PRIME INTO ETA E+ E- (VIOLATES C IN         548+  .5+  .5
                                      BORN APPROX.)
P18    ETA PRIME INTO PIO RHO 0 (VIOLATES C)           134+ 770
P19    ETA PRIME INTO PIO OMEGA (VIOLATES C)           134+ 783
```

FITTED PARTIAL DECAY MODE BRANCHING FRACTIONS

The matrix below is derived from the error matrix for the fitted partial decay mode branching fractions, P_i, as follows: The diagonal elements are $P_i \pm \delta P_i$, where $\delta P_i = \sqrt{\langle \delta P_i \delta P_i \rangle}$, while the off-diagonal elements are the normalized correlation coefficients $\langle \delta P_i \delta P_j \rangle / (\delta P_i \cdot \delta P_j)$. For the definitions of the individual P_i, see the listings above; only those P_i appearing in the matrix are assumed in the fit to be nonzero and are thus constrained to add to 1.

```
        P 1          P 2          P 3          P 4
P 1 .4719+-.0342
P 2   -.3506    .2465+-.0207
P 3   -.6026     -.5278    .2622+-.0350
P 4    .0217     -.1663      .0036   .0194+-.0029
```

Note on η' (958) Branching Fractions

In our calculation of the branching fractions of the η' (958) we assume the decay modes $\eta\pi\pi$ (including $\eta\pi^0\pi^0$, 71% of the η's have neutral decays), $\rho^0\gamma$, and $\gamma\gamma$.

In the fit we do not use the constraint

$$R = \Gamma(\eta' \to \eta\pi^+\pi^-)/\Gamma(\eta' \to \eta\pi^0\pi^0) = 2$$

from I-spin conservation. The result of the fit is in agreement with it, R = 1.9 ± 0.2.

```
2  ETA PRIME BRANCHING RATIOS

R1      ETA PRIME INTO (PI+ PI-ETA (NEUTRAL DEC.))/TOTAL (PIN)
R1  K   68   (0.36)   (0.05)          KALBFLEIS 64 HBC     2.7 K-P           10/66
R1  K        KALBFLEISCH 64 SUPERSEDED BY RITTENBERG 69
R1     281    0.314    0.026          RITTENBER 69 HBC     1.7-2.7 K-P        9/69
R1           . . . . . . . . . .
R1  FIT       0.336    0.024  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 2.0)

R2      ETA PRIME INTO (PI+ PI- NEUTRALS) / TOTAL          (P1N+P2C)
R2      33    0.35     0.06           BADIER    65 HBC     3.0 K-P           10/66
R2      39    0.4      0.1            LONDON    66 HBC     2.2 K-P           10/66
R2           . . . . . . . . . .
R2  AVG       0.363    0.051   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R2  FIT       0.407    0.023  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 2.3)

R3      ETA PRIME INTO (PI+ PI- ETA (CHRGD.DECAY))/TOTAL (PIC)
R3  K   44   (0.12)   (0.02)          KALBFLEIS 64 HBC     2.7 K-P           10/66
R3  K        KALBFLEISCH 64 SUPERSEDED BY RITTENBERG 69
R3       7    0.07     0.04           BADIER    65 HBC     3.0 K-P           10/66
R3      10    0.1      0.04           LONDON    66 HBC     2.2 K-P           10/66
R3     107    0.123    0.014          RITTENBER 69 HBC     1.7-2.7 K-P        9/69
R3           . . . . . . . . . .
R3  AVG       0.116    0.013   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R3  FIT       0.1364   0.0099 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 2.0)

R4      ETA PRIME INTO (PI+ PI- NEUTRALS (EXCLUDING        (P2C)
R4           PI+ PI- ETA (NEUTR.DEC.))) / TOTAL
R4  K   10   (0.05)   (0.04)          KALBFLEIS 64 HBC     2.7 K-P           10/66
R4  K        KALBFLEISCH 64 SUPERSEDED BY RITTENBERG 69
R4      42    0.045    0.029          RITTENBER 69 HBC     1.7-2.7 K-P        9/69
R4           . . . . . . . . . .
R4  FIT       0.0712   0.0060 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R5      ETA PRIME INTO (NEUTRALS) / TOTAL                  (P2N+P4)
R5  K   54   (0.25)   (0.05)          KALBFLEIS 64 HBC     2.7 K-P           10/66
R5  K        KALBFLEISCH 64 SUPERSEDED BY RITTENBERG 69
R5      16    0.24     0.17           BADIER    65 HBC     3.0 K-P           10/66
R5      32    0.3      0.1            LONDON    66 HBC     2.2 K-P           10/66
R5     123    0.189    0.026          RITTENBER 69 HBC     1.7-2.7 K-P        9/69
R5     535    0.185    0.022          BASILE1   71 CNTR   1.6 PI- P,N XO    11/71
R5           . . . . . . . . . .
R5  AVG       0.190    0.016   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R5  FIT       0.195    0.025  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.8)

R6      ETA PRIME INTO (PI+ PI- GAMMA (INCLUDING RHO GAMMA))/TOTAL
R6                                                         (P3)
R6  K   42   (0.22)   (0.04)          KALBFLEIS 64 HBC     2.7 K-P           10/66
R6  K        KALBFLEISCH 64 SUPERSEDED BY RITTENBERG 69
R6      35   (0.34)   (0.09)          BADIER    65 HBC     3.0 K-P           10/66
R6      20    0.2      0.1            LONDON    66 HBC     2.2 K-P           10/66
R6     298    0.329    0.033          RITTENBER 69 HBC     1.7-2.7 K-P        9/69
R6           . . . . . . . . . .
R6  AVG       0.316    0.038   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.2)
R6  FIT       0.262    0.035  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 2.2)

R7      ETA PRIME INTO (PI+ PI- GAMMA (INCLUDING RHO GAMMA))/(PI PI ETA)
R7                                                         (P3)/(P1+P2)
R7            0.25     0.14           DAUBER    64 HBC     1.95 K-P          10/66
R7           . . . . . . . . . .
R7  FIT       0.365    0.065  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 2.1)

R8      ETA PRIME INTO (PIO E+ E-)/TOTAL                   (P16)
R8           (0.013)OR LESS           RITTENBER 65 HBC          2.7 K-P      10/66

R9      ETA PRIME INTO (ETA E+ E-)/TOTAL                   (P17)
R9           (0.011)OR LESS           RITTENBER 65 HBC          2.7 K-P      10/66

R10     ETA PRIME INTO (PIO RHOO)/TOTAL                    (P18)
R10          (0.04) OR LESS           RITTENBER 65 HBC          2.7 K-P      10/66

R11     ETA PRIME INTO (PIO OMEGA) /TOTAL                  (P19)
R11          (0.08) OR LESS           RITTENBER 65 HBC          2.7 K-P      10/66

R12     ETA PRIME INTO (PI+ PI- E+ E-)/TOTAL               (P10)
R12          (0.006)OR LESS           RITTENBER 65 HBC          2.7 K-P      10/66

R13     ETA PRIME INTO (2 PI)/TOTAL                        (P11)
R13          (0.07) OR LESS           LONDON    66 HBC     COMPILATION       10/66

R14     ETA PRIME INTO (3 PI)/TOTAL                        (P12)
R14          (0.07) OR LESS           LONDON    66 HBC     COMPILATION       10/66

R15     ETA PRIME INTO (4 PI)/TOTAL                        (P13)
R15          (0.01) OR LESS           LONDON    66 HBC     COMPILATION       10/66

R16     ETA PRIME INTO (6 PI)/TOTAL                        (P15)
R16          (0.01) OR LESS           LONDON    66 HBC     COMPILATION       10/66

R18     ETA PRIME INTO (RHOO GAMMA)/(PI PI ETA)            (P6)/(P1+P2)
R18           0.31     0.15           DAVIS     68 HBC     5.5 K- P           9/68
R18          . . . . . . . . . .
R18 FIT       0.365    0.065  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 2.1)

R19     ETA PRIME INTO (2 GAMMA)/TOTAL                     (P4)
R19      5    0.055    0.036   0.030 BOLLINI   68 CNTR    1.9 PI- P         12/72*
R19      7    0.126    0.075         BENSINGER 70 DBC     2.2 PI+ D         12/72*
R19 S   41   (0.017)  (0.004)        BASILE2   71 CNTR    1.6 PI- P,N XO    12/72*
R19 S   SUPERSEDED BY DALPIAZ 72
R19     31    0.020    0.008   0.006 HARVEY    71 OSPK    3.65 PI- P,N XO   11/71
R19     68    0.0171   0.0033        DALPIAZ   72 CNTR    1.6 PI- P,N XO    12/72*
R19          . . . . . . . . . .
R19 AVG       0.0181   0.0030  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R19 FIT       0.0194   0.0029 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R20     ETA PRIME INTO (PI+PI-)/TOTAL                      (P11)
R20          (0.02) OR LESS           RITTENBER 69 HBC     1.7-2.7 K-P        9/69

R21     ETA PRIME INTO (PI+PI-PIO)/TOTAL                   (P12)
R21          (0.05) OR LESS           RITTENBER 69 HBC     1.7-2.7 K-P        9/69

R22     ETA PRIME INTO (PI+PI+PI-PI-)/TOTAL                (P13)
R22          (0.01) OR LESS           RITTENBER 69 HBC     1.7-2.7 K-P        9/69

R23     ETA PRIME INTO (PI+PI+PI-PI-PIO)/TOTAL             (P14)
R23          (0.01) OR LESS           RITTENBER 69 HBC     1.7-2.7 K-P

R24     ETA PRIME INTO (PI+PI+PI-PI- NEUTRALS)/TOTAL       (P16+...)
R24          (0.01) OR LESS           RITTENBER 69 HBC     1.7-2.7 K-P        9/69

R25     ETA PRIME INTO (RHOO GAMMA)/(ALL PI+ PI- GAMMA)    (P6)/(P3)
R25           0.94     0.20           AGUILAR   70 HBC     3.9-4.6K-P         1/71
R25          (1.1)    (0.1)           DANBURG   72 HBC     2.2 K- P,L XO     12/72*
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Mesons
$\eta'(958)$, $\delta(970)$


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R26     ETA PRIME INTO (PIO PIO ETA INTO 3 PIO)/TOTAL    (P2N(3PIO))
R26      4    0.11      0.06          BENSINGER 70 DBC     2.2 PI+ D          1/71
R26              . . . . . . . . . .
R26 FIT        0.0739   0.0062 FROM FIT (ERROR INCLUDES SCALE-FACTOR OF 1.0)

R27     ETA PRIME INTO (PI+ PI- GAMMA)/(PI+ PI- ETA(NEUTRAL DEC.))
R27                                                  (P3)/(P1N)
R27             0.54     0.10          AGUILAR   72 HBC     3.9,4.6 K- P     12/72*
R27            (0.81)   (0.09)         DANBURG   72 HBC     2.2 K- P,L XO   . 2/73*
R27              . . . . . . . . . .
R27 FIT         0.78     0.15   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 2.3)

R28     ETA PRIME INTO(2 GAMMA)/(PIO PIO ETA(NEUTRAL DEC.)
R28                                                  (P4)/(P2(N))
R28      16 .  0.188    0.058          APEL      72 OSPK    3.8 PI- P,N XO    1/73*
R28              . . . . . . . . . .
R28 FIT        0.111    0.054  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 2.8)

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                              REFERENCES FOR ETA PRIME

DAUBER   64 PRL 13 449          DAUBER,SLATER,SMITH,STORK,TICHO       (UCLA)JP
    ALSO 64 DUBNA CONF 1 418    DAUBER,SLATER,L T SMITH,STORK,TICHO  (UCLA)
GOLDBERG 64 PRL 12 546          +GUNDZIK,LICHTMAN,CONNOLLY,HART,+(SYRA+BNL)
GOLDBERG 64 PRL 13 249          +GUNDZIK,LEITNER,CONNOLLY,HART,+ (SYRA+BNL)
KALBFLEI 64 PRL 13 349          G.R.KALBFLEISCH,O.DAHL,A.RITTENBERG    (LRL)JP

BADIER   65 PL 17 337           BADIER,DEMOULIN,BARLOUTAUD+(EPOL+SACL+ZEEM)
KIENZLE  65 PL 19 438           KIENZLE,MAGLIC,LEVRAT,LEFEBVRES +     (CERN)
RITTENBE 65 PRL 15 556          RITTENBERG,KALBFLEISCH             (LRL+BNL)
TRILLING 65 PL 19 427           +BROWN,GOLDHABERS,KADYK,SCANIO          (LRL)

COHN     66 PL 21 347           COHN,MCCULLOCH,BUGG,CONDO  (ORNL+TENN+UCND)
LONDON   66 PR 143 1034         LONDON,RAU,SAMIOS,GOLDBERG + (BNL+SYRACUSE)IJP
MARTIN   66 PL 22,352           MARTIN,CRITTENDEN,SCHROEDER      (INDIANA U)I

BARBARO- 68 PRL 20 349          BARBARO-GALTIERI,MATISON,RITTENBERG+  (LRL)I=0
BARLOUTA 68 PL 26 B  674        BARLOUTAUD+     (SACLAY+AMST+BGNA+REHO+EPOL)I=0
BOLLINI  68 NC 58 A  289        +BUHLER,DALPIAZ,MASSAM+      (CERN+BGNA+STRB)
DAVIS    68 PL 27 B 532         +AMMAR,MOTT,DAGAN,DERRICK,FIELDS (NWES+ANL)

DUFEY    69 PL 29 B 605         +GOBBI,POUCHON,CNOPS,+      (ETHZ+CERN+SACL)IJP
MOTT     69 PR 177 1966         +AMMAR,DAVIS,KROPAC,SLATE,DAGAN+ (NWES+ANL)
RITTENBE 69  UCRL-18863         ALAN RITTENBERG (THESIS)             (LRL)I=0

AGUILAR  70 PRL 25 1635         AGUILAR-BENITEZ,BASSANO,SAMIOS,BARNES+(BNL)
BENSINGE 70 PL 33 B 505         BENSINGER,ERWIN,THOMPSON,W.D.WALKER  (WISC)

BARDADIN 71 PR D4 2711          BARDADIN-OTWINOWSKA,HOFMOKL,MICHEJDA+(WARS)
BASILE1  71 NC 3 A 371          +BOLLINI,DALPIAZ,FRABETTI,+(CERN+BGNA+STRB)
BASILE2  71 NP B 33 29          +BOLLINI,DALPIAZ,FRABETTI,+(CERN+BGNA+STRB)
HARVEY   71 PRL 27 885          +MARQUIT,PETERSON,RHOADES,+      (MINN+MICH)
OGIEVETS 71 PL 25 B 69          OGIEVETSKY,TYBOR,ZASLAVSKY            (DUBNA)

AGUILAR  72 PR D 6 29           AGUILAR-BENITEZ,CHUNG,EISNER,SAMIOS   (BNL)
APEL     72 PL 40 B 680         +AUSLANDER,MULLER,BERTOLUCCI,+  (KARL+PISA)
BINNIE   72 PL 39 B 275         +CAMILLERI,DUANE,GARBUTT,BURTON+(LOIC+SHMP)
BLOODWOR 72 NP B 39 525         BLOODWORTH,JACKSON,PRENTICE,YOON  (TORONTO)
DALPIAZ  72 PL 42 B 377         +FRABETTI,MASSAM,NAVARRIA,ZICHICHI   (CERN)
DANBURG  72 PHIL.CONF.PROC.     +BORENSTEIN,KALBFLEISCH,CHAPMAN,+(BNL+MICH)
RADER    72 PR D 6 3059         +ABOLINS,DAHL,DANBURG,DAVIES,HOCH,+    (LBL)
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$\delta(970)$ $\rightarrow \eta\pi, \cdots$

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36  DELTA(970,JPG=0+-) .I=1
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Under this entry, we list three types of I = 1 peaks near $K\bar{K}$ threshold.

1) Missing-mass peaks, some of them controversial.
2) $\eta\pi$ decays, peaking slightly below $K\bar{K}$ threshold. This defines $I^G = 1^-$ and J^P = Normal.
3) Threshold enhancements in the $(K\bar{K})^\pm$ system with I = 1. The Q value is low and J^P therefore probably 0^+.

In listing them together under a common entry we do not imply that they are necessarily all related. However, the $K\bar{K}$ threshold enhancement may be due to a virtual bound state that could also be responsible for the $\eta\pi$ peaks (ASTIER 67). More complete studies of the mass dependence of the $K\bar{K}$ threshold effect, using coupled channel analysis, are needed to clarify this question.

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                   36  DELTA(970) MASS  (MEV)

M  PEAKS SEEN IN MISSING MASS EXPERIMENTS
M   K  262 (962.0)    (5.0)           KIENZLE   65 MMS   -  3-5 PI- P          9/66
M   K    NOT SEEN BY BANNER1 67 (1.8 PI- P)
M   O       (966.0)    (8.0)          OOSTENS   66 MMS  +  3.8 PP TO D + MM   9/66
M   O    NOT SEEN BY BANNER2 67 AND ANDERSON 71
M            975.0      6.0           ABOLINS   70 MMS  +  3.8-6.3 PP--D+MM   1/71
M   N  215 (962.9)    (1.7)           CHESHIRE  72 MMS   0 2.4 PI- P,N MM    12/72*
M   N    NOT SEEN BY BINNIE 72 AT THRESHOLD.

M  ETA PI FINAL STATE ONLY.
M  S     30  980.0     10.0           AMMAR     68 HBC  +-     ,5.5K-,ETA PI  2/73*
M  S     SEE ALSO AMMAR 70.
M        10 (960.)     APPROX.        CHUNG S   68 HBC   -  3.2 PI-P          5/70
M        80 (975.0)                   DEFOIX    68 HBC  +-  1.2 PB P,ETA PI   3/69
M        20  970.0     15.0           BARNES    69 HBC   -  4-5 K-P,PI-ETA    9/69
M            980.      10.            CAMPBELL  69 DBC  +- 2.7 PI+ D          1/73*
M        15 (980.0)   (10.0)          MILLER    69 HBC   -  4.5 K-N,ETA PI    7/69
M        21  948.0      7.0           BARDADIN  71 HBC  +- 8 PI+P,P DO PI     2/72
M       150  972.      10.            DEFOIX    72 HBC  +- 0.7 PBAR P,7 PI    1/73*
M             . . . . . . . . . .
M   AVG      965.8      7.1     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.7)
                              (SEE IDEOGRAM BELOW )
                    WEIGHTED AVERAGE = 965.8 ± 7.1
                         ERROR SCALED BY 1.7
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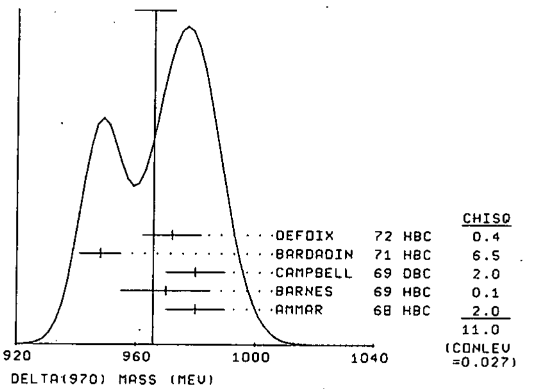


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M  K KBAR ONLY, SEE THE TYPED NOTE ABOVE
M      143(1003.3)      7.0+SYSTEMATIC ROSENFELD 65 RVUE +-                    . 8/66
M            SCAT. LENGTH 2 TO 6 FERMIS.BALTAY    66 HBC        3.7 PBAR P      8/66
M   A  100(1016.)      (10.)              ASTIER    67 HBC  +-  0 PBAR P       . 7/67
M   A    SCATT.LENGTH ALSO FITS, SEE BELOW
M        SCATT.LENGTH +2.5 +-1. FERMI   ASTIER    67 HBC  +-  0-1.2 PBAR P     7/67
M        OR CMPLX, RE PART=-2.3 F       ......    .. ...  ..  ..... .... .     7/67
M                     IM PART=.5F OR LESS ......  .. ...  ..  ..... .... .     7/67
M   B          (1.8)      (0.4)     (0.3)  DUBOC     72 HBC     1.2 PBAR P,3PI2K 12/72*
M   B  ABSOLUTE VALUE OF SCAT.LENGTH                                          12/72*

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                   36  DELTA(970) WIDTH  (MEV)

W  PEAKS SEEN IN MISSING MASS EXPERIMENTS
W   S  262    (5.0)  OR LESS              KIENZLE   65 MMS   -  3-5 PI- P          9/66
W   S        (10.0)  OR LESS              OOSTENS   66 MMS  +  3.8 PP TO D + MM   9/66
W    1        60.0      16.0      10.0    ABOLINS   70 MMS  +  3.8-6.3 PP--D+MM   1/71
W   S  215    (5.9)  OR LESS  CL=.90      CHESHIRE  72 MMS   0 2.4 PI- P,N MM    12/72*
W   S    SEE NOTES ON DELTA MASS ABOVE

W  ETA PI  FINAL STATE ONLY
W        30   80.0      30.0              AMMAR     68 HBC  +-     ,5.5K-,ETA PI  2/73*
W        80  (25.0)                       DEFOIX    68 HBC  +-  1.2 PB P,ETA PI   3/69
W        20  (50.0)  OR LESS              BARNES    69 HBC   -  4-5 K-P,PI-ETA    9/69
W             40.       15.               CAMPBELL  69 DBC  +- 2.7 PI+ D          1/73*
W   R    15  (60.0)    (30.0)             MILLER    69 HBC   -  4.5 K-N,ETA PI    7/69
W   R    21  (31.0)    (28.0)             BARDADIN  71 HBC  +- 8 PI+P,P DO PI  . 2/72
W   R   150  (30.)      (5.)              DEFOIX    72 HBC  +- 0.7 PBAR P,7 PI    1/73*
W   R    RESOLUTION NOT UNFOLDED
W             . . . . . . . . .
W   AVG       48.0      16.0      AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.2)

W  K KBAR ONLY, SEE THE TYPED NOTE ABOVE
W       143  (57.0)    13.0+SYSTEMATIC ROSENFELD 65 RVUE +-                    8/66
W   A   100  (25.) APPROX.                ASTIER    67 HBC  +- SEE NOTE A ABOVE  9/67

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                   36  DELTA(970) PARTIAL DECAY MODES

                                                          DECAY MASSES
P1      DELTA(970)   INTO ETA PI                           548+ 134
P2      DELTA(970)   INTO 3 PI
P3      DELTA(970)   INTO RHO PI                           770+ 134
P4   S  DELTA(970)   INTO K KBAR                           770+ 134
P4   S   SEE THE TYPED NOTE ABOVE                          770+ 134

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                   36  DELTA(970) BRANCHING RATIOS

R1      DELTA(970)   INTO (RHO PI)/(ETA PI)                (P3)/(P2)
R1            (0.25) OR LESS  CL=.70   AMMAR     70 HBC  +- 4.1,5.5K-,ETA PI. 5/70

R10     CHARGED DELTA OF KIENZLE 65 INTO (1 CHARGED)/(3 OR MORE CHARGED)
R10            1.3       0.9       0.7   KIENZLE   65 MMS   -  3-5 PI- P          9/66

R11     DELTA OF CHESHIRE 72 INTO (NEUTRAL)/(TWO-CHARGE)/(FOUR-CHARGE)
R11           (0.10)    (0.82)    (0.08) CHESHIRE  72 MMS   0 2.4 PI- P,N MM    12/72*

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Data Card Listings

For notation, see key at front of Listings.

Mesons

δ(970), H(990), S*(1000), φ(1019)

REFERENCES FOR DELTA

TURKOT 63 SIENNA CONF 1 661 +COLLINS,FUJII,KEMP+ (BNL+PITTSBURGH)

ARMENTER 65 PL 17 344 ARMENTEROS,EDWARDS, JACOBSEN + (CERN+CDEF)
BARASH 65 PR 139 B 1659 +FRANZINI,KIRSCH,MILLER,STEINBERGER+ (COLU)
KIENZLE 65 PL 19 438 + MAGLIC,LEVRAT,LEFEBVRES + (CERN)
ROSENFEL 65 OXFORD CONF 58 A H ROSENFELD (LRL--RVUE)

ALLEN D 66 PL 22 543 +GP FISHER,G GODDEN,L MARSHALL,SEARS (COLO)G=+
BALTAY 66 PR 142 B 932 +LACH,SANDWEISS,TAFT,YEH,STONEHILL+ (YALE)
FOCACCI 66 PRL 17 890 + KIENZLE,LEVRAT,MAGLIC,MARTIN (CERN)
OOSTENS 66 PL 22 708 +CHAVANON,CROZON,TOCQUEVILLE (SACLAY,CDEF)I=1

ALLISON 67 PL 25B 619 +CRUZ+ (OXF+MPIM+BIRM+RHEL+GLAS+LOIC)
ASTIER 67 PL 25 B 294 +MONTANET,BAUBILLIER,DUBOC+(CDEF+CERN+IRAD)
ASTIER 67 INCLUDES DATA OF BARLOW 67,CONFORTO 67,ARMENTEROS 65.
BAILLON 67 NC 50A 393 +EDWARDS+D.ANDLAU+ASTIER+ (CERN+CDEF+IRAD)
BANNER 1 67 PL 25 B 300 +FAYOUX,HAMEL,ZSEMBERY,CHEZE+ (SACLAY+CAEN)
BANNER 2 67 PL 25 B 569 +CHEZE,HAMEL,MAREL,TEIGER+ (CDEF+SACL)
BARLOW 67 NC 50 A 701 +MONTANET,D,ANDLAU+ (CERN+CDEF+IRAD+LIVP)
CONFORTO 67 NP B3 469 CONFORTO,MARECHAL+ (CERN+CDEF+IPNP+LIVP)

AMMAR 68 PRL 21 1832 +DAVIS,KROPAC,DERRICK,FIELDS,+ (NWES+ANL)
CHUNG S 68 PR 165 1491 +O.DAHL, J. KIRZ, D.H.MILLER (LRL)
DEFOIX 68 PL 28 B 253 +RIVET,SIAUD,CONFORTO+ (CDEF+IPNP+CERN)
GALTIERI 68 PRL 20 349 BARBARO-GALTIERI,MATISON,RITTENBERG+ (LRL)
JUHALA 68 PL 27 B 257 +LEACOCK,RHODE,KOPELMAN,LIBBY+ (IOWA+COLO)
SABRE CO 68 PL 26 B 674 BARLOUTAUD+ (SACL+AMST+BGNA+REHO+EPOL)

BARNES 69 PRL 23 610 +CHUNG,EISNER,BASSANO,GOLDBERG+ (BNL+SYRA)
CAMPBELL 69 PRL 22 1204 J.H.CAMPBELL,LICHTMAN,LOEFFLER,+ (PURDUE)
CRENNELL 69 PRL 22 1398 +KARSHON,KWAN WU LAI,+ (BNL+NYU)
JUHALA 69 PR 184 1461 +LEACOCK,RHODE,KOPELMAN,LIBBY,+ (ISU+COLO)
KRUSE 69 PR 177 1951 KRUSE,LOOS,GOLDWASSER (ILLINOIS)
MILLER 69 PL 29 B 255 D.H.MILLER,S.L.KRAMER,D.O.CARMONY,+(PURDUE)
ALSO 69 PR 188 2011 YEN,AMMANN,CARMONY,ELSNER,+ (PURDUE)
SCHROEDE 69 PR 188 2081 SCHROEDER,KERNAN,FISHER,LIBBY,+ (ISU+COLO)

ABOLINS 70 PRL 25 469 +GRAVEN,MCCARTHY,G.SMITH,L.SMITH+ (LRL+UCD)
AMMAR 70 PR D 2 430 +KROPAC,DAVIS,DERRICK+ (KANS+NWES+ANL+WISC)
COOPER 70 NP B 23 605 +HANNER,MUSGRAVE,POLLARD,VOYVODIC (ANL)
YIOU 70 THESIS, A 646 TCHIU-PUNG YIOU (ORSAY)

ANDERSON 71 PRL 26 108 +DIXIT,+ (CHIC+ANL+CARL+LASL+CNRC+NAGOYA)
BARDADIN 71 PR D4 2711 BARDADIN-OTWINOWSKA,HOFMOKL,MICHEJDA+(WARS)

ATHERTON 72 SUBM. TO PL +FRANEK,FRENCH,GHIDINI,HILPERT,+ (CERN)
BINNIE 72 PL 39 B 275 +CAMILLERI,DUANE,GARBUTT,BURTON+(LOIC+SHMP)
CHESHIRE 72 PRL 28 520 +HOFFMAN,GARFINKEL,+ (IOWA+ANL+PURD)
DEFOIX 72 NP B 44 125 +NASCIMENTO,BIZZARRI,+ (CDEF+CERN)
DUBOC 72 NP B 46 429 +GOLDBERG,MAKOWSKI,DONALD,+ (LPNP+LIVP)
HOLLOWAY 72 PHIL.CONF.PROC.133+HULO,KOETZ,KRUSE,BERNSTEIN,+ (ILL+ILLC)

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H(990)

35 H (990,JPG=A -) I=0

→ THE EVIDENCE OF BENSON 66 HAS DISAPPEARED AFTER RE-ANALYSIS (CHAUDHARY 70). NO STATISTICALLY SIGNIFICANT EVIDENCE FOR THE PRE-1968 H-ENHANCEMENT THEREFORE REMAINS (BARBARO-GALTIERI 69). HOWEVER, GOLDHABER 69 REPORT A NEW (PI+PI-PIO) ENHANCEMENT AT ABOUT THE SAME MASS, M=1000 MEV, SEEN UNDER CONDITIONS DIFFERENT FROM THOSE OF THE EARLIER OBSERVATIONS. OMITTED FROM TABLE.

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REFERENCES FOR H

BARTSCH 64 PL 11 167 AACHEN-ZEUTHEN-BIRM-BONN-HAMB-MUNCHEN COLL
GOLDHABE 65 CORAL GABLES P.76 G. GOLDHABER (LRL)
BENSON 66 PRL 17 1234 +MARQUIT,ROE,SINCLAIR,VANDER VELDE (MICH)IJP
COHN 67 NP B1 57 +MC CULLOCH,BUGG,CONDO (ORNL+UNIV.TENN)
ROSENFEL 67 RMP 39 1,APPENDIX ROSENFELD,BARBARO-GALTIERI+(LRL+CERN+YALE)
ARMENISE 68 PL 26B 336 +GHIDINI,FORINO+ (BARI+BGNA+FIRZ+ORSAY)
BARBARO- 68 PHILAD.CONF.P.137 A.BARBARO-GALTIERI,P.SODING (LRL)
FUNG 68 PRL 21 47 +JACKSON+PU+BROWN+GIDAL (U.C.RIVERS+LRL)
GOLDHABE 69 LUND CONF.P.271 G.GOLDHABER QUOTED BY B.MAGLIC (LRL)
CHAUDHAR 70 PR D 2 2110 B.CHAUDHARY,E.MARQUIT (MINNESOTA)
GORDON 70 COO 1195 179 THESIS,ILLINOIS (ILL)
MICHAEL 72 PRL 28 1475 W.MICHAEL,G.GIDAL (LBL)

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S*(1000)

3 S* (1000,JPG=0++) I=0

WE ONLY LIST DETERMINATIONS OF POLE POSITION. FOR EARLY WORK USING BREIT-WIGNER OR SCATTERING LENGTH PARAMETRIZATION IN FITS TO THE (K KBAR) MASS SPECTRUM SEE REFERENCE SECTION AND OUR 1972 EDITION.

S-wave $K\bar{K}$ Interactions in the Region 990-1200 MeV

Under this entry we list parameters of the S^* pole in the $I^G(J^P)C = 0^+(0^+)+$ wave. For discussion, see the entry "S-wave ππ interactions," near the beginning of these Meson Data Card Listings.

Note that possible evidence of D-wave ππ interactions in the S^* region is listed separately under $\eta_N(1080)$.

3 REAL PART OF THE S* POLE POSITION (MEV)

M	H	970.	30.	130.	HOANG	69 OSPK	4. PI-P,KS KS N	1/73*
M	H	920.	80.	90.	HOANG	69 OSPK	5. PI-P,KS KS N	1/73*
M	H	CALCULATED FROM SCATTERING LENGTH FIT OF HOANG 69.						
M	B	(965.)			BEUSCH	70 OSPK	4,6 PI-P	1/73*
M	B	CALCULATED FROM SCATTERING LENGTH FIT OF BEUSCH 70.						
M		(996.0)			BASDEVANT	72 RVUE	SHEET 2	1/73*
M		997.	5.		PROTOPOPE	72 HBC	SHEET 2 7. PI+ P	1/73*
M		. . . .						
M	AVG	996.6	5.0	AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)				

3 NEGATIVE IMAG. PART OF THE S* POLE POSITION (MEV)
CORRESPONDS TO HALF-WIDTH, NOT FULL WIDTH.

W	H	40.	40.	60.	HOANG	69 OSPK	4. PI-P,KS KS N	1/73*
W	H	30.	30.	70.	HOANG	69 OSPK	5. PI-P,KS KS N	1/73*
W	B	(13.)			BEUSCH	70 OSPK	4,6 PI-P	1/73*
W		(65.0)			BASDEVANT	72 RVUE		1/73*
W	P	27.	8.		PROTOPOPE	72 HBC	7. PI+ P	1/73*
W	P	ANOTHER SOLUTION HAS 52 MEV AND NO EPSILON POLE.						
W		. . . .						
W	AVG	27.4	7.8	AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)				

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REFERENCES FOR S*

WANG 61 JETP 13 323 WANG TSU-TSENG,VEKSLER,VRANA,+ (JINR)
BIGI 62 CERN CONF 247 A BIGI,S BRANDT, R CARRARA + (CERN)
BINGHAM 62 CERN CONF 240 H H BINGHAM,M BLOCH + (EPOL+CERN)
ERWIN 62 PRL 9 34 ERWIN,HOYER,MARCH,WALKER,WANGLER (WISC+BNL)
BALTAY 64 DUBNA CONF 1 409 BALTAY,LACH,CRENNELL,OREN,STUMP +(YALE+BNL)
BARMIN 64 DUBNA CONF 1 433 BARMIN,DOLGOLENKO,YEROFEEV,KRESTNI+ (ITEP)
CRENNELL 66 PRL 16 1025 CRENNELL,KALBFLEISCH,LAI,SCARR,SCHU+ (BNL)
HESS 66 PRL 17 1109 +DAHL+HARDY+KIRZ+MILLER (LRL)

BARLOW 67 NC 50A 701 +LILLESTOL+MONTANET+ (CERN+CDEF+IRAD+LIVP)
BEUSCH 67 PL 25 B 357 +FISCHER,GOBBI,ASTBURY+ (ETHZ+CERN)
DAHL 67 PR 163 1377 +HARDY+HESS+KIRZ+MILLER (LRL)
ALITTI 68 PRL 21 1705 +BARNES,CRENNELL,FLAMINIO,GOLDBERG,+ (BNL)
LAI 68 PHILAD.CONF.P.303 KWAN WU LAI (BNL)
PHELAN 68 THESIS JAMES J. PHELAN (ANL+ST.LOUIS UNIV)
ALSO 68 PRL 21 316 HOANG,EARTLY,PHELAN,ROBERTS+(ANL+CHIC+NDAM)
AGUILAR- 69 PL 29 B 241 M.AGUILAR-BENITEZ,J.BARLOW,+ (CERN+CDEF)
ALSO 67 BARLOW
ALSO 69 NP B 14 195 M.AGUILAR-BENITEZ,J.BARLOW,+ (CERN+CDEF)
HOANG 69 NC 61 A 325 T.F.HOANG (ANL)
HOANG 69 PR 184 1363 +EARTLY,PHELAN,ROBERTS,+ (ANL+ILLC)

BADIER 70 NP B 22 512 +BONNET,DREVILLON,BAUBILLIER,+ (EPOL+IPNP)
BATON 70 PL 33 B 528 +LAURENS,REIGNIER (SACLAY)
BEUSCH 70 PHILA.CONF.P.185 W.BEUSCH (ETHZ+CERN)
HYAMS 70 PHILA.CONF.P.41 +KOCH,BEUSCH,+ (CERN+MPIM+ETHZ+LOIC+HAWA)
ALSO 70 NP B 22 189 HYAMS,KOCH,POTTER,VON LINDERN,+ (CERN+MPIM)
OH 70 PR D 1 2494 +GARFINKEL,MORSE,WALKER,PRENTICE(WISC+TNTO)
ALSTON-G 71 PL 36 B 152 ALSTON-GARNJOST,BARBARO-GALTIERI,+ (LBL)

BASDEVAN 72 PL 41 B 178 BASDEVANT,FROGGATT,PETERSEN (CERN)
DAMERI 72 NC 9 A 1 +BORZATTA,GOUSSU,+ (GENO+MILA+SACL)
DUBOC 72 NP B 46 429 +GOLDBERG,MAKOWSKI,DONALD,+ (LPNP+LIVP)
FLATTE 72 PL 38 B 232 +ALSTON-GARNJOST,BARBARO-GALTIERI,+ (LBL)
GRAYER 72 PHIL.CONF.PROC. 5 +HYAMS,JONES,SCHLEIN,BLUM,DIETL+(CERN+MPIM)
PROTOPOP 72 PREPRINT LBL-970 PROTOPOPESCU,ALSTON,BARBARO,FLATTE,+ (LBL)
WILLIAMS 72 PR D 6 3178 P.K.WILLIAMS (FSU)

FUJII 73 NC 13 A 311 Y.FUJII,M.KATO (TOKYO)

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φ(1019)

4 PHI (1019,JPG=1--) I=0

4 PHI MASS (MEV)

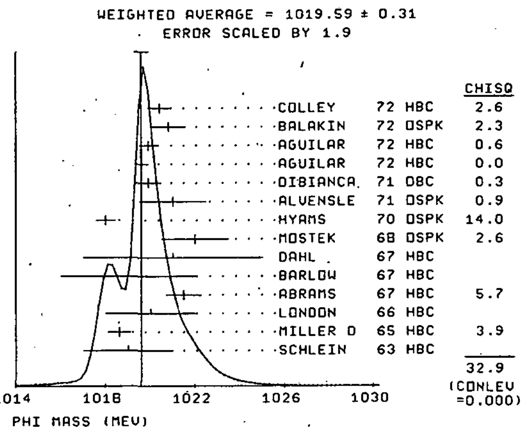
M		1019.0	2.0		SCHLEIN	63 HBC	2.0 K- P	
M		1018.6	0.5		MILLER D	65 HBC	0.0 PBAR P	8/66
M		1020.0	2.0		LONDON	66 HBC	2.2 K-P	6/66
M		1021.5	0.8		ABRAMS	67 HBC	4.2 K- P	11/67
M		1019.	3.		BARLOW	67 HBC	1.2 PBAR P	11/66
M		1021.0	4.0		DAHL	67 HBC	1-4 PI- P	9/66
M	165	1022.	1.5		MOSTEK	68 OSPK	1.8 GAMMA + C	6/68
M		1018.	0.5	0.35	HYAMS	70 OSPK	11. PI- P	6/70
M		(1020.)	(1.)		SABRE	70 DBC	3.0 K- N	1/71
M		1021.0	1.5		ALVENSLE	71 OSPK	GAMMA+C	1/72
M		1019.9	0.6		DIBIANCA	71 DBC	4.93 K- N	1/72
M	410	(1019.9)	(0.3)		STOTTLEMY	71 HBC	2.9 K-P,Y K KBAR	11/71
M	120	1019.6	0.3		AGUILAR	72 HBC	3.9,4.6 K- P	12/72*
M	100	1019.9	0.4		AGUILAR	72 HBC	3.9,4.6 K- P	12/72*
M	87	1020.8	0.8		BALAKIN	72 OSPK	E+ E- COLL.BEAMS	12/72*
M	131	1020.4	0.5		COLLEY	72 HBC	10.K+ P,K+ P PHI	12/72*
M		. . . .						
M	AVG	1019.59	0.31	AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.9) (SEE IDEOGRAM BELOW)				

4 PHI WIDTH (MEV)

W			3.5	1.0		MILLER D	65 HBC	0.0 PBAR P	8/66
W			6.0	4.0		LONDON	66 HBC	2.2 K-P	6/66
W			1.8	3.0	1.5	ABRAMS	67 HBC	4.2 K- P	11/67
W			(10.)	OR LESS		BARLOW	67 HBC	1.2 PBAR P	11/66
W		165	(4.5)	(3.0)	(2.0)	MOSTEK	68 OSPK	1.8 GAMMA + C	6/68
W		150	4.2	0.9		AUGUSTIN	69 OSPK	E+ E- COLL.BEAMS	12/72*
W			4.09	0.29		BIZOT	70 OSPK	E+ E- COLL.BEAMS	12/72*
W			3.3	1.5	0.9	HYAMS	70 OSPK	11. PI- P	6/70
W			4.67	0.42		BALAKIN	71 OSPK	E+ E- COLL.BEAM	11/71
W			5.5	1.3	1.1	DIBIANCA	71 DBC	4.93 K- N	1/72
W	S		(4.7)	(0.7)		LEFRANCOI	71 OSPK	E+E- COLL. BEAMS	2/73*
W	S	SUPERSEDED BY JEAN-MARIE 73.							
W		110	(4.5)	(3.0)	(4.0)	STOTTLEMY	71 HBC	2.9 K-P,Y K KBAR	11/71
W		120	4.6	1.0	0.8	AGUILAR	72 HBC	3.9,4.6 K- P	12/72*
W		100	4.7	1.3	1.0	AGUILAR	72 HBC	3.9,4.6 K- P	12/72*
W		131	5.0	1.3		COLLEY	72 HBC	10.K+ P,K+ P PHI	12/72*
W			3.81	0.34		JEAN-MARI	73 OSPK	E+E- COLL.BEAMS	2/73*
W			. . . .						
W	AVG		4.16	0.17	AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)				

Mesons
$\phi(1019)$

Data Card Listings
For notation, see key at front of Listings.

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                    4  PHI PARTIAL DECAY MODES

                                                          DECAY MASSES
P1     PHI INTO K+ K-                                     493+ 493
P2     PHI INTO KL KS                                     497+ 497
P3     PHI INTO PI+ PI- PIO (INCLUDING RHO PI)            139+ 139+ 134
P4     PHI INTO ETA GAMMA                                 548+   0
P5     PHI INTO E+ E-                                      .5+  .5
P6     PHI INTO MU+ MU-                                   105+ 105
P7     PHI INTO PIO GAMMA                                 134+   0
P8     PHI INTO PI+ PI- (VIOLATES G)                      139+ 139
P9     PHI INTO PI+PI-GAMMA                               139+ 139+   0
P10    PHI INTO OMEGA GAMMA (VIOLATES C)                  783+   0
P11    PHI INTO ETA PIO (VIOLATES C)                      548+ 134
P12    PHI INTO RHO GAMMA (VIOLATES C)                    770+   0
P13    PHI INTO ETA NEUTRALS
P14    PHI INTO 5PI
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FITTED PARTIAL DECAY MODE BRANCHING FRACTIONS

The matrix below is derived from the error matrix for the fitted partial decay mode branching fractions, P_i, as follows: The diagonal elements are $P_i \pm \delta P_i$, where $\delta P_i = \sqrt{\langle \delta P_i \delta P_i \rangle}$, while the off-diagonal elements are the normalized correlation coefficients $\langle \delta P_i \delta P_j \rangle / (\delta P_i \cdot \delta P_j)$. For the definitions of the individual P_i, see the listings above; only those P_i appearing in the matrix are assumed in the fit to be nonzero and are thus constrained to add to 1.

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         P 1        P 2        P 3        P 4
 P 1 .4675+-.0258
 P 2   -.3525   .3496+-.0272
 P 3   -.3805     -.6557  .1524+-.0304
 P 4   -.1338     -.1588     -.1287  .0305+-.0107

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                    4  PHI BRANCHING RATIOS

R1      PHI INTO (K+ K-)/TOTAL                             (P1)
R1   B   27   (0.26)   (0.06)       BADIER    65 HBC                       10/66
R1      252    0.48     0.04        LINDSEY   66 HBC      2.7 K-P          10/66
R1   C        (0.493)  (0.044)      BIZOT     70 OSPK   E+ E- COLL.BEAMS 11/71
R1   C SUPERSEDED BY CHATELUS 71                                           11/71
R1             0.540    0.034       BALAKIN   71 OSPK   E+ E- COLL.BEAM  11/71
R1             0.486    0.044       CHATELUS  71 OSPK   E+ E- COLL.BEAMS 11/71
R1            . . . . . . . . . .
R1   AVG       0.507    0.022   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R1   FIT       0.468    0.026 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.6)

R2 .    PHI INTO (KL KS)/TOTAL                             (P2)
R2   B   25   (0.23)   (0.06)       BADIER    65 HBC                       10/66
R2      167    0.40     0.04        LINDSEY   66 HBC      2.7 K-P          10/66
R2             0.257    0.038       BALAKIN   71 OSPK   E+ E- COLL.BEAMS.  1/73*
R2            . . . . . . . . . .
R2   AVG       0.325    0.071   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 2.6)
R2   FIT       0.350    0.027 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.6)

R3      PHI INTO (PI+ PI- PIO (INCL.RHO PI))/TOTAL         (P3)
R3       30    0.12     0.08        LINDSEY   66 HBC      2.7 K-P         .10/66
R3            . . . . . . . . . .
R3   FIT       0.152    0.030 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.5)

R5      PHI INTO (KL KS)/(K KBAR)                          (P2)/(P1+P2)
R5       10    0.40     0.10        SCHLEIN   63 HBC      2.0 K-P          10/66
R5   .   52    0.48     0.07        BADIER    65 HBC      3.0 K-P          11/67
R5             0.44     0.07        LONDON    66 HBC      2.2 K-P         .10/66
R5            . . . . . . . . . .
R5   AVG       0.448    0.044   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R5   FIT       0.428    0.027 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.6)

R6      PHI INTO (PI+ PI- PIO (INCL.RHO PI))/(K KBAR)      (P3)/(P1+P2)
R6             0.30     0.15        LONDON    66 HBC      2.2 K-P          10/66
R6            . . . . . . . . . .
R6   FIT       0.187    0.044 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.5)

R7      PHI INTO (PI+ PI- PIO (INCL.RHO PI))/(KL KS)       (P3)/(P2)
R7            (0.3)  OR LESS        BERLEY    65 HBC      2.9 PI+P         10/66
R7             0.69     0.14        BIZOT1    70 OSPK   E+ E- COLL.BEAM    1/71
R7            . . . . . . . . . .
R7   FIT       0.44     0.11  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.5)

R8      PHI INTO (PI+ PI-)/(K KBAR) (SEE ALSO R18)         (P8)/(P1+P2)
R8           (0.2)  OR LESS         LONDON    66 HBC      2.2 K-P          10/66

R9      PHI INTO (E+ E-)/(K+ K-) (UNITS 10**-4)            (P5)/(P1)
R9       (SEE ALSO R16)
R9       40    6.1      1.7         BECKER    68 CNTR        GAMMA C        9/68

R10     PHI INTO (MU+ MU-)/TOTAL (UNITS 10**-4)            (P6)
R10           3.5      3.5     1.8  WEHMANN   68 OSPK    12 K- C            6/68
R10           2.34     1.01         MOY       69 CNTR     PHOTOPROD.       11/70
R10           2.17     0.60         EARLES    70 CNTR    6.0 BREMSSTR.     11/70
R10           2.69     0.46         HAYES     71 CNTR   PHOTOPROD.        .11/71
R10          . . . . . . . . . .
R10 AVG       2.50     0.34    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

R11     PHI INTO (ETA GAMMA)/TOTAL                         (P4)
R11          (0.2)  OR LESS         BADIER    65 HBC      3.0 K-P          10/66
R11          (0.08) OR LESS         LINDSEY   66 HBC      2.7 K-P          10/66
R11 A    10  (0.020)  (0.0075)      BENAKSAS  70 OSPK        E+ E-          2/72
R11 A    SUPERSEDED BY BENAKSAS2 72.
R11      27   0.073    0.019        BASILE    72 CNTR    1.8 PI- P         12/72*
R11      25   0.026    0.007        BENAKSAS2 72 OSPK   E+E- COLL.BEAMS    2/73*
R11          . . . . . . . . . .
R11 AVG       0.032    0.015   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 2.3)
R11 FIT       0.030    0.011  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.6)

R12     PHI INTO (PI+ PI- GAMMA)/(K KBAR)                  (P9)/(P1+P2)
R12          (0.05) OR LESS         LINDSEY   65 HBC      2.7 K-P          10/66

R13     PHI INTO (ETA NEUTRALS)/(K KBAR)                   (P13)/(P1+P2)
R13          (0.15) OR LESS         LINDSEY   66 HBC      2.7 K-P          10/66

R14     PHI INTO (OMEGA GAMMA) / TOTAL                     (P10)
R14          (0.05) OR LESS         LINDSEY   66 HBC      2.7 K-P          10/66

R15     PHI INTO (RHO GAMMA) / TOTAL                       (P12)
R15          (0.02) OR LESS         LINDSEY   66 HBC      2.7 K-P          10/66

R16     PHI INTO (E+ E-)/TOTAL (UNITS 10**-4)              (P5)
R16      (SEE ALSO R9)
R16 A     5   (6.6)    (4.4)   (2.8)  ASTVACATU 68 OSPK   4 PI- P          6/68
R16 A    ERROR OF ASTVACATUROV 68 DOES NOT INCLUDE SIGMA(PHI) UNCERTAINTY.  6/68
R16      27   7.2      3.9          BINNIE    68 OSPK   1.6 PI- P          6/68
R16       9   6.1      2.6          BOLLINI   68 CNTR   1.9 PI- P          9/68
R16 C        (3.45)   (0.27)        BIZOT     70 OSPK   E+ E- COLL.BEAMS 11/71
R16 C SUPERSEDED BY CHATELUS 71                                          11/71
R16           2.81     0.25         BALAKIN   71 OSPK    E+ E- COLL.BEAM 11/71
R16           3.50     0.27         CHATELUS  71 OSPK   E+ E- COLL.BEAMS 11/71
R16          . . . . . . . . . .
R16 AVG       3.15     0.34    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.9)

R17     PHI INTO (PIO GAMMA)/(TOTAL)                       (P7)
R17          (.0035)OR LESS         BEMPORAD  69 CNTR    5.5 GAMMA N        7/69
R17 A        (0.0024)OR LESS CL=.95 BENAKSAS  70 OSPK        E+ E-          2/72
R17 A    SUPERSEDED BY BENAKSAS2 72
R17       7  (0.0025) (0.0012)      BENAKSAS2 72 OSPK   E+E- COLL. BEAMS   2/73*

R18     PHI INTO (PI+ PI-)/(TOTAL) (UNITS 10**-4)          (P8)
R18      (SEE ALSO R8)
R18        (500.)   OR LESS         LINDSEY2  65 HBC    1.7-2.7 K-P
R18         (50.)   OR LESS  CL=.95 BIZOT2    70 OSPK   E+ E- COLL.BEAMS 11/71
R18         (80.)   OR LESS  CL=.95 BALAKIN   71 OSPK    E+ E- COLL.BEAM  1/71
R18          (2.7)  OR LESS  CL=.95 ALVENSLE  72 OSPK   GAMMA+C            1/72

R19     PHI INTO (KL KS)/(K+ K-)                           (P2)/(P1)
R19     144   0.89     0.10         AGUILAR   72 HBC    3.9,4.6 K- P      12/72*
R19     125   1.15     0.15         COLLEY    72 HBC    10.K+ P,K+ P PHI  12/72*
R19          . . . . . . . . . .
R19 AVG       0.97     0.12    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.4)
R19 FIT       0.748    0.082  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.6)

R20     PHI INTO (PI+ PI- PIO(INCL.RHO PI)/(K+ K-)         (P3)/(P1)
R20      34   0.28     0.09         AGUILAR   72 HBC    3.9,4.6 K- P      12/72*
R20          . . . . . . . . . .
R20 FIT       0.326    0.074  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.4)

R21     PHI INTO (2PI+ 2PI- PIO)/(K+ K-)
R21          (0.02) OR LESS  CL=0.95 AGUILAR  72 HBC    3.9,4.6 K- P      12/72*

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REFERENCES FOR PHI


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BERTANZA 62 PRL 9 180           BERTANZA,BRISSON,CONNOLLY,HART + (BNL+SYRA)
GELFAND  63 PRL 11 438          GELFAND,MILLER,NUSSBAUM,KIRSCH+ (COLU+RUTG)
  GELFAND 63 DATA INCLUDED IN MILLER 65 BELOW
SCHLEIN  63 PRL 10 368          SCHLEIN,SLATER,SMITH,STORK,TICHO     (UCLA)

BADIER   65 PL 17 337           BADIER,DEMOULIN,BARLOUTAUD+     (SACL+ZEEM)
BERLEY   65 PR 139 B 1097       D BERLEY,N GELFAND            (BNL+COLUMBIA)
GALTIERI 65 PRL 14 279          A BARBARO GALTIERI,R D TRIPP          (LRL)
LINDSEY  65 PRL 15 221          JAMES S LINDSEY,GERALD A SMITH        (LRL)
  LINDSEY 65 DATA INCLUDED IN LINDSEY 66 BELOW
LINDSEY2 65 UCRL 16526          JAMES S. LINDSEY (THESIS)             (LRL)
MILLER D 65 CU-237(NEVIS 131) DAVID C MILLER  (THESIS)          (COLUMBIA)

GRAY, L  66 PRL  17  501        +HAGERTY,BIZZARRI,CIAPETTI +    (SYRA+ROMA)JPG
LINDSEY  66 PR  147  913        JAMES S LINDSEY, GERALD A SMITH       (LRL)
LINDSEY1 66 PL 20 93            J.S.LINDSEY, G.A.SMITH                (LRL)
  LINDSEY 1 66 DATA INCLUDED  IN LINDSEY 66 ABOVE
LONDON   66 PR 143 1034         LONDON,RAU,SAMIOS,GOLDBERG + (BNL+SYRACUSE)

ABRAMS   67 MD TECH REP 720     GERALD ABRAMS , THESIS           (MARYLAND)
BARLOW   67 NC 50A 701          +LILLESTOL+MONTANET+  (CERN+CDEF+IRAD+LIVP)
CHASE    67 PRL 18 710          R.C.CHASE,P.ROTHWELL,R.WEINSTEIN (CEA+NEAS)
DAHL     67 PR 163 1377         +HARDY+HESS+KIRZ+MILLER               (LRL)
HERTZBAC 67 PR 155  1461        HERTZBACH,KRAEMER,MADANSKI,ZDANIS+(JHU+BNL)
KHACHATU 67 PL 24B 349          KHACHATURYAN+AZIMOV+BALDIN+BELOUSOV+(DUBNA)

ABRAMS   68 PR 175 1697         +GLASSER,KEHOE,SECHI-ZORN,WOLSKY (MARYLAND)
ASTVACAT 68 PL 27 B  45         ASTVACATUROV,AZIMOV,BALDIN+   (JINR+MOSCOW)
   ALSO 67 PRL 19 869           ASBURY,BECKER,BERTRAM,TING+ (DESY+COLUMBIA)
BECKER   68 PRL 21 1504         +BERTRAM,BINKLEY,JORDAN,KNASEL+  (DESY+MIT)
BINNIE   68 PL 27B 106          +DUANE+FARUQI+HORSEY+           (LOIC+RHEL)
BOLLINI  68 NC 56 A 1171        +BUHLER,DALPIAZ,MASSAM+     (CERN+BGNA+STRB)
MOSTEK   68 PRL 20 1057         +EISENHANDLER,MCCLELLAN,MISTRY+   (CORNELL)
WEHMANN  68 PRL 20 748          +ENGELS+ (HARVARD+CASE+SLAC+CORNELL+MCGILL)

AUGUSTIN 69 PL 28 B 517         +BIZOT,BUON,DELCOURT,HAISSINSKI,+  (ORSAY)
BALAKIN  69  IYAF 327 TRANS     +BUDKER,KORSHUNOV,MISHNEV,SIDOROV+  (NOVO)
   ALSO 69 SIDOROV
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0 0 0 0 3 6 0 4 0 0 9

Data Card Listings

For notation, see key at front of Listings.

Mesons

$\phi(1019)$, M(1033), $B_1(1040)$, $\eta_N(1080)$, $A_1(1100)$


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BEMPORAD 69 PL 29 B 383            +BRACCINI,CASTALDI,LUBELSMEYER,+(PISA+BONN)
MOY      69  THESIS                KEN MIN MOY       (NORTHEASTERN UNIVERSITY)
SCOTTER  69 NC 62 A 1057           +ERSKINE,PALER,+  (BIRM+GLAS+LOIC+MPIM+OXF)
SIDOROV  69 LIVERPOOL SYMP.ON ELECTRONS+PHOTONS,P.227, SIDOROV          (NOVO)

BALAKIN  70  PREPRINT              +BUTLER,PAKHTUSOVA,SIDOROV,SKRINSKY,+(NOVO)
BENAKSAS 70  LAL 1240              +COSME,JEAN-MARIE,JULLIAN,LAPLANCHE+ (ORSA)
BIZOT    70 PL 32 416              +BUON,CHATELUS,JEANJEAN,LALANNE,+    (ORSA)
    ALSO 69 PEREZ-Y-JORBA, LIVERPOOL SYMP.69
BIZOT1   70  PRIV.COMM.            PEREZ-Y-JORBA                        (ORSA)
BIZOT2   70 LNC 4 1273             +DELCOURT,JEANJEAN,LALANNE,+        (ORSAY)
EARLES   70 PRL 25 1312            +FAISSLER,GETTNER,LUTZ,MOY,TANG,+    (NEAS)
HYAMS    70 NP B 22 189            +KOCH,POTTER,V.LINDERN,LORENZ,LUTJENS(CERN)
SABRE    70  PREPRINT              SABRE COLLABOR.  (SACL+AMST+BGNA+REHO+EPOL)

ALVENSLE 71 PRL 27 441             ALVENSLEBEN,BECKER,BUSZA,CHEN,+  (MIT+DESY)
BALAKIN  71 PL 34 B 328            +BUDKER,PAKHTUSOVA,SIDOROV,SKRINSKY,+(NOVO)
DIBIANCA 71 NP B 35 13             +EINSCHLAG,ENDORF,ENGLER,FISK,+      (PITT)
CHATELUS 71  LAL 1247(THESIS) Y.CHATELUS                          (STRASBOURG)
HAYES    71 PR D 4 899             +IMLAY,JOSEPH,KEIZER,STEIN           (CORN)
LEFRANCO 71  PREPRINT LAL1256 J.LEFRANCOIS                             (ORSAY)
STOTTLEM 71  THESIS                A.R.STOTTLEMYER                  (MARYLAND)

AGUILAR  72 PR D 6 29              AGUILAR-BENITEZ,CHUNG,EISNER,SAMIOS   (BNL)
ALVENSLE 72 PRL 28 66              ALVENSLEBEN,BECKER,BIGGS,BINKLEY+(MIT+DESY)
BALAKIN  72 PL 40 B 431            +BOKIN,PAKHTUSOVA,SIDOROV,+   (NOVOSIBIRSK)
BASILE   72 NP B 44 605            +DALPIAZ,FRABETTI,ZICHICHI+(CERN+BGNA+STRB)
BENAKSAS272 PL 42 B 511            +COSME,JEAN-MARIE,JULLIAN,LAPLANCHE+(ORSAY)
COLLEY   72 NP B 50 1              +JOBES,RIDDIFORD,GRIFFITHS,+    (BIRM+GLAS)

JEAN-MAR 73  PRIV.COMM.            B.JEAN-MARIE,G.PARROUR              (ORSAY)
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M(1033) →MM →

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67  M(1033)

EVIDENCE NOT COMPELLING.OMITTED FROM TABLE.

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                    67  M(1033) MASS  (MEV)

M      240 1032.6     2.3               GARFINKEL 72 MMS   0 2.4 PI- P,N MM   12/72*

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                    67  M(1033) WIDTH  (MEV)

W      240   16.2     4.8       7.5     GARFINKEL 72 MMS   0 2.4 PI- P,N MM   12/72*

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                          REFERENCES FOR M(1033)

GARFINKE 72 PRL 29 1477       GARFINKEL,HOFFMAN,JACOBEL,+ (PURD+ANL+IOWA)

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$B_1(1040)$ →$\omega\pi$ →

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48  B1(1040)  IG=1+

EVIDENCE NOT COMPELLING. OMITTED FROM TABLE.

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                    48  B1(1040) MASS (MEV)

M          (1040.)                      DEFOIX    72 HBC  +- 0.7 PBAR P,7 P9   2/73*

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                    48  B1(1040) WIDTH (MEV)

W           (55.)                       DEFOIX    72 HBC  +- 0.7 PBAR P,7 P9   2/73*

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                    48  B1(1040) PARTIAL DECAY MODES

                                                           DECAY MASSES
P1     B1(1040) INTO OMEGA PI                             139+ 783

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                        REFERENCES FOR B1(1040)

DEFOIX   72  SUBMITTED TO PL  +DOBRZYNSKI,ESPIGAT,NASCIMENTO,+    (CDEF)

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$\eta_N(1080)$ →$\pi\pi$ →

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30  ETA N (1080, JPG=N +) I=0 J GREATER THAN 1
    SOME EXPERIMENTS SUGGEST J=2..

    OMITTED FROM TABLE
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Note on $\pi^+\pi^-$ Peaks Called $\eta_N(1080)$

The $\eta_N(1080)$ is seen in $\pi^-p \to \pi^+\pi^-n$ predominantly at backward decay angles, $\cos\theta < -0.75$. OH 70 state that this "bump is almost certainly the result of P-D interference."

Note that the selection made in some HBC experiments to reduce the background under the $\eta_N(1080)$ in the reaction $\pi^-p \to \pi^+\pi^-n$ may lead to a sample of events ambiguous with $\pi^-p \to p\pi^-\pi^0\pi^0$. This is so because selection on small momentum transfer to the $\pi^+\pi^-$ system, together with large $\pi^-_{in}\pi^-_{out}$ scattering angle, leads to rather high lab momenta of the π^+, so that ionization cannot be used to discriminate between the two hypotheses (BATON 70, footnote, p. 525; and private communications from G. Laurens).

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                    30  ETA N MASS (MEV)

M           1060.0     15.0              MILLER    68 HBC    4.0 PI- P          9/68
M        70 1085.0     10.0              WHITEHEAD 68 ASPK   3.1-3.6 PI-P      10/67
M           1120.0    100.0      40.0    OH        69 HBC    7.PI- P,PI+ D      9/69
M           1112.0     16.0              CLAYTON   70 HBC    2.5 PBAR P,4 PI    1/71
M          (1080.0)                      DIAZ      70 HBC    0. PBAR P, 4 PI    5/70
M           1070.0     20.0              REYNOLDS  70 HBC    2.26-2.36 PI- P    1/71
M            . . . . . . . . . .
M    AVG    1083.3      9.8       AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.4)

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                    30  ETA N WIDTH (MEV)

W           (70.0)  OR LESS              MILLER    68 HBC    4.0 PI- P          9/68
W           (25.0)  OR LESS              WHITEHEAD 68 ASPK   3.1-3.6 PI-P      10/67
W           150.0     100.0     -40.0    OH        69 HBC    7.PI- P,PI+ D      9/69
W           (80.0)                       CLAYTON   70 HBC    2.5 PBAR P,4 PI    1/71
W           (80.0)                       DIAZ      70 HBC    0. PBAR P, 4 PI    5/70
W            85.0      35.0              REYNOLDS  70 HBC    2.26-2.36 PI- P    1/71
W            . . . . . . . . . .
W    AVG     98.0      31.3       AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

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                          REFERENCES FOR ETA N

MILLER   68 PRL 21 1489         +GUTAY,JOHNSON,KENNEY+    (PURDUE+NDAM+SLAC)
WHITEHEA 68 NC 53 A 817         C.WHITEHEAD +                (AERE+SHMP+LOIC)
OH       69 PRL 23 331          +WALKER,CARROLL,FIREBAUGH,+       (WISC+TNTO)
BATON    70 PL 33 B 528         +LAURENS,REIGNIER                    (SACLAY)
CLAYTON  70 NP B 22 85          +MASON,MUIRHEAD,RIGOPOULOS,+      (LIVP+ATEN)
DIAZ     70 NP B 16 239         +GAVILLET,LABROSSE,MONTANET+      (CERN+CDEF)
OH       70 PR D 1 2494         +GARFINKEL,MORSE,WALKER,PRENTICE(WISC+TNTO)
REYNOLDS 70 NP B 21 77          +ALBRIGHT,BRADLEY,+      (OHIO+FSU+MINN+COLO)
WHITEHEA 72 NP B 48 365         WHITEHEAD,AULD,+        (AERE+RHEL+SHMP+LOUC)
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$A_1(1100)$

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10  A1(1100, JPG=1+-) I=1
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The $A_1 \to \rho\pi$ bump has been mainly observed in the diffraction-like process $\pi N \to (\pi\pi\pi)N$ without quantum number exchange and at small momentum transfer. There are also observations of structure in the A_1 mass region in reactions with production of additional mesons, and in backward production from pions (see Data Card Listings). The indications for A_1 production in charge exchange reactions, or in $\bar{p}p$ annihilation, do not appear significant.

The dominant effect in the A_1 mass region, for diffractive three-pion production, is a broad $J^P = 1^+$ $\rho\pi$ S-wave enhancement starting from $\rho\pi$ threshold; it has a maximum at ~1150 MeV and a width of the order of 300 to 400 MeV (ASCOLI 71 and 72). Such a behavior is obtained in Reggeized pion exchange models (the so-called Deck effect) [BERGER 71]. In recent partial wave analyses of the three-pion system (ASCOLI 72) one finds very little phase

Mesons

$A_1(1100)$, M(1150)

variation of the $J^P = 1^+$ ($\ell = 0$) $\rho\pi$ amplitude relative to various possible "background" amplitudes. Though not completely model-independent, these results suggest that the $J^P = 1^+$ $\rho\pi$ system is not resonant in the A_1 mass region. The observed effect may still be due to a pole on an unphysical sheet, shielded from the physical region by a cut due to coupling to e.g. the $S^*\pi$ channel (WRIGHT 72). In this case the Breit-Wiger approximation is not a good representation of the effects of the pole. (For further discussion of our criteria for resonances, see our text, Sect. III, 3).

For a recent review of the A_1, see DIEBOLD 72.

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                   10  A1 MASS (MEV)

M    PRODUCED BY PI +
M          (1080.0)                    ADERHOLZ  64 HBC      4.0 PI+P
M          (1080.)   APPROX.           BOESEBECK 68 HBC  +   8 PI+ P        6/68
M          (1040.0)                    ARMENISE  70 HBC    0 9 PI+ N -- A1 P 1/71
M
M    PRODUCED BY PI -
M          (1060.)                     ASCOLI    68 HBC  -0 5 PI-P          6/68
M          (1089.0)   (12.0)           BALLAM    68 HBC  - 16.0 PI- P       9/68
M          (1090.)   APPROX.           CHUNG     68 HBC  -  3.2,4.2 PI-P    2/67
M          (1055.0)    (6.0)           JUNKMANN  68 HBC  -  16. PI- P, 5PI  9/69
M    S     (1119.)    (30.)            KEY       68 HBC  -  3 PI-P          9/68
M    S      SHOULDER ON A2 ONLY
M          (1069.0)    (7.0)           CASO      70 HBC  - 11.2PI-P         5/70
M          (1120.0)                    CRENNELL  70 HBC  -  6. PI- P,F PI   5/70
M
M    PRODUCED BY PIONS,BACKWARDS SCATT.
M          (1115.0)   (20.0)           ANDERSON  69 MMS  -  16 PI- P,BACKW9 8/69
M          (1046.)    (10.)            BUHL      71 HBC  - 2.5 PI- P       11/71
M
M    PRODUCED BY PBARS, SEE TYPED NOTE.
M          (1054.)     (7.)            DANYSZ    67 HBC  +-  3,3.6 PBAR P   7/67
M          (1042.)    (21.)            FRIDMAN   68 HBC  +-  5.7 PBAR P     6/68
M    A     (1076.)     (5.)            ATHERTON  72 HBC  +- 5.7 PBAR P      1/73*
M    A   JP ANALYSIS GIVES SOME EVIDENCE FOR RHO PI D-WAVE                  1/73*
M
M    PRODUCED BY K-, SEE TYPED NOTE.
M          (1111.)    (10.)            ALLISON   67 HBC  +   6 K-P,LAM +5 PI 1/68
M          (1117.)    (30.)            ALLISON   67 HBC  +   6 K-P,LAM +4 PI 1/68
M          (1060.)    (15.)            JUHALA    67 HBC    0 4.6-5 K-P,5BODY 1/68
M
M    PRODUCED BY K+, SEE TYPED NOTE.
M    K+    (1060.0)   (20.0)           ALEXANDER 69 HBC  +    9 K+P         9/69
M    K+    (1030.0)   (20.0)           BERLINGHI 69 HBC  + 0 12.7 K+ P      9/69
M    K+ FOR CONTRADICTORY EVIDENCE SEE RABIN 70 AND TYPED NOTE.
M    A
M    A       AVERAGING NOT MEANINGFUL

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                   10  A1 WIDTH (MEV)

W    PRODUCED BY PIONS, RESONANCE INTERP. CONFUSED BY DECK EFFECT
W
W    PRODUCED BY PI +
W          (80.0)                      ADERHOLZ  64 HBC      4.0 PI+P
W         (130.)    APPROX.            BOESEBECK 68 HBC  +   8 PI+ P        6/68
W          (50.0)   OR LESS            ARMENISE  70 HBC    0 9 PI+ N -- A1 P 1/71
W   F     (300.)    APPROX.            RINAUDO   71 HBC  + 5. PI+P,P (3PI)+ 11/71
W   F         FOR JP=1+ (RHO PI) STATE                                     11/71
W
W    PRODUCED BY PI -
W         (140.0)   (31.0)             BALLAM    68 HBC  - 16.0 PI- P       9/68
W         (125.)    APPROX.            CHUNG     68 HBC  -  3.2,4.2 PI-P    2/67
W          (77.0)   (17.0)             JUNKMANN  68 HBC  -  16. PI- P, 5PI  9/69
W    K     (76.)    (46.)              KEY       68 HBC  - 3.0 PI- P       11/67
W    K        SHOULDER ON A2 ONLY
W          (99.0)   (15.0)             CASO      70 HBC  - 11.2PI-P         5/70
W
W    PRODUCED BY PIONS,BACKWARDS SCATT.
W         (98.0)    (45.0)    (20.0)   ANDERSON  69 MMS  -  16 PI- P,BACKW9 8/69
W
W    PRODUCED BY PBARS, SEE TYPED NOTE.
W          (33.)    (19.)              DANYSZ    67 HBC  +-  3,3.6 PBAR P   7/67
W         (130.)    APPROX.            FRIDMAN   68 HBC  +-  5.7 PBAR P     6/68
W    A     (36.)    (20.)     (15.)    ATHERTON  72 HBC  +- 5.7 PBAR P      1/73*
W    A   JP ANALYSIS GIVES SOME EVIDENCE FOR RHO PI D-WAVE                  1/73*
W
W    PRODUCED BY K-, SEE TYPED NOTE.
W          (50.)    (50.)              ALLISON   67 HBC  +   6 K-P,LAM +4 PI 1/68
W          (50.)    (25.)              ALLISON   67 HBC  +   6 K-P,LAM +5 PI 1/68
W         (120.)    (15.)              JUHALA    67 HBC    0 4.6-5 K-P,5BODY 1/68
W
W    PRODUCED BY K+, SEE TYPED NOTE.
W         (160.0)   (20.0)             ALEXANDER 69 HBC  +    9 K+P         9/69
W    B    (120.0)   (30.0)             BERLINGHI 69 HBC     12.7 K+ P       8/69
W    K+ FOR CONTRADICTORY EVIDENCE SEE RABIN 70 AND TYPED NOTE.
W         (130.0)   (20.0)             BERLINGHI 69 HBC  + 0 12.7 K+ P      9/69
W    A
W    A       AVERAGING NOT MEANINGFUL

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                   10  A1 PARTIAL DECAY MODES

                                                          DECAY MASSES
P1     A1 INTO RHO PI                                     770+ 139
P2     A1 INTO KBAR K                                     493+ 497
P3     A1 INTO ETA PI                                     548+ 139
P4     A1 INTO ETA PRIME PI                               958+ 139
P5     A1 INTO 3 PI                                       139+ 139+ 139

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                   10  A1 BRANCHING RATIOS

R1     A1 INTO (KBAR K)/(RHO PI)                      (P2)/(P1)
R1          (0.0025)OR LESS       DAHL      67 HBC  -  4.0 PI- P       .10/66

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                          REFERENCES FOR A1

BELLINI   63 NC 29 896        BELLINI,FIORINI,HERZ,NEGRI,RATTI       (MILAN)

ADERHOLZ  64 PL 10 226        AACH+BERL+BIRM+BONN+DESY+HAMBURG+LOIC+MPIM
GOLDHABE  64 PRL 12 336       GOLDHABER,BROWN,KADYK,SHEN+          (LRL+UCB)
LANDER    64 PRL 13 346 A     LANDER,ABOLINS,CARMONY,HENDRICKS +    (UCSD)  JP

ABOLINS   65 ATHENS(OHIO)CONF. +CARMONY,LANDER,XUONG,YAGER       (LA JOLLA)I=1
ALITTI    65 PL 15 69         ALITTI,BATON,DELER,CRUSSARD+        (SACL+BGNA)

ALLARD    66 NC 46A 737       +DRIJARD+HENNESSY+    (ORSAY+MILAN+SACL+UCB)
DEUTSCHM  66 PL 20 82         DEUTSCHMANN,STEINBERG +  (AACH+BERLIN+CERN)
HESS      66 UCRL-16832       R I HESS (THESIS, BERKELEY)              (LRL)

ALLISON   67 PL 25B 619       +CRUZ+        (OXF+MPIM+BIRM+RHEL+GLAS+LOIC)
DAHL      67 PR 163 1377      +HARDY+HESS+KIRZ+MILLER                  (LRL)
DANYSZ    67 NC 51 A 801      DANYSZ+FRENCH+SIMAK                     (CERN)
JUHALA    67 PRL 19 1355      +LEACOCK+RHODE+KOPELMAN+           (IOWA+COLO)
SLATTERY  67 NC 50A 377       +KRAYBILL+FORMAN+FERBEL            (YALE+ROCH)  JP

ARMENISE  68 PL 26 B  336     +FORINO+CARTACCI+      (BARI+BGNA+FIRZ+ORSAY)
ASCOLI    68 PRL 21 113       +CRAWLEY,KRUSE,MORTARA,SCHAFER,+ (ILLINOIS)
BALLAM    68 PRL 21 934       +BRODY,CHADWICK,FRIES,GUIRAGOSSIAN+  (SLAC)JP
BOESEBEC  68 NP B 4 501       BOESEBECK,DEUTSCHMANN,+(AACHEN+BERLIN+CERN)
CASO      68 NC 54 A 983      +CONTE+CORDS+DIAZ+  (GENOVA+HAMB+MILA+SACL)
CHUNG     68 PR 165 1491      S.U.CHUNG,O.DAHL,J.KIRZ,D.H.MILLER      (LRL)
CNOPS     68 PRL 21 1609      +HOUGH,COHN,BUGG+ (BNL+ORNL+UCND+TENN+PENN)
FRIDMAN   68 PR 167 1268      +MAURER,MICHALON,OUDET+    (HEID+STRASBOURG)
JUNKMANN  68 NP B8 471        +COCCONI+          (AACH+BERL+BONN+CERN+WARS)
KEY       68 PR 166 1430      +PRENTICE+COOPER+MANNER+       (TNTO+ANL+WISC)

ALEXANDE  69 PR 183 1168      G.ALEXANDER,A.FIRESTONE,G.GOLDHABER     (LRL)
ALLABY    69 PL 29B 198       +BINON+DIDDENS+DUTEIL+KLOVNING+...     (CERN)
ANDERSON  69 PRL 22 1390      +COLLINS,+                         (BNL+CARN)
BERLINGH  69 PRL 23 42        BERLINGHIERI,FARBER,+                  (ROCH)
DONALD    69 NP B 11 551      +EDWARDS,BURAN,BETTINI,+    (LIVP+OSLO+PADO)
FAYOLLE   69 NP B 13 40       +DE MONTAIGNAC,MORANO,STRACHMAN+       (PARIS)
JUHALA    69 PR 184  1461     +LEACOCK,RHODE,KOPELMAN,LIBBY,+  (ISU+COLO)
KENYON    69 PRL 23 146       +KINSON,SCARR,+                (BNL+UCND+ORNL)

ARMENISE  70 LNC 4  199       +GHIDINI,FORING,CARTACCI,+ (BARI+BGNA+FIRZ)
BRANDENB  70 NP B16 369       +BRENNER,IOFFREDO,JOHNSON,KIM+      (HARVARD)
CASO      70 LNC 3  707       +CORDS,COSTA+     (GENO+DESY+HAMB+MILA+SACL)
    ALSO  68 CASO
CRENNELL  70 PRL 24 781       +KARSHON,LAI,SCARR,SIMS                  (BNL)
CHIEN1    70  TORONTO PREPRINT +CHAO,JOHNSTON,PRENTICE,WALKER   (TNTO+WISC)
CHIEN2    70  JHU 7011        C.Y.CHIEN                     (JOHNS HOPKINS)
GARELICK  70 PHILAD.CONF.P.205 D.A.GARELICK,REVIEW            (NORTHEASTERN)
RABIN     70 PRL 24 925       +GALTIERI,DERENZO,FLATTE,FRIEDMAN+      (LRL)
SHIH      70  BNL 14059-REV   +YOUNG                                  (BNL)

ASCOLI    71 PRL 26 929       ILLINOIS+GENO+HAMB+MIL+SACL+HARV+TNTO+WISC
BEMPORAD  71 NP B 33 397      +BEUSCH,MELISSINOS,+  (CERN+ETHZ+LOIC+MILA)
BERGER    71 PHENOMENOLOGY  IN PARTICLE PHYSICS, CALTECH 1971         (LRL)
BUHL      71  PREPRINT        +CLINE,TERREL                     (WISCONSIN)
LAMSA     71  PREPRINT        +EZELL,GAIDOS,WILLMANN                (PURD)  JP
RINAUDO   71 NC 5 A 239       +BOECKMANN,MAJOR+(TORI+BONN+DURH+NIJM+EPOL) JP

ANTIPOV   72 PHIL.CONF.PROC.  +ASCOLI,BUSNELLO,DAMGAARD,+       (SERP+CERN)
ATHERTON  72  SUBM. TO PL     +FRANEK,FRENCH,GHIDINI,HILPERT,+      (CERN)
BERENYI   72 NP B 37 621      +PRENTICE,STEENBERG,YOON,WALKER (TNTO+WISC)
BLOODWOR  72 NP B 46 402      BLOODWORTH,JACKSON,PRENTICE,YOON  (TORONTO)
DIEBOLD   72  BATAV.CONF.     R.DIEBOLD  RAPPORTEUR TALK              (ANL)
LAMSA     72 NP B 41 388      +EZELL,GAIDOS,WILLMANN               (PURDUE)
MORSE     72 NP B 43 77       +OH,WALKER,JOHNSTON,YOON          (WISC+TNTO)

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M(1150)
→MM

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            68  M(1150)

            EVIDENCE NOT COMPELLING.OMITTED FROM TABLE.

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            68  M(1150) MASS  (MEV)

M      65 1148.3      3.3            JACOBEL   72 MMS  O 2.4 PI- P,N MM  12/72*
------ --------- --------- --------- --------- --------- --------- --------

            68  M(1150)  WIDTH  (MEV)

W      65   15.0       9.0      11.7  JACOBEL   72 MMS  O 2.4 PI- P,N MM  12/72*

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                          REFERENCES FOR M(1150)

JACOBEL   72 PRL 29 671       +GARFINKEL,HOFFMAN,+          (IOWA+PURD+ANL)

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0 0 0 0 3 6 0 4 8 1 0

Data Card Listings

For notation, see key at front of Listings.

$A_{1.5}(1170) \to 3\pi$

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44  A 1.5 (1170, JPG=  -) I=1

THIS ENTRY LISTS REFERENCES TO PEAKS OF LOW STATISTI-
CAL SIGNIFICANCE IN THE 3 PI SYSTEM BETWEEN THE A1 AND
THE A2. OMITTED FROM TABLE.

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REFERENCES FOR A 1.5


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BUTTERWO 67 HEIDELB.CONF.P.28 REVIEW TALK ON MESONS  AT HEIDELBERG CONF.
CASON    67 PRL 18  880       +LAMSA,BISWAS,DERADO,GROVES,+    (NOTREDAME)
ASCOLI   68 PRL 21 113        +CRAWLEY,KRUSE,MORTARA,SCHAFER,+ (ILLINOIS)
DONALD   68 PL 26 B  327      +FRODESEN,BETTINI,+  (LIVERPOOL,OSLO,PADUA)
VON KROG 68 PL 27B 253        +MIYASHITA,KOPELMAN,MARSHALL LIBBY   (COLO)
JUNKMANN 68 NP B8 471         +COCCONI+          (AACH+BERL+BONN+CERN+WARS)
ARMENISE 69 LNC 2 501         +GHIDINI,FORINO,CARTACCI+  (BARI+BGNA+FIRZ)
GALLOWAY 70 PR D 1 3077       +MOTT,ALYEA,LEE,MARTIN,PRICKETT          (IND)
MORSE    72 NP B 43 77        +OH,WALKER,JOHNSTON,YOON          (WISC+TNTO)
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B(1235)

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11  B (1235,JPG=1++) I=1

JP=2+ NOT YET COMPLETELY RULED OUT. FRENKIEL 72 FIT
TWO STATES ,JP=1+ AND JP=1- ,IN THE B-REGION.

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                 11  B MASS (MEV)

M       60(1220.0)                  ABOLINS   63 HBC  +   3.5 PI+P
M         (1220.0)                  GOLDHABER 65 HBC      3.7 PI+,PI-P
M      376 1200.       20.          BALTAY    67 HBC  +- 0.0 PBAR P      2/67
M       25(1250.)   ESTIMATED       LEE       67 HBC  -   3.6 PI- P      1/68
M          1259.0      27.0         BOESEBECK 68 HBC  +   8.0 PI+ P     10/67
M          1220.       20.          CHUNG     68 HBC  - 3.2,4.2 PI- P    9/67
M   B  300(1245.)     (10.)         BIZZARRI  69 HBC  +-  0 PBAR P      12/72*
M   B   SUPERSEDED BY FRENKIEL 72
M          1240.0      20.0         ANDERSON  70 CNTR  0 5-18 GAMMA P   11/70
M   C     (1265.0)    (19.0)        CASO      70 HBC  - 11.2PI-P         2/73*
M   C   SUPERSEDED BY AFZAL 73
M         (1272.0)    (15.0)        CASON     70 HBC  -   8.0 PI-P,4PI
M          1200.0     (10.0)        EROFEEV   70 HBC  -   3.25 PI- P     1/71
M          1225.0      22.0         HONES     70 HBC  +  18.5 PI+ P     11/70
M          1236.0      15.0         HOOGLAND  70 DBC  -   3.0 K- D       2/71
M          1200.0      15.0         MIYASHITA 70 HBC  -   6.7 PI-P,4PI
M   P     (1230.)     (10.)         POLS      70 HBC  +   5. PI+ P      11/71
M   P   HANDDRAWN BACKGROUND.ERRORS STATISTICAL ONLY.                   11/71
M   W     (1228.)     (5.)          FRENKIEL  72 HBC  +- 0. PBAR PI,5 PI 12/72*
M   W   FIT REQUIRES AN ADDITIONAL JP=1- RESONANCE
M   W   AT 1256 MEV, WIDTH 129 MEV.
M  O 1163 1243.        6.           OTT       72 HBC  +  7.1 PI+ P,P B+   2/73*
M  O    FROM FIT OF THE MASS SPECTRUM
M   A     (1252.)     (6.)          OTT       72 HBC  +  7.1 PI+ P,P B+   2/73*
M   A   FROM FIT OF MASS SPECTRUM AND MOMENTS DISTRIBUTION WITH A STRONG
M   A   INTERFERENCE WITH THE BACKGROUND.
M          1235.       15.          AFZAL     73 HBC  +  11.7 PI+ P      2/73*
M          1268.       16.          AFZAL     73 HBC  -  11.2 PI- P      2/73*
M          . . . . . . . . . .
M   AVG    1236.8      5.6     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.3)
                          (SEE IDEOGRAM BELOW )
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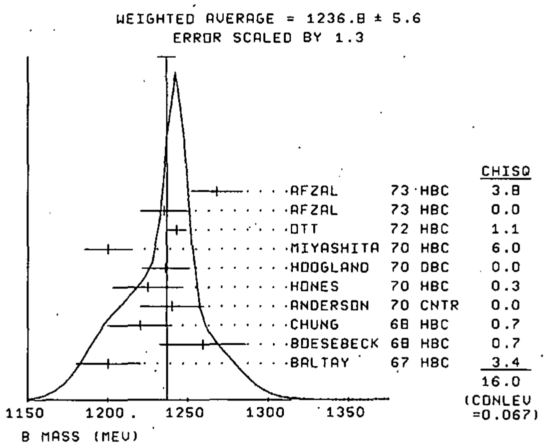


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                 11  B WIDTH (MEV)

W      60  100.0     20.0               ABOLINS   63 HBC  +   3.5 PI+P
W         (80.0)                        GOLDHABER 65 HBC      3.7 PI+,PI-P
W     376  100.      30.                BALTAY    67 HBC  +- 0.0 PBAR P       2/67
W      25 (100.)   ESTIMATED            LEE       67 HBC  -   3.6 PI- P       1/68
W          203.      75.                BOESEBECK 68 HBC  +   8. PI+ P       11/67
W          150.      20.                CHUNG     68 HBC  - 3.2,4.2 PI- P     9/67
W   B 300  (83.)    (12.)               BIZZARRI  69 HBC  +-  0 PBAR P       12/72*
W   B   SUPERSEDED BY FRENKIEL 72
W        (100.0)   APPROX.              ANDERSON  70 CNTR  0 5-18+GAMMA P    11/70
W   C    (150.0)                        CASO      70 HBC  - 11.2PI-P          2/73*
W   C   SUPERSEDED BY AFZAL 73
W        (122.0)    (38.0)    (28.0)    CASON     70 HBC  -   8.0 PI-P,4PI
W         100.0      20.0               EROFEEV   70 HBC  -   3.25 PI- P      1/71
W          78.0      14.0      46.0     HONES     70 HBC  +  18.5 PI+ P      11/70
W         132.0      20.0               HOOGLAND  70 DBC  -   3.0 K- D        2/71
W         113.0      44.0               MIYASHITA 70 HBC  -   6.7 PI-P,4PI
W   P    (120.)     (20.)               POLS      70 HBC  +. 5. PI+ P        11/71
W   P   HANDDRAWN BACKGROUND.ERRORS STATISTICAL ONLY.                        11/71
W   W    (126.)     (10.)               FRENKIEL  72 HBC  +- 0. PBAR PI,5 PI 12/72*
W   W   SEE NOTE UNDER THE MASS ABOVE.
W  O 1163 134.       23.       26.      OTT       72 HBC  +  7.1 PI+ P,P B+   2/73*
W  O    FROM FIT OF THE MASS SPECTRUM
W   A    (156.)     (21.)     (18.)     OTT       72 HBC  +  7.1 PI+ P,P B+   2/73*
W   A   SEE NOTE UNDER THE MASS ABOVE.
W          120.      50.                AFZAL     73 HBC  +  11.7 PI+ P       2/73*
W          130.      50.                AFZAL     73 HBC  -  11.2 PI- P       2/73*
W          . . . . . . . . . .
W   AVG    118.3     8.1     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

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                 11  B PARTIAL DECAY MODES

                                                        DECAY MASSES
P1     B INTO OMEGA+PI                                  783+ 139
P2     B INTO 2PI+ 2PI-                                 139+ 139+ 139+ 139
P3     B INTO K KBAR                                    493+ 493
P4     B INTO PI PI                                     139+ 139
P5     B INTO PI PHI                                    134+1019
P6     B INTO ETA PI (FORBIDDEN BY G)                   548+ 139
P7     B INTO K KBAR PI                                 493+ 493+ 139

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                 11  B BRANCHING RATIOS

R1     B INTO (4PI)/(OMEGA PI)                          (P2)/(P1)
R1          (0.5)  OR LESS              ABOLINS   63 HBC  +   3.5 PI+P

R2     B INTO (K KBAR)/(OMEGA PI)                       (P3)/(P1)
R2          (0.02) OR LESS              DAHL      67 HBC  -  1.6-4.2 PI- P  10/66
R2          (0.10) OR LESS  CL=.90      BALTAY    67 HBC  +- 0.0 PBAR P      2/67
R2          (0.08) OR LESS  CL=.95      BIZZARRI  69 HBC  +-  0 PBAR P       9/69

R3     B INTO (PI PI)/(PI OMEGA)                        (P4)/(P1)
R3          (0.3)  OR LESS              ADERHOLZ  64 HBC     4.0 PI+P        7/66
R3          (0.15) OR LESS  CL=.90      OTT       72 HBC  +  7.1 PI+ P      12/72*

R4     B INTO (PI PHI) / (PI OMEGA)                     (P5)/(P1)
R4          (0.015)OR LESS              DAHL      67 HBC     1.6-4.2 PI- P  10/66
R4          (0.04) OR LESS  CL=.95      BIZZARRI  69 HBC  +-  0 PBAR P       9/69

R5     B INTO (ETA PI) / (PI OMEGA)                     (P6)/(P1)
R5          (0.25) OR LESS  CL=.90      BALTAY    67 HBC  +- 0.0 PBAR P      2/67

R6     B+- INTO ((K KBAR)+- PI0) / (PI OMEGA)
R6          (0.08) OR LESS  CL=.90      BALTAY    67 HBC  +- 0.0 PBAR P      2/67

R6     B+- INTO (KS KS PI+-) / (PI OMEGA)
R6          (0.02) OR LESS  CL=.90      BALTAY    67 HBC  +- 0.0 PBA- P      2/67

R6     B+- INTO (KS KL PI+-) / (PI OMEGA)
R6          (0.06) OR LESS  CL=.90      BALTAY    67 HBC  +- 0.0 PBAR P      2/67

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REFERENCES FOR B


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ABOLINS  63 PRL 11 381        ABOLINS,LANDER,MEHLHOP,XUONG,YAGER   (UCSD)
BONDAR   63 PL 5 209          BONDAR,DODD+   (AACHEN+BIRM+HAMB+LOIC+MPIM)
ADERHOLZ 64 PL 10 240         AACHEN+BERLIN+BIRM + BONN+HAMBUR+LOIC+MPIM
CARMONY  64 PRL 12 254        CARMONY,LANDER,RINDFLEISCH,XUONG,YAGER(UCB) JP
GOLDHABE 65 PRL 15 118        G GOLDHABER,S GOLDHABER,KADYK,SHEN    (LRL)

BALTAY   67 PRL 18 93         +SEVERIENS+YEH+ZANELLO            (COLU+BNL)
DAHL     67 PR 163 1377       +HARDY+HESS+KIRZ+MILLER               (LRL)
LEE      67 PR 159 1156       +MOEBS,ROE,SINCLAIR,VANDERVELDE      (MICH)
SLATTERY 67 NC 50A 377        +KRAYBILL+FORMAN+FERBEL         (YALE+ROCH)

ASCOLI   68 PRL 20 1411       +CRAWLEY,MORTARA,SHAPIRO              (ILL)  JP
BOESEBEC 68 NP B 4 501        BOESEBECK,DEUTSCHMANN,+(AACHEN+BERLIN+CERN)
CASO     68 NC 54 A 983       +CONTE+CORDS+DIAZ+  (GENOVA+HAMB+MILA+SACL)
CHUNG    68 PR 165 1491       S.U.CHUNG,O.DAHL,J.KIRZ,D.H.MILLER    (LRL)
BIZZARRI 69 NP B 14 169       +FOSTER,GAVILLET,MONTANET,+      (CERN+CDEF)

ANDERSON 70 PR D 1 27         +GUSTAVSON,JOHNSON,+   (SLAC+CIT+UCSB+NEAS)
CASO     70 LNC 3 707         +CONTE,TOMASINI,CORDS+(GENO+HAMB+MILA+SACL)
CASON    70 PR D 1 851        +ANDREWS,BISWAS,GROVES,HARRINGTON,+  (NDAM)
EROFEEV  70 SJNP 11 450       +VETLITSKY,WLADIMIRSKY,GRIGOREV,+    (ITEP)
HONES    70 PR D 2 827        +CASON,BISWAS,HELLAND,KENNEY,MCGAHAN+(NDAM)
HOOGLAND 70 PL 33 B 631       SABRE COLLABOR.  (ZEEM+SACL+BGNA+REHO+EPOL)
MIYASHIT 70 PR D 1 771        MIYASHITA,VON KROGH,KOPELMAN,LIBBY   (COLO)
POLS     70 NP B 25 109       +BOECKMANN,CIRBA,+     (BONN+DURH+EPOL+TORI)
WERBROUC 70 LNC 4 1267        WERBROUCK,RINAUDO,+    (TORI+NIJM+BONN+LBL)JP
DEVONS   71 PRL 27 1614       +KOZLOWSKI,HORWITZ,+              (COLU+SYRA)

FRENKIEL 72 NP B 47 61        +GHESQUIERE,LILLESTOL,CHUNG,+   (CDEF+CERN)JP
OTT      72  LBL-1547         R.L.OTT  THESIS                         (LBL)JP
SISTERSO 72 NP B 48 493       SISTERSON,HARRISON,HEYDA,JOHNSON,+(HARVARD)

AFZAL    73 NCL               +BASSLER,+        (DURH+GENO+DESY+MILA+SACL)  JP
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f(1270)

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5  F (1270,JPG=2++) I=0

    WE NO LONGER LIST EVERY PUBLISHED VALUE.                       1/73*
    WE AVERAGE ONLY THE MOST SIGNIFICANT                           1/73*
    DETERMINATIONS OF MASS AND WIDTH.                              1/73*
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5  F MASS (MEV)

M        (1250.0)  (25.0)   SELOVE     62 HBC    3.0 PI- P           1/73*
M    1416(1267.0)  (10.0)   JACOBS     66 HBC    2-3 PI-P,T CUT20   10/67
M         1276.     11.     RABIN      67 HBC    8.5 PI+ P           9/67
M  T 1960 1261.      5.     ARMENISE   68 DBC    5.1 PI+N,P PI+ -    1/73*
M  T  360 1270.     10.     ARMENISE   68 DBC    5.1 PI+N,P PI0 0    1/73*
M         1265.      8.     BOESEBECK  68 HBC    8 PI+ P             6/68
M    J    1268.0     6.0    JOHNSON    68 HBC    3.7-4.2 PI- P       7/69
M    J    JOHNSON 68 INCLUDES BONDAR 63, LEE 64, DERADO 65, EISNER 67.
M         1275.0    13.0    ARMENISE   70 HBC    9 PI+ N -- F P      1/71
M         1273.0     7.0    ARMENISE   70 HBC    9 PI+ N -- MM P     1/71
M    C    1277.     16.     EISENSTE   70 DBC    4.2 PI+ N           1/71
M    C    INCLUDES 14 MEV SYSTEMATIC ERROR ESTIMATED FROM RHO MASS SHIFT
M     600 1275.0    10.0    OH         70 HBC    1.26 PI- P,P F      1/71
M   E    (1273.0)   (6.0)   STUNTEBEC  70 HBC    8.PI-P,5.4 PI+D    11/71
M    5300 1277.0     4.0    FLATTE     71 HBC    7.0 PI+ P           6/71
M   E  300(1272.)           KEMP       72 DBC    11.7 PI+ N         12/72*
M    2000 1261.0    10.0    JACOBS     72 HBC    2.8 PI- P           1/73*
M     600 1258.0    10.0    TAKAHASHI  72 HBC    8. PI- P,N 2PI      1/73*
M    1200 1274.     12.     WHITEHEAD  72 ASPK   3.1-3.6 PI- P       2/73*
M
M  E    EVIDENCE FOR A STRUCTURE CLAIMED                            12/72*
M  T    ERROR INCREASED BY US. SEE TYPED NOTE ON K* MASS.
M         . . . . . . . . .
M   AVG   1269.9     2.1      AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
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5  F WIDTH (MEV)

W        (100.0)   (25.0)   SELOVE     62 HBC    3.0 PI- P
W    1416 (99.0)   (10.0)   JACOBS     66 HBC    2-3 PI-P,T CUT20   10/67
W         155.      17.     RABIN      67 HBC    8.5 PI+ P           9/67
W  T 1960 216.      20.     ARMENISE   68 DBC    5.1 PI+N,P PI+ -    1/73*
W  T  360 (188.)   (40.)    ARMENISE   68 DBC    5.1 PI+N,P PI0 0    1/73*
W         128.      23.     BOESEBECK  68 HBC    8 PI+ P             6/68
W    J    176.0     13.0    JOHNSON    68 HBC    3.7-4.2 PI- P       7/69
W    J    JOHNSON 68 INCLUDES BONDAR 63, LEE 64, DERADO 65, EISNER 67.
W         131.0     25.0    ARMENISE   70 HBC    9 PI+ N -- MM P     1/71
W         173.0     11.0    ARMENISE   70 HBC    9 PI+ N -- F P      1/71
W     600 120.0     15.0    OH         70 HBC    1.26 PI- P,P F      1/71
W   E    (196.0)   (18.0)   STUNTEBEC  70 HBC    8.PI-P,5.4 PI+D    11/71
W    5300 183.0     15.0    FLATTE     71 HBC    7.PI+P,DELTA++F     1/71
W   E  300 (143.)           KEMP       72 DBC    11.7 PI+ N         12/72*
W    2000 130.0     25.0    JACOBS     72 HBC    2.8 PI- P           1/73*
W  T  600 166.0     28.0    TAKAHASHI  72 HBC    8. PI- P,N 2PI      1/73*
W    1200 (217.)   (24.)    WHITEHEAD  72 ASPK   3.1-3.6 PI- P       2/73*
W
W  E    EVIDENCE FOR A STRUCTURE CLAIMED                            12/72*
W  T    ERROR INCREASED BY US. SEE TYPED NOTE ON K* MASS.
W         . . . . . . . . .
W   AVG   162.9      8.8      AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.7)
                              (SEE IDEOGRAM BELOW )
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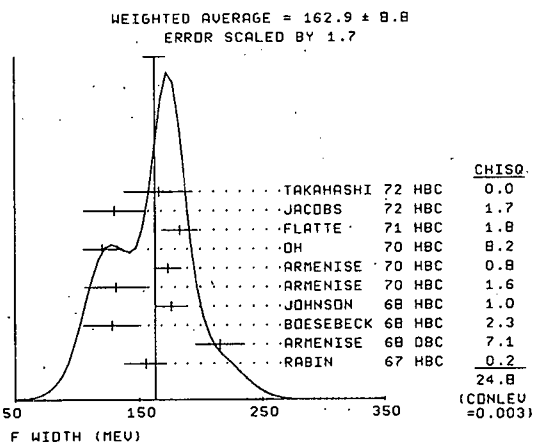


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5  F PARTIAL DECAY MODES

                                               DECAY MASSES
P1     F INTO PI PI                            139+ 139
P2     F INTO 2PI+ 2PI-                        139+ 139+ 139+ 139
P3     F INTO K KBAR                           497+ 497
P4     F INTO K KBAR PI                        497+ 497+ 139
P5     F INTO ETA PI PI                        548+ 139+ 139
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5  F BRANCHING RATIOS

R10     F PARTIAL WAVE (I.E. I=1, JP=2+) AMPLITUDE AT F RESONANCE
R10       WE TABULATE X = 1/2 (1 + ETA).  THIS SHOULD BE PI PI FRACTION
R10       FOR PURE BW WITH NO BACKGROUND.
R10   600    0.8      0.04               OH         70 HBC   01.26 PI- P,P F    1/71
R10   250    0.85     0.05               BEAUPRE    71 HBC   08 PI+ P,DELTA++F  1/71
R10        . . . . . . . . .
R10 AVG      0.820    0.031   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

R1      F INTO (2PI+ 2PI-) / (PI PI)                        (P2)/(P1)
R1    ASCOLI 68 SUGGEST DECAY IS MAINLY RHO-RHO, 1/3 OF WHICH YIELD 2PI+ 2PI
R1           0.08     0.06               BONDAR     63 HBC   4.0 PI-P
R1     D     0.04     0.05               CHUNG      65 HBC   3.2 PI-P
R1     D  CORRECTED BY O.DAHL                                                 11/71
R1      50   0.07     0.04               ASCOLI     68 HBC   5 PI- P           6/68
R1           0.022    0.045     0.022 BARDADIN  71 HBC   8. PI+ P          2/72
R1           0.047    0.013              OH         70 HBC   1.26 PI- P,P F    2/73*
R1         . . . . . . . . .
R1  AVG      0.047    0.011   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

R2      F INTO (K KBAR)/(PI PI)                             (P3)/(P1)
R2        DETERMINATION DIFFICULT BECAUSE PROXIMITY OF A2 WHICH HAS SAME
R2        NEUTRAL (K KBAR) MODES. SINCE INTERFERENCE MAY BE CONSTRUCTIVE
R2        OR DESTRUCTIVE, EVEN UPPER LIMITS ARE DUBIOUS.
R2     SOME UPPER LIMITS (X OR LESS) HAVE BEEN PUNCHED AS (0 +-X)
R2          (0.00)   (0.09)              BARMIN     65 HLBC  2.8 PI-           2/73*
R2          (0.00)   (0.16)              WANGLER    65 HBC   3.0 PI-P          2/73*
R2          PROBABLY SEEN                BARLOW     67 HBC   1.2 PBAR P--K1K1 11/66
R2          (0.047)  (0.012)+ SYST.      BEUSCH     67 OSPK  5,7,12 PI-P-      9/67
R2     D     0.05     0.05               DAHL       67 HBC   1.6-4.2 PI- P    10/66
R2     D    CORRECTED BY O.DAHL                                               11/71
R2     A    (0.031)  (0.012)             ADERHOLZ   69 HBC   8 PI+ P,K+K-PI-   8/69
R2     A    K+K- PEAK IS AT ABOUT 1260 MEV WHILE (KKBAR)+ PEAKS AT 1320.
R2     A    ALSO (CROSSSECTION*BRANCHING RATIO) FOR A2 IS SMALL.
R2          (0.06)   (0.02)              OH         70 HBC   1.26 PI- P,P F    1/73*
R2 L        (0.07) OR LESS  CL=.95       AGUILAR    72 HBC   3.9,4.6 K- P     12/72*
R2 L         0.0      0.04               LIMIT ABOVE RESTATED FOR AVERAGING   12/72*
R2 L   SMALL (CROSS SECTION*BRANCHING RATIO) FOR A2                           12/72*
R2           0.13     0.05               BISWAS     72 HBC   18.5 PI+- P       1/73*
R2          (0.02) OR LESS  CL=.85       WHITEHEAD  72 ASPK  3.1-3.6 PI- P    12/72*
R2         . . . . . . . . .
R2  AVG      0.051    0.063   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 2.0)

R3      F INTO (K0 K- PI+ AND C.C.)/(PI PI)                 (P4)/(P1)
R3          (0.07) OR LESS  CL=.95   AGUILAR    72 HBC       3.9,4.6 K- P     12/72*

R4      F  INTO (ETA PI PI)/(PI PI)                         (P5)/(P1)
R4          (0.19) OR LESS  CL=.95   AGUILAR    72 HBC       3.9,4.6 K- P     12/72*
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REFERENCES FOR F


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SELOVE    62 PRL 9 272         SELOVE,HAGOPIAN,BRODY,BAKER,LEBOY        (PENN)
BONDAR    63 PL 5 153          BONDAR+   (AACHEN+BIRM+BONN+DESY+LOIC+MPIM)
GUIRAGOS  63 PRL 11 85         Z.G.T. GUIRAGOSSIAN                       (LRL)
HAGOPIAN  63 PRL 10 533        V HAGOPIAN,W SELOVE                      (PENN)
VEILLET   63 PRL 10 29         VEILLET,HENNESSY,BINGHAM,BLOCH+(EPOL+MILAN)

ADERHOLZ  64 PL 10 240         AACHEN-BERLIN-BERLIN-BONN-HAMBURG-LOIC-MPI  IJ
BRUYANT   64 PL 10 232         BRUYANT,GOLDBERG,HOLDER,FLEURY+ (CERN+EPOL) I
LEE       64 PRL 12 342        LEE,ROE,SINCLAIR,VANDERVELDE             (MICH)
SODICKSO  64 PRL 12 485        SODICKSON,WAHLIG,MANNELLI,FRISCH+       (MIT) I

BARMIN    65 SJNP 1 230        +DOLGOLENKO,ELENSKY,EROFEEV+  (ITEP MOSCOW)  JP
BARMIN    65 SJNP 1 623        +DOLGOLENKO+EROFEEV+KRESTNIKOV+ (ITEP MOSC)
CHUNG     65 PRL 15 325        CHUNG,DAHL,HARDY,HESS,JACOBS,KIRZ         (LRL)
DERADO    65 PRL 14 872        DERADO,KENNEY,POIRIER,SHEPHARD (NOTRE DAME)
GUIRAGOS  65 PRL 11 85         Z G T GUIRAGOSSIAN                        (LRL)
WANGLER   65 PR 137 B 414      T P WANGLER,A R ERWIN,W WALKER    (WISCONSIN)

ACCENSI   66 PL 20 557         ACCENSI,ALLES-BORELLI,FRENCH,FRISK+     (CERN)
JACOBS    66 UCRL-16877        L.D.JACOBS,THESIS                         (LRL)
WAHLIG    66 PR 147 941        +SHIBATA,GORDON,FRISCH,MANNELLI  (MIT+PISA) J

BARLOW    67 NC 50A 701        +LILLESTOL+MONTANET+  (CERN+CDEF+IRAD+LIVP)
BEUSCH    67 PL 25 B 357       +FISCHER,GOBBI,ASTBURY+             (ETHZ+CERN)
DAHL      67 PR 163 1377       +HARDY+HESS+KIRZ+MILLER                   (LRL)
EISNER    67 PR 164 1699       +JOHNSON+KLEIN+PETERS+SAHNI+YEN+      (PURDUE)
POIRIER   67 PR 163 1462       +BISWAS,CASON,DERADO,KENNEY+     (NDAM+PENN)
RABIN     67 THESIS            M. RABIN                            (RUTGERS)

ARMENISE  68 NC 54 A 999       +FORINO+CARTACCI+ (BARI+BGNA+FIRENZE+ORSAY)
ASCOLI    68 PRL 21 1712       G.ASCOLI,H.B.CRAWLEY,D.W.MORTARA,+      (ILL)
BOESEBEC  68 NP B 4 501        BOESEBECK,DEUTSCHMANN,+(AACHEN+BERLIN+CERN)
FOSTER    68 NP B 6 107        +GAVILLET+LABROSSE+MONTANET+       (CERN+CDEF)
JOHNSON   68 PR 176 1651       +POIRIER,BISWAS,GUTAY+      (NDAM+PURD+SLAC)
   ALSO   63BONDAR, LEE 64, DERADO 65, EISNER 67
LAMSA     68 PR 166 1395       +CASON+BISWAS+DERADO+GROVES+     (NOTREDAME)
   ALSO   67 POIRIER
WHITEHEA  68 NC 53A 817        +MCEWEN,OTT,AITKEN+            (AERE+SHMP+LOUC)

ADERHOLZ  69 NP B 11 259       +BARTSCH,+            (AACH+BERL+CERN+JAGL+WARS)
AGUILAR-  69 PL 29 B 241       M.AGUILAR-BENITEZ,J.BARLOW,+     (CERN+CDEF)
ARMENISE  69 LNC 2 501         +GHIDINI,FORINO,CARTACCI+  (BARI+BGNA+FIRZ)
CASO      69 NC 62 A 755       +CONTE,BENZ,+        (GENO+DESY+HAMB+MILA+SACL)
DONALD    69 NP B 11 551       +EDWARDS,BURAN,BETTINI,+    (LIVP+OSLO+PADO)

AGUILAR   70 PRL 25 58         AGUILAR-BENITEZ,BARNES,BASSANO,+ (BNL+SYRA)
ARMENISE  70 LNC 4 199         +GHIDINI,FORINO,CARTACCI,+ (BARI+BGNA+FIRZ)
BADIER    70 NP B 22 512       +BONNET,DREVILLON,BAUBILLIER,+  (EPOL+IPNP)
EISENSTE  70 COO 1195 194      EISENSTEIN,GORDON                       (ILL)
OH        70 PR D 1 2494       +GARFINKEL,MORSE,WALKER,PRENTICE(WISC+TNTO)
STUNTEBE  70 PL 32 B 391       STUNTEBECK,KENNEY,DEERY,BISWAS,CASON+(NDAM)

BARDADIN  71 PR 04 2711        BARDANIN-OTWINOWSKA,HOFMOKL,+          (WARS)
BEAUPRE   71 NP B 28 77        +DEUTSCHMANN,GRAESSLER,+    (AACH+BERL+CERN)
FARBER    71 NP B 29 237       +DE PINTO,BISWAS,CASON,DEERY,KENNEY,+(NDAM)
FLATTE    71 PL 34 B 551       +ALSTON-GARNJOST,BARBARO-GALTIERI,+     (LBL)

AGUILAR   72 PR D 6 29         AGUILAR-BENITEZ,CHUNG,EISNER,SAMIOS     (BNL)
BISWAS    72 PR D 5 1564       +CASON,HARRINGTON,KENNEY,SHEPHARD      (NDAM)
FOGLI     72 NC 8 A 670        FOGLI-MUCIACCIA,PICCIARELLI            (BARI)
GRAYER    72 PHIL.CONF.PROC. 5 +HYAMS,JONES,SCHLEIN,BLUM,DIETL+(CERN+MPIM)
JACOBS    72 PR D 6 1291       L.D.JACOBS                            (SACLAY)
KEMP      72 NC 8 A 611        +MAJOR,CONTRI,+   (DURH+GENO+MILA+EPOL+LPNP)
SCARROTT  72 LNC 3 271         SCARROTT,KEMP                         (DURHAM)
TAKAHASH  72 PR D 6 1266       TAKAHASHI,BARISH,+        (TOHO+PENN+NDAM+ANL)
WHITEHEA  72 NP B 48 365       WHITEHEAD,AULD,+          (AERE+RHEL+SHMP+LOUC)
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Data Card Listings

For notation, see key at front of Listings.

Mesons

D(1285), A_2(1310)

D(1285)

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8  D (1285,JPG=  +) I=0
(JP=0-,1+,2- WITH 1+ FAVORED.)
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                    8  D MASS (MEV)

M          (1290.)   APPROX.         BARLOW     67 HBC    1.2 PBAR P, 4PFS  5/67
M           1283.0     5.0           DAHL       67 HBC     1.6-4.2 PI- P   10/66
M           1290.      7.            D.ANDLAU   68 HBC  1.2 PBAR P, 5-6 PFS 6/68
M          (1310.0)                  DEFOIX     68 HBC     1.2 PB P,7 PI    3/69
M           1270.0    10.0           CAMPBELL   69 DBC     2.7 PI+ D        8/69
M           1285.      7.            LORSTAD    69 HBC  0.7 PB P, 4,5-BODY  9/69
M           1303.0     8.0           BARDADIN   71 HBC     8 PI+ P, P+6PI   9/69
M           1283.0     6.0           BOESEBECK  71 HBC     16.0 PI P,5 PI   6/71
M       150 1292.     10.            DEFOIX     72 HBC     0.7 PBAR P,7 PI  1/73*
M       180 1286.      3.            DUBOC      72 HBC     1.2 PBAR P,2K4PI 12/72*
M   S   500(1280.)    (3.)           THUN       72 MMS     13.4 PI- P       12/72*
M   S    SEEN IN THE MISSING MASS SPECTRUM                                  12/72*
M            . . . . . . . . .
M   AVG     1286.1     2.2     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.1)

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                    8  D WIDTH (MEV)

W   R       (35.0)    (10.0)         DAHL       67 HBC     1.6-4.2 PI- P   11/71
W  U         46.       20.           D.ANDLAU   68 HBC  1.2 PBAR P, 5-6 PFS 2/72
W  U     UNFOLDED BY DOBRZYNSKI 71
W   R       (40.0)                   DEFOIX     68 HBC     1.2 PB P,7 PI   11/71
W            30.0      15.0          CAMPBELL   69 DBC     2.7 PI+ D        8/69
W   R       (60.)     (15.)          LORSTAD    69 HBC  0.7 PB P, 4,5-BODY 11/71
W   R       (44.0)    (24.0)         BARDADIN   71 HBC     8 PI+ P, P+6PI  11/71
W            10.0      10.0          BOESEBECK  71 HBC     16.0 PI P,5 PI   6/71
W   R  150  (28.)     (5.)           DEFOIX     72 HBC     0.7 PBAR P,7 P9  1/73*
W   R  180  (46.)     (9.)           DUBOC      72 HBC     1.2 PBAR P,2K4PI 12/72*
W   S  500  (37.)     (5.)           THUN       72 MMS     13.4 PI- P       12/72*
W   S    SEEN IN THE MISSING MASS SPECTRUM                                  12/72*
W   R  RESOLUTION NOT UNFOLDED                                              11/71
W            . . . . . . . . .
W   AVG      20.6      9.6     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.3)

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                    8  D   PARTIAL DECAY MODES

                                                           DECAY MASSES
P1      D INTO K KBAR PI                                   497+ 497+ 134
P2      D INTO PI PI RHO                                   134+ 134+ 770
P3      D INTO ETA PI PI                                   548+ 134+ 134
P4      D INTO DELTA PI                                    970+ 134
P5      D INTO 2PI+ 2PI-                                   139+ 139+ 139+ 139

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                    8  D BRANCHING RATIOS

R1      D INTO (PI PI RHO) / (K KBAR PI)                (P2)/(P1)
R1           (2.0)  OR LESS           DAHL       67 HBC     CHARGED PI ONLY 10/66
R1  D        (4.0)  OR LESS           DONALD     69 HBC     1.2 PBAR P,5P+ .
R1  D          THIS IS FOR (RHOO PI+ PI-)/(K KBAR PIO)

R2      D INTO (K KBAR PI)/(ETA PI PI)                  (P1)/(P3)
R2 K R         0.166      0.055       DEFOIX     68 HBC     1.2 PBAR P        1/73*
R2   R   REVISED BY DEFOIX 72
R2             0.16       0.08        CAMPBELL   69 DBC     2.7 PI+ D         1/73*
R2 K           0.20       0.08        DEFOIX     72 HBC     0.7 PBAR P,7 PI   1/73*
R2 K     K KBAR SYSTEM CHARACTERIZED BY THE I=1 THRESHOLD
R2 K     ENHANCEMENT (SEE UNDER DELTA(970)).
R2            . . . . . . . . .
R2  AVG        0.173      0.039   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

R3      D INTO (DELTA PI)/(ETA PI PI)                   (P4)/(P3)
R3             POSSIBLY SEEN          AMMAR      70 HBC     .4.1,5.5K-,ETA  5/70
R3             POSSIBLY SEEN          OTWINOWSK  70 HBC     8 PI+ P, P+6PI  9/69
R3             (0.8)      (0.2)       DEFOIX     72 HBC     0.7 PBAR P,7 PI . 1/73*

R4      D INTO (2PI+ 2PI- (INCL. RHO PI PI))/(ETA PI+ PI-)
R4                                                      (P5)/(2/3P3)
R4       50    (0.55) OR MORE         BOESEBECK  71 HBC     16. PI+- P,P 5PI 11/71

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                     REFERENCES FOR D

D.ANDLAU 65 PL 17 347          +BARLOW,ADAMSON,+       (CDEF+CERN+IRAD+LIVP)
MILLER   65 PRL 14 1074        +CHUNG,DAHL,HESS,HARDY,KIRZ,+        (LRL+UCB)
BARLOW   67 NC  50 A  701      +MONTANET,D-ANDLAU+    (CERN+CDEF+IRAD+LIVP)
DAHL     67 PR 163 1377        +HARDY+HESS+KIRZ+MILLER                (LRL)I JP
D.ANDLAU 68 NP  B 5  693       +ASTIER,BARLOW+         (CDEF+CERN+IRAD+LIVP)I JP
DEFOIX   68 PL 28 B 353        +RIVET,SIAUD,CONFORTO+       (CDEF+IPNP+CERN)

CAMPBELL 69 PRL  22 1204       +LICHTMAN,+                            (PURD)
DONALD   69 NP B 11 551        +EDWARDS,BURAN,BETTINI,+   (LIVP+OSLO+PADO)
LORSTAD  69 NP B 14 63         B.LORSTAD,D.ANDLAU,ASTIER,+     (CDEF+CERN)  JP
OTWINOWS 69 PL 29 B 529        S.OTWINOWSKI                         (WARSAW)

AMMAR    70 PR D2 430          +KROPAC,DAVIS,DERRICK+ (KANS+NWES+ANL+WISC)

BARDADIN 71 PR D4 2711         BARDADIN-OTWINOWSKA,HOFMOKL,MICHEJDA+(WARS)
BOESEBEC 71 PL 34 B 659              (AACH+BERL+BONN+CERN+CRAC+HEID+WARS)
DOBRZYNS 71  PRIV.COMMUN.      L.DOBRZYNSKI                    (CERN+CDEF)
GOLDBERG 71 LNC 1 627          +MAKOWSKI,TOUCHARD,DONALD,+      (IPN+LIVP)  JP

BERENYI  72 NP B 37 621        +PRENTICE,STEENBERG,YOON,WALKER (TNTO+WISC)
CHAPMAN  72 NP B 42 1          +CHURCH,LYS,MURPHY,RING,VANDER VELDE (MICH)
DEFOIX   72 NP B 44 125        +NASCIMENTO,BIZZARRI,+          (CDEF+CERN)
DUBOC    72 NP B 46 429        +GOLDBERG,MAKOWSKI,DONALD,+     (LPNP+LIVP)
THUN     72 PRL 28 1733        +BLIEDEN,FINOCCHIARO,BOWEN,+    (STON+NEAS)

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A_2(1310)

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12  A2 (1310,JPG=2+-) I=1
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We list the A_2 as an ordinary Breit-Wigner resonance. This conclusion is based on the failure of experiments with high statistics and good resolution to confirm the reported splitting; moreover the re-analyses of the most significant "split-peak" experiment have reduced the significance of the dip and revealed some experimental difficulties (DAMGAARD 72, e.g., Fig. 8; KIENZLE 72, e.g., Fig. 6).

For a recent review see DIEBOLD 72.

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                  12  A2 MASS (MEV),  3PI MODE

M          (1320.0)                  ADERHOLZ  64 HBC     4.0 PI+P
M           1335.0    10.0           GOLDHABER 64 HBC +-  3.7 PI+- P
M       130(1310.0)                  FORINO    65 DBC + 0 4.5 PI+ D         10/66
M      1425 1290.0    (5.0)          LEFEBVRES 65 MMSP -  5.6,6.0 PI-P       1/73*
M          (1300.0)                  SEIDLITZ  65 DBC  -  3.2 PI-D           6/66
M          (1290.0)   (10.0)         BARNES    66 HBC  -  6.0 PI-P           2/73*
M           1310.0    10.0           BENSON    66 DBC   0 3.65 PI+D          6/66
M      1060 1286.     (8.)           LEVRAT    66 MMS  -   6-7 PI- P         1/73*
M      4000 1307.     16.            CHIKOVANI 67 MMS  -  7 PI- P            8/67
M       260 1311.0     6.0           ARMENISE  68 DBC   0 5.1 PI+D           9/67
M       120 1320.     10.            BOESEBECK 68 HBC   0 8 PI+ P            6/68
M   D      (1310.)    (20.)          CHUNG     68 HBC  -  2.7-4.5 PI- P      5/68
M          (1301.0)   (8.0)          VON KROGH 68 HBC  -  6.7 PI- P          9/68
M   A      (1300.0)   (4.0)          JUNKMANN  68 HBC  -  16. PI- P, 5PI     1/73*
M   A      (1299.)    (14.)          LAMSA     68 HBC  -  8 PI- P            1/71
M   O      (1295.0)   (20.0)         ANDERSON  69 MMS  -  16 PI- P,BACKW9    8/69
M   A   241(1299.0)   (12.0)         ARMENISE  69 DBC  +  5.1 PI+D,3PI++-    5/70
M           1310.0    14.0           EISENBERG 69 HBC  +  4.3,5.3 GAMMA P   12/69
M           1305.     (3.)           ASCOLI    70 HBC  -  5 - 7.5 PI- P      1/71
M       941 1306.0     4.0           ALSTON-GA 70 HBC  +  7.0 PI+P,3PI P     1/71
M       280 1313.0     7.0           BOCKMANN  70 HBC     05. PI+P           5/70
M   A   581(1288.0)   (10.0)         CASO      70 HBC  - 11.2PI-P,PI RHO     1/73*
M           1335.0    15.0           DIAZ      70 HBC +- 0. PBAR P, 4 PI     5/70
M   D      (1330.0)   (15.0)         GARFINKEL 70 DBC  -  4.5 K-D,LAMBDA     1/71
M          (1274.0)   (22.0)         GORDON    70 DBC   0 4.2 PI+ D        . 1/71
M       360 1304.0     4.5           BARNHAM   71 HBC  +  3.7 PI+ P,(3PI)+ 11/71
M     10000 1307.      5.            BINNIE1   71 MMS  - PI-P NEAR A2 THR  11/71
M      5000 1309.      5.            BINNIE1   71 MMS  - PI-P NEAR A2 THR  11/71
M     28000 1299.0     6.0           BOWEN     71 MMS  - 5. PI- P           11/71
M     24000 1300.      6.0           BOWEN     71 MMS  + 5. PI+ P           11/71
M     17000 1309.0     4.0           BOWEN     71 MMS  - 7. PI- P           11/71
M   C      (1307.)    (12.)          BUHL      71 HBC  - 2.5 PI- P          11/71
M   P       1315.      4.            ANTIPOV   72 CNTR -  40. PI- P,P 3PI   12/72*
M       160 1307.      7.            BLOODWORT 72 HBC  +  5.45 PI+ P,P 3PI   1/73*
M      1580 1306.      9.            CHALOUPKA 73 HBC  -  3.9 PI- P,P A2     2/73*
M
M   O   ONLY EXPERIMENTS GIVING ERROR LESS THAN 20 MEV KEPT FOR AVERAGING   12/72*
M   D   MAY BE DIFFERENT OBJECT, ALTHOUGH JPC=2++. COMPARE CRENNELL 69.
M   A   ANALYSIS COMPLICATED BY NEARBY PEAK (A1.5) AND/OR A1
M   C      BACKWARD PRODUCTION                                              11/71
M   P   FROM A FIT TO JP=2+ RHO PI
M            . . . . . . . . .
M   AVG     1308.8     1.6     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.1)

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                  12  A2 MASS (MEV), K KBAR MODE

MK       80(1317.0)   (3.0)          BARLOW    67 HBC +-  1.2 PBAR P, KK . 2/72
MK       60 1333.0    13.0           BARLOW    67 HBC +-  1.2 PBAR P, KK   9/67
MK  N      (1344.0)   (7.)   (6.)    BEUSCH    67 OSPK  0 5-12 PI-P,K1K1  11/71
MK      130 1280.0    12.0           CONFORTO  67 HBC +-  0. PBAR P IN KK. 9/67
MK          1317.2     4.0           DAHL      67 HBC  -  2.7-4.5 PI- P    8/67
MK  N      (1315.7)   (10.8)         DAHL      67 HBC   0 2.7-4.5 PI- P   11/71
MK  N      (1311.0)   (5.0)          CRENNELL  68 HBC   0 6.0 PI-P,K1K1   11/71
MK       12(1315.0)                  ADERHOLZ  69 HBC  +  8 PI+ P,K+KO     8/69
MK      132 1301.0     7.0           ALSTON-GA 70 HBC  +  7.0 PI+P,K+KS P  1/71
MK      190 1313.0     7.0           CRENNEL   71 HBC  - 4.5 PI- P,KSK-P  11/71
MK S   1500 1319.0     3.0           GRAYER    71 ASPK - 17.2 PI-P,K-KS P  2/72
MK      730 1313.0     4.0           FOLEY     72 CNTR - 20.3 PI- P,K- KS 12/72*
MK
MK  N   THE NEUTRAL MODE CAN INTERFERE WITH THE F MESON
MK S    SYSTEMATIC ERROR IN MASS SCALE SUBTRACTED
MK           . . . . . . . . .
MK  AVG     1315.0 .   3.1     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.7)
                     (SEE IDEOGRAM BELOW )

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                  12  A2 MASS (MEV),  ETA PI MODE

M       189 1312.0     7.0           ALSTON-GA 70 HBC  + 7.0 PI+P,PI ETA   1/71
M           1300.0    20.0           CASO      70 HBC  - 11.2PI-P,PI ETA   5/70
M        32 1300.0     8.            DZIERBA   70 HBC  -  8. PI- P,PI ETA  1/73*
M        30 1288.      7.            JOHNSTON  70 HBC  -  7.PI-P,PI-ETA P  1/71
M           1320.     20.            ESPIGAT   72 HBC  <- 0.PBAR P,ETA 2PI 11/71
M       906(1326.)    (3.)           PREPOST   72 OSPK - 6.PI- P,P PI ETA  1/73*
M            . . . . . . . . .
M   AVG     1300.8     5.3     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.3)
                     (SEE IDEOGRAM BELOW )

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M       FOR THE MASSES OF A2L AND A2H SEE OUR APRIL 72 EDITION.
M       SEE ALSO THE TYPED NOTE ABOVE.

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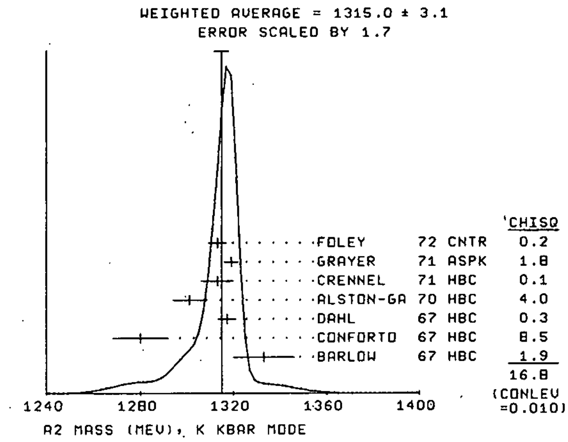
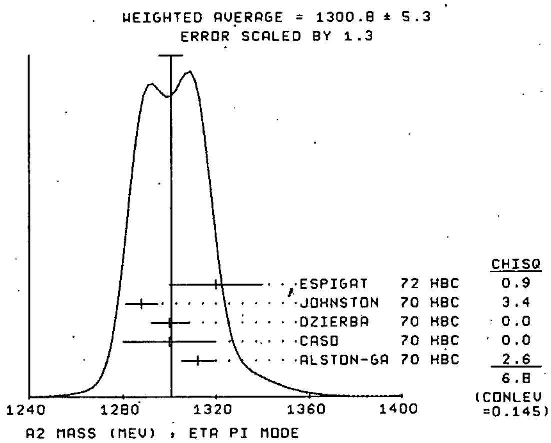
Mesons

$A_2(1310)$

Data Card Listings

For notation, see key at front of Listings.



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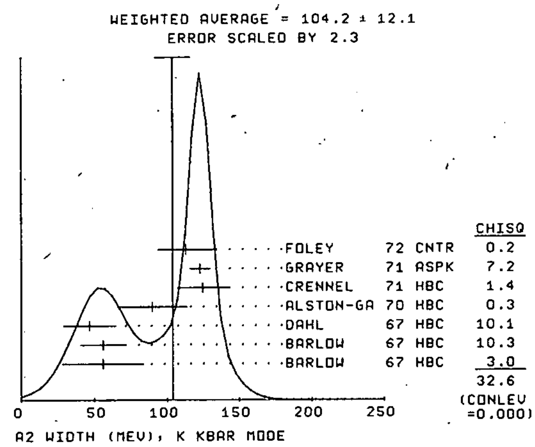
                  12  A2 WIDTH (MEV), 3PI MODE

W            (100.0)                         ADERHOLZ  64 HBC      4.0 PI+P
W              90.0      10.0                GOLDHABER 64 HBC  +-  3.7 PI+- P
W       1425   99.0     (15.0)               LEFEBVRES 65 MMSP  -  6.0 PI-P          1/73*
W             (140.0)                        SEIDLITZ  65 DBC   -  3.2 PI-D          6/66
W             (70.0)    (10.0)               BARNES    66 HBC   -  6.0 PI-P          2/73*
W              100.      15.                 BENSON    66 DBC   0 3.65 PI+D          1/67
W       1060   98.       (5.)                LEVRAT    66 MMS   -  6,7 PI- P         1/73*
W       4000   90.       15.                 CHIKOVANI 67 MMS   -  7 PI- P           8/67
W        260   96.0      16.0                ARMENISE  68 DBC   0 5.1 PI+D           9/67
W   O    120  (56.)     (21.)                BOESEBECK 68 HBC   0 8 PI+ P            1/73*
W   O         (80.)     (20.)                CHUNG     68 HBC   -  2.7-4.5 PI- P     5/68
W             (40.0)    (25.0)               VON KROGH 68 HBC   -  6.7 PI- P         9/68
W   A         (52.0)    (16.0)               JUNKMANN  68 HBC   -  16. PI- P, 5PI    1/73*
W              90.0      10.0      50.0      ANDERSON  69 MMS   -  16 PI- P,BACKW9   8/69
W   AE   241 (164.0)    (20.0)               ARMENISE  69 DBC   +  5.1 PI+D,3PI++-   5/70
W   O         (80.0)    (30.0)               EISENBERG 69 HBC   + 4.3,5.3 GAMMA P   12/69
W        941   79.0      12.0                ALSTON-GA 70 HBC   + 7.0 PI+P,3PI P     1/71
W   O    280  (70.0)    (29.0)               BOCKMANN  70 HBC    05. PI+P            5/70
W   A    581 (135.0)    (26.0)               CASO      70 HBC   - 11.2PI-P,PI RHO    1/73*
W   O         (90.0)    (20.0)               DIAZ      70 HBC  +- 0. PBAR P, 4 PI    5/70
W   D         (35.0)    (35.0)               GARFINKEL 70 DBC   -  4.5 K-D,LAMBDA    1/71
W            (215.0)    (22.0)               GORDON    70 DBC   0 4.2 PI+ D          1/71
W        360  111.4      18.0                BARNHAM   71 HBC   + 3.7 PI+ P,(3PI)+ 11/71
W      10000 (100.)                          BINNIE1   71 MMS   - PI-P NEAR A2 THR 11/71
W       5000   72.       16.                 BINNIE1   71 MMS   - PI-P NEAR A2 THR 11/71
W      28000  105.0       5.0                BOWEN     71 MMS   - 5. PI- P          11/71
W      24000   99.0       5.0                BOWEN     71 MMS   + 5. PI+ P          11/71
W      17000  103.0       5.0                BOWEN     71 MMS   - 7. PI- P          11/71
W  P           110.      15.                 ANTIPOV   72 CNTR - 40. PI- P,P 3PI  12/72*
W   O    160  (72.)     (25.)                BLOODWORT 72 HBC  + 5.45 PI+ P,P 3PI 12/72*
W       1580   99.       15.                 CHALOUPKA 73 HBC  - 3.9 PI- P,P A2    2/73*
W
W   O   ONLY EXPERIMENTS GIVING ERROR LESS THAN 20 MEV KEPT FOR AVERAGING   12/72*
W   E   BACKGROUND SUBTRACTION MODEL-DEPENDENT.                              5/70
W   D   MAY BE DIFFERENT OBJECT, ALTHOUGH JPC=2++. COMPARE CRENNELL 69.
W  A    ANALYSIS COMPLICATED BY NEARBY PEAK (A1.5) AND/OR A1
W  P    FROM A FIT TO JP=2+ RHO PI
W           . . . . . . . . .
W   AVG        99.6       2.4    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
```

```
                  12  A2 WIDTH (MEV), K KBAR MODE

WK       60   56.0      28.0               BARLOW    67 HBC  +-  1.2 PBAR P, KK    9/67
WK       80   56.0      15.0               BARLOW    67 HBC  +-  1.2 PBAR P, KK    9/67
WK  N        (88.)     (23.)      (22.)    BEUSCH    67 OSPK  0 5-12 PI-P,K1K1   11/71
WK      130  (90.0)                        CONFORTO  67 HBC  +-  0. PBAR P IN KK   9/67
WK             47.      18.                DAHL      67 HBC   -  2.7-4.5 PI- P     8/67
WK  N        (80.5)    (36.5)              DAHL      67 HBC   0 2.7-4.5 PI- P    11/71
WK  N        (21.0)    (10.0)     (6.0)    CRENNELL  68 HBC   0 6.0 PI-P,K1K1    11/71
WK       12  (34.0)                        ADERHOLZ  69 HBC  +   8 PI+ P,K+K0     8/69
WK      132   90.0      24.0               ALSTON-GA 70 HBC  +  7.0 PI+P,K+KS P   1/71
WK      190  125.0      19.0      16.0     CRENNEL   71 HBC   - 4.5 PI- P,KSK-P  11/71
WK     1500  123.0       7.0               GRAYER    71 ASPK  - 17.2 PI-P,K-KS P 11/71
WK      730  113.0      19.0               FOLEY     72 CNTR  - 20.3 PI- P,K- KS 12/72*
WK  N   THE NEUTRAL MODE CAN INTERFERE WITH THE F MESON
WK          . . . . . . . . .
WK  AVG      104.2      12.1      AVERAGE (ERROR INCLUDES SCALE FACTOR OF 2.3)
                         (SEE IDEOGRAM BELOW )
```

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                  12  A2 WIDTH (MEV); ETA PI MODE

W        189  103.0     20.0               ALSTON-GA 70 HBC  +  7.0 PI+P,PI ETA   1/71
W            (120.0)                       CASO      70 HBC  - 11.2PI-P,PI ETA   5/70
W         32  (41.0)   (20.0)    (16.0)    DZIERBA   70 HBC  -   8. PI- P,PI ETA 11/70
W   T     30  (38.0)   (30.0)              JOHNSTON  70 HBC  -   7.PI-P,PI-ETA P  1/73*
W              120.     30.                ESPIGAT   72 HBC  +- 0.PBAR P,ETA 2PI 11/71
W        906 (116.)    (16.)               PREPOST   72 OSPK -  6.PI- P,P PI ETA  1/73*
W   T   ERROR INCREASED BY US. SEE TYPED NOTE ON K* MASS.
W          . . . . . . . . .
W   AVG       108.2     16.6     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
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W       FOR THE WIDTHS OF A2L AND A2H SEE OUR APRIL 72 EDITION.
W       SEE ALSO THE TYPED NOTE ABOVE.
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                  12  A2 PARTIAL DECAY MODES

                                                         DECAY MASSES
P1       A2 INTO RHO PI                                  770+ 139
P2       A2 INTO K KBAR.                                 493+ 497
P3       A2 INTO ETA PI                                  548+ 139
P4       A2 INTO OMEGA PI PI                             139+ 139+ 783
P5 S     A2 INTO PI+ PI- PI0 EXCL.RHO PI                 139+ 139+ 134
P6 S     A2 INTO PI+ PI- PI- EXCL.RHO PI                 139+ 139+ 139
P7 S     A2 INTO PI GAMMA                                139+   0
P8 S     A2 INTO ETA PRIME PI                            958+ 139
P  S      SMALL, NOT USED IN THE FIT
```

FITTED PARTIAL DECAY MODE BRANCHING FRACTIONS

The matrix below is derived from the error matrix for the fitted partial decay mode branching fractions, P_i, as follows: The diagonal elements are $P_i \pm \delta P_i$, where $\delta P_i = \sqrt{\langle \delta P_i \delta P_i \rangle}$, while the off-diagonal elements are the normalized correlation coefficients $\langle \delta P_i \delta P_j \rangle / (\delta P_i \cdot \delta P_j)$. For the definitions of the individual P_i, see the listings above; only those P_i appearing in the matrix are assumed in the fit to be nonzero and are thus constrained to add to 1.

	P 1	P 2	P 3	P 4
P 1	.7236+-.0211			
P 2	.0077	.0475+-.0058		
P 3	-.2538	-.0925	.1526+-.0132	
P 4	-.7960	-.2131	-.3270	.0764+-.0223

Data Card Listings

For notation, see key at front of Listings.

Mesons

$A_2(1310)$, E(1420)

12 A2 BRANCHING RATIOS

R1 A2 INTO (K KBAR) / (RHO PI) (P2)/(P1)
R1 (0.08) OR LESS LANDER 64 HBC + 3.5 PI+P 10/66
R1 N (0.13) (0.03) BEUSCH 67 OSPK 0 5.7,12 PI-+ 9/67
R1 11 0.09 0.06 0.09 ASCOLI 68 HBC - 5 PI-P 6/68
R1 0.054 0.022 CHUNG 68 HBC - 3.2 PI-P 1/67
R1 (0.03) (0.012) DONALD 68 HBC +- 1.2 PBAR P 2/72
R1 N (0.14) (0.05) BOCKMANN 70 HBC 0 5.0 PI+P 9/69
R1 0.07 0.05 BOCKMANN 70 HBC + 5.0 PI+P 9/69
R1 N THE NEUTRAL MODE CAN INTERFERE WITH F.
R1 0.06 0.03 ABRAMOVIC 70 HBC - 3.93 PI- P 1/71
R1 E (0.024) (0.006) DIAZ 70 HBC +- 0. PBAR P, 4 PI 11/71
R1 E SUPERSEDED BY ESPIGAT 71 (SEE UNDER R2 AND R8) 11/71
R1 0.07 0.03 NEF 70 MMS - 7.0 PI- P 6/70
R1 113 0.097 0.018 ALSTON-GA 71 HBC + 7.0 PI+ P 2/71
R1 50 0.056 0.014 CHALOUPKA 73 HBC - 3.9 PI- P,P A2 2/73*
R1 . . . .
R1 AVG 0.0678 0.0088 AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R1 FIT 0.0656 0.0082 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R2 A2 INTO (ETA PI)/(RHO PI + K KBAR + ETA PI) (P3)/(P1+P2+P3)
R2 34 0.15 0.04 BARNHAM 71 HBC + 3.7 PI+ P 11/71
R2 0.13 0.04 ESPIGAT 72 HBC +- 0.PBAR P, 11/71
R2 . . . .
R2 AVG 0.140 0.028 AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R2 FIT 0.165 0.013 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R3 A2 INTO (ETA PI) / (RHO PI) (P3)/(P1)
R3 0.3 0.2 ADERHOLZ 64 HBC 4.0 PI+P
R3 0.22 0.09 CONTE 67 HBC - 11.0 PI-P 8/67
R3 22 0.23 0.08 ASCOLI 68 HBC - 5 PI-P 6/68
R3 0.12 0.08 CHUNG 68 HBC - 3.2 PI-P 12/66
R3 (0.072)OR LESS DONALD 68 HBC +- 1.2 PBAR P 6/68
R3 0.16 0.10 KEY 68 HBC - 3 PI-P 11/67
R3 D (0.18) (0.06) VETLITSKY 69 HBC - 3.3 PI- P 9/68
R3 0.3 0.13 ABRAMOVIC 70 HBC - 3.93 PI- P 1/71
R3 15 0.25 0.09 BOCKMANN 70 HBC + 5.0 PI+P 9/69
R3 0.34 0.17 0.34 BOCKMANN 70 HBC 0 5.0 PI+ P 9/69
R3 D 39 (0.18) (0.07) DZIERBA 70 HBC - 8. PI- P 11/71
R3 167 0.246 0.042 ALSTON-GA 71 HBC + 7.0 PI+ P 2/71
R3 149 0.211 0.044 CHALOUPKA 73 HBC - 3.9 PI- P,P A2 2/73*
R3 . . . .
R3 AVG 0.221 0.023 AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R3 FIT 0.211 0.021 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R4 A2 INTO (ETA PRIME PI) / TOTAL (P8)
R4 (0.1) OR LESS CHUNG 65 HBC - 3.2 PI-P
R4 S 0.02 OR LESS CL=.97 BARNHAM 71 HBC + 3.7 PI+ P 2/72
R4 S 0.0 0.01 LIMIT ABOVE RESTATED FOR AVERAGING 2/72

R5 A2 INTO (ETA PRIME PI)/(RHO PI) (P8)/(P1)
R5 S 14 (0.07) (0.03) ASCOLI 68 HBC - 5.0 PI-P 12/72*
R5 S SUPERSEDED BY EISENSTEIN 72
R5 0.04 0.03 0.04 BOCKMANN 70 HBC 0 5.0 PI+ P 9/69
R5 D 8 (0.15) (0.09) DZIERBA 70 HBC - 8. PI- P 11/71
R5 D STRONGLY DEPENDENT ON BACKGROUND SUBTRACTION 11/71
R5 (0.04) OR LESS ALSTON-GA 71 HBC + 7.0 PI+ P 2/71
R5 (0.011)OR LESS CL=.90 EISENSTEI 72 HBC - 5.PI- P,P 6PI 12/72*

R6 A2 INTO (PI+ PI- PIO) / (RHO PI) (P5)/(P1)
R6 (0.17) OR LESS BENSON 66 DBC 0 3.7 PI+D

R7 A2 INTO (ETA PI)/(K KBAR) (P3)/(P2)
R7 E (3.0) OR LESS FOSTER 68 HBC - PBAR P,PBA REST 11/71
R7 E SUPERSEDED BY ESPIGAT 72 (SEE UNDER R2 AND R8) 11/71
R7 . . . .
R7 FIT 3.22 0.50 FROM FIT

R8 A2 INTO (K KBAR)/(RHO PI + K KBAR + ETA PI) (P2)/(P1+P2+P3)
R8 17 0.06 0.03 BARNHAM 71 HBC + 3.7 PI+ P,KSK+P 11/71
R8 A (0.020) (0.004) ESPIGAT 72 HBC +- 0.PBAR P, 2/72
R8 A NOT AVERAGED BECAUSE OF DISCREPANCY BETWEEN MASSES
R8 A FROM (K KBAR) AND (RHO PI) MODES
R8 8 0.03 0.02 DAMERI 72 HBC - 11. PI- P 12/72*
R8 . . . .
R8 AVG 0.039 0.017 AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R8 FIT 0.0514 0.0062 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R9 A2 INTO (PI+ PI- PI-)/(RHOO PI-) (P6C)/(P1C)
R9 (0.23) OR LESS CL=.90 ABRAMOVIC 70 HBC - 3.93 PI- P 1/71

R11 A2 INTO (PI GAMMA)/TOTAL (P7)
R11 R (0.005) (0.005) (0.003)EISENBERG 71 HBC PHOTOPRODUCTION 11/71
R11 R PION EXCHANGE MODEL USED IN THIS ESTIMATION 11/71

R12 A2 INTO (OMEGA PI PI)/(RHO PI) (P4)/(P1)
R12 D 0.23 0.10 DEFOIX 72 HBC 0 0.7 PBAR P,7 PI 2/73*
R12 D DECAYS TO B1(1040) PI, B1 INTO OMEGA PI .
R12 D ERROR INCREASED TO ACCOUNT FOR POSSIBLE SYST. ERRORS
R12 D OF COMPLICATED ANALYSIS.
R12 0.08 0.05 GARNJOST 72 HBC 0 7.1 PI+ P 2/73*
R12 279 0.10 0.05 CHALOUPKA 73 HBC - 3.9 PI- P,P A2 2/73*
R12 . . . .
R12 AVG 0.106 0.033 AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R12 FIT 0.106 0.033 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)
****** ********* ********* ********* ********* ********* ********* ********

REFERENCES FOR A2

ADERHOLZ 64 PL 10 248 (AACHEN+BERLIN+BIRM+BONN+HAMBURG+LOIC+MPIM)
CHUNG 64 PRL 12 621 +DAHL,HARDY,HESS,KALBFLEISCH,KIRZ (LRL)
GOLDHABE 64 DUBNA CONF 1 480 G GOLDHABER,S GOLDHABER,OHALLORAN,SHEN(LRL)
LANDER 64 PRL 13 346 +ABOLINS,CARMONY,HENDRIKS,XUONG+ (LA JOLLA)

ABOLINS 65 ATHENS(OHIO)CONF. +CARMONY,LANDER,XUONG,YAGER (LA JOLLA)I=1
ADERHOLZ 65 PR 138 B 897 (AACHEN+BERL+BIRM+BONN+HAMB+LOIC+MPIM)
ALITTI 65 PL 15 69 ALITTI,BATON,DELER,CRUSSARD+ (SACLAY+BGNA) JP
CHUNG 65 PRL 15 325 +DAHL,HARDY,HESS,JACOBS,KIRZ,MILLER (LRL)
FORINO 65 PL 19 68 +GESSAROLI+ (BGNA+BARI+FIRZ+ORSA+SACL)
LEFEBVRE 65 PL 19 434 CERN MISSING MASS SPECTROMETER GROUP (CERN)
SEIDLITZ 65 PRL 15 217 L SEIDLITZ,O I DAHL,D H MILLER (LRL)

BARNES 66 PRL 16 41 BARNES,FOWLER,LAI,ORENSTEIN + (BNL+CUNY)
BENSON 66 MICH COO-1112-4 G.C.BENSON, THESIS (MICH)
ALSO 66 PRL 16 1177 G BENSON,LOVELL,MARQUIT,ROE + (MICH)
EHRLICH 66 PR 152 1194 R. EHRLICH,W.SELOVE,H.YUTA (PENN)
FERBEL 66 PL 21 111 FERBEL (ROCHESTER)
LEVRAT 66 PL 22 714 CERN MISSING MASS SPECTROMETER GROUP (CERN)

ARMENISE 67 PL 25B 53 ARMENISE,FORINO,+ (BARI+BGNA+FIRZ+ORSAY)
BALTAY 67 PL 25B 160 +KIRSCH+KUNG+YEH+RABIN (COLU+BNL+RUTGERS)
BARLOW 67 NC 50A 701 +LILLESTOL+MONTANET+ (CERN+CDEF+IRAD+LIVP)
BARTSCH 67 PL 25B 48 +DEUTSCHMANN+GROTE+COCCONI+(AACH+BERL+CERN)
BEUSCH 67 PL 25 B 357 +FISCHER,GOBBI,ASTBURY+ (ETHZ+CERN)
CASON 67 PRL 18 880 +LAMSA,BISWAS,DERADO,GROVES,+ (NOTREDAME)
ALSO 68 LAMSA
CHIKOVAN 67 PL 25B 44 CERN MISSING MASS SPECTROMETER GROUP (CERN)
CHUNG 67 PRL 18 100 +DAHL,HARDY,HESS,KIRZ,MILLER (LRL)
ALSO 66 UCRL-16832 RICHARD I HESS--THESIS,BERKELEY (LRL)
COHN 67 NP B1 57 +MCCULLOCH+BUGG+CONDO (ORNL+UNIV.TENN.)
CONFORTO 67 NP B3 469 +MARECHAL,MONTANET+ (CERN+CDEF+IPN+LIVP)
CONTE 67 NC 51 A 175 +TOMASINI,CORDS+(GENOVA+HAMB+MILANO+SACLAY)
DAHL 67 PR 163 1377 +HARDY+HESS+KIRZ+MILLER (LRL)
DANYSZ 67 NC 51 A 801 DANYSZ+FRENCH+SIMAK (CERN)
SLATTERY 67 NC 50A 377 +KRAYBILL+FORMAN+FERBEL (YALE+ROCH) JP

ARMENISE 68 PL 26B 336 ARMENISE,FORINO,+ (BARI+BGNA+FIRZ+ORSAY)
ASCOLI 68 PRL 20 1321 +CRAWLEY,MORTARA,SHAPIRO,BRIDGES+(ILLINOIS) JP
BALLAM 68 PRL 21 934 +BRODY,CHADWICK,FRIES,GUIRAGOSSIAN+ (SLAC)
BENZ 68 PL 28 B 233 CERN MISSING MASS SPECTROMETER GROUP (CERN)
BOESEBEC 68 NP B 4 501 BOESEBECK,DEUTSCHMANN,+(AACHEN+BERLIN+CERN)
CASO 68 NC 54 A 983 +CONTE+CORDS+DIAZ+ (GENOVA+HAMB+MILAN+SACL)
CHUNG 68 PR 165 1491 S.U.CHUNG,O.DAHL,J.KIRZ,D.H.MILLER (LRL)
CRENNELL 68 PRL 20 1318 +KARSHON+KWAN LAI,SCARR,SKILLICORN (BNL)
DONALD 68 PL 26 B 327 +FRODESEN+BETTINI+ (LIVERPOOL+OSLO+PADUA)
FOSTER 68 NP B 8 174 +GAVILLET,LABROSSE,MONTANET,+ (CERN+CDEF)
FRIDMAN 68 PR 167 1268 +MAURER,MICHALON,OUDET+(HEID +STRASBOURG)
JUNKMANN 68 NP 88 471 +COCCONI,+ (AACH+BERL+BONN+CERN+WARS)
KEY 68 PR 166 1430 +PRENTICE+COOPER+MANNER+ (TNTO+ANL+WISC)
LAMSA 68 PR 166 1395 +CASON+BISWAS+DERADO+GROVES+ (NOTREDAME)
VON KROG 68 PL 27 B 253 +MIYASHITA,KOPELMAN,MARSHALL LIBBY (COLO)

ADERHOLZ 69 NP B 11 259 +BARTSCH,+ (AACH+BERL+CERN+JAGL+WARS)
AGUILAR 169 PL 29 B 62 +BARLOW,JACOBS,DELLA NEGRA+(CERN+CDEF+LIVP)
AGUILAR 269 PL 29 B 241 M.AGUILAR-BENITEZ,J.BARLOW,+ (CERN+CDEF)
ANDERSON 69 PRL 22 1390 +COLLINS,+ (BNL+CARN)
ARMENISE 69 LNC 2 501 +GHIDINI,FORINO,CARTACCI+ (BARI+BGNA+FIRZ)
CHIKOVAN 69 PL 28 B 526 CERN MISSING MASS SPECTROMETER GROUP (CERN) JP
CRENNELL 69 PRL 22 1327 +KARSHON,KWAN WU LAI,+ (BNL)JP
DONALD 69 NP B 12 325 +EDWARDS,FOSTER,MOORE (LIVERPOOL)
EISENBER 69 PRL 23 1322 EISENBERG,HABER,BALLAM,CHADWICK+(REHO+SLAC)
ALSO 67 BARLOW,67 CONFORTO
VETLITSK 69 SJNP 9 596 VETLITSKY,GRIGOREYEV,GRISHIN,+ (ITEP)

ABRAMOVI 70 NP B 29 466 ABRAMOVICH,BLUMENFELD,BRUYANT,+ (CERN) JP
ALSTON-GA70 PL 33 B 607 +BARBARO,BUHL,DERENZO,EPPERSON,FLATTE+(LRL)
ASCOLI 70 PRL 25 962 +BROCKWAY,CRAWLEY,EISENSTEIN,HANFT,+ (ILL) JP
BASILE 70 LNC 4 838 +DALPIAZ,FRABETTI,MASSAM,+ (CERN+BGNA+STRB)
BAUD1 70 PL 31B 397 CERN BOSON SPECTROMETER GROUP (CERN)
BAUD2 70 PHILAD.CONF.P.311 CERN BOSON SPECTROMETER GROUP (CERN)
BAUD3 70 PL 31 B 401 CERN BOSON SPECTROMETER GROUP (CERN)
BOCKMANN 70 NP B 16 221 +MAJOR,POLS,+ (BONN+DURH+NIJM+EPOL+TORI)
BUTLER 70 UCRL 19845 THESIS (LRL)
CAROLL 70 PRL 25 1393 +FIREBAUGH,GARFINKEL,MORSE,OH,+ (WISC+TNTO)
CASO 70 LNC 3 707 +CONTE,TOMASINI,CORDS+(GENO+HAMB+MILA+SACL)
DIAZ 70 NP B 16 239 +GAVILLET,LABROSSE,MONTANET+ (CERN+CDEF)JP
DZIERBA 70 PR D 2 2544 +SHEPHARD,BISWAS,CASON,JOHNSON,KENNEY(NDAM)
ALSO 68 LAMSA
GARFINKE 70 PL 33 B 536 GARFINKEL,AMMANN,CARMONY,YEN (PURDUE)JC
GORDON 70 COO 1195 179 THESIS,ILLINOIS (ILL)
JOHNSTON 70 NP B 24 253 +KEY,PRENTICE,YOON,GARFINKEL,+ (TNTO+WISC)
KRUSE 70 PHILAD.CONF.P.359 U.KRUSE, PARTIAL WAVE ANALYSIS (ILL) JP
NEF 70 THESIS+PRIV.COMM.CERN BOSON SPECTROMETER GROUP (CERN)
SUTHERLA 70 PHILAD.CONF.P.369 G.SUTHERLAND,INTERFERING RESONANCE(GLASGOW)

AGUILAR 71 PR D 4 2583 AGUILAR-BENITEZ,EISNER,KINSON (BNL)
ALSTON-GA71 PL 34 B 156 +BARBARO,BUHL,DERENZO,EPPERSON,FLATTE+(LRL)
BARNHAM 71 PRL 26 1494 +ABRAMS,BUTLER,COYNE,GOLDHABER,HALL,+ (LBL)
BEKETOV 71 SJNP 4 765 +SOMBKOWSKY,KONONALOV,KRUTSCHININ,+ (ITEP) JP
BINNIE1 71 PL 36 B 257 +CAMILLERI,DUANE,FARUQI,BURTON,+(LOIC+SHMP)
BINNIE2 71 PL 36 B 537 +CAMILLERI,DUANE,FARUQI,BURTON,+(LOIC+SHMP)
BOWEN 71 PRL 26 1663 +FARLES,FAISSLER,BLIEDEN,+ NEAS+STON
BUHL 71 PREPRINT +CLINE,TERREL (WISCONSIN)
CLAYTON 71 PREPRINT +MASON,MUIRHEAD,RIGOPOULOS,+ (LIVP+ATEN)
CRENNEL 71 PL 35 B 185 +GORDON,KWAN-WU LAI,SCARR (BNL)
EISENBER 71 SLAC-PUB-933 EISENBERG,HABER,BALLAM,CHADWICK+(REHO+STAN)
FARBER 71 NP B 29 237 +DE PINTO,BISWAS,CASON,DEERY,KENNEY,+(NDAM)
FOLEY 71 PRL 26 413 +LOVE,OZAKI,PLATNER,LINDENBAUM,+ (BNL+CUNY)
GRAYER 71 PL 34 B 333 +HYAMS,JONES,SCHLEIN,BLUM,DIETL+(CERN+MPIM)
LYNCH 71 UCRL 20022 AND 71 AMSTERDAM CONF. G.LYNCH (LBL)
RINAUDO 71 NC 5 A 239 +BOECKMANN,MAJOR+(TORI+BONN+DURH+NIJM+EPOL) JP

ANKENBRA 72 PRL 29 1688 ANKENBRANDT,BRABSON,CRITTENDEN,HEINZ,+(INO)
ANTIPOV 72 PHIL.CONF.PROC. +ASCOLI,BUSNELLO,DAMGAARD,+ (SERP+CERN)
BERENYI 72 NP B 37 621 +PRENTICE,STEENBERG,YOON,WALKER (TNTO+WISC)
BLOODWOR 72 NP B 37 203 BLOODWORTH,JACKSON,PRENTICE,YOON (TNTO)
DAMERI 72 NC 9 A 1 +BORZATTA,COUSSU,+ (GENO+MILA+SACL)
DAMGAARD 72 UNPUBLISHED MEMO +LECHANOINE,MARTIN (BOHR+GEVA)
DEFOIX 72 SUBMITTED TO PL +DOBRZYNSKI,ESPIGAT,NASCIMENTO,+ (COEF)
DIEBOLD 72 BATAV.CONF. R.DIEBOLD RAPPORTEUR TALK (ANL)
EISENBER 72 PR D 5 15 EISENBERG,BALLAM,DAGAN,+ (REHO+SLAC+TELA)
EISENSTE 72 COO-1195-247 EISENSTEIN,SCHULTZ,ASCOLI,IOFFREDO,+ (ILL)
ESPIGAT 72 NP B 36 93 +GHESQUIERE,LILLESTOL,MONTANET (CERN+CDEF)
FOLEY 72 PR D 6 747 +LOVE,OZAKI,PLATNER,LINDENBAUM,+ (BNL+CUNY)
GARNJOST 72 PRIV.COMMUNIC. M.ALSTON-GARNJOST (LBL)
GETTNER 72 PREPRINT NUB2145 M.GETTNER (NEAS)
KIENZLE 72 UNPUBLISHED MEMO W.KIENZLE (CERN)
LASSILA 72 PRL 28 1491 LASSILA,YOUNG (IOWA)
MORSE 72 NP B 43 77 +OH,WALKER,JOHNSTON,YOON (WISC+TNTO)
PREPOST 72 PHIL.CONF.PROC. +CONFORTO,KEY,MOBLEY,+ (WISC+CHIC+TNTO+NAL)

CHALOUPK 73 SUBMITTED TO PL CHALOUPKA,DOBRZYNSKI,FERRANDO,LOSTY,+(CERN)

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E(1420)

6 E (1420,JPG=A +) I=0

BAILLON 67 FAVOR JP=0-. DAHL 67 FAVOR 1+ BUT DO NOT
EXCLUDE 2-, 0-. LORSTAD 69 FIND 0- OR 1+.

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6 E MASS (MEV)

M 1425. 7. BAILLON 67 HBC 0. PBAR P 11/66
M 1420.0 20.0 DAHL 67 HBC 1.6-4.2 PI- P 10/66
M 1423. 10. FRENCH 67 HBC 3-4 PBAR P 6/67
M 310 1420. 7. LORSTAD 69 HBC 0.7 PB P, 4,5-BODY 9/69
M 170 1398. 10. DEFOIX 72 HBC 0.7 PBAR P,7 PI 1/73*
M 280 1406. 7. DUBOC 72 HBC 1.2 PBAR P,2K4PI 12/72*
M . . . .
M AVG 1415.5 4.3 AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.2)

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Mesons

E(1420), X_0(1430), X_1(1440), f′(1514)

Data Card Listings

For notation, see key at front of Listings.

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                    6  E WIDTH (MEV)

W             80.       10.           BAILLON   67 HBC    0. PBAR P          11/66
W             60.0      20.0          DAHL      67 HBC     1.6-4.2 PI- P     10/66
W             45.       20.           FRENCH    67 HBC     3-4 PBAR P         6/67
W       310   60.       20.           LORSTAD   69 HBC  0.7 PB P, 4,5-BODY   9/69
W       170   50.       10.           DEFOIX    72 HBC     0.7 PBAR P,7 PI    1/73*
W       280   50.       12.           DUBOC     72 HBC     1.2 PBAR P,2K4PI  12/72*
W             . . . . . . . . . .
W    AVG      59.8       6.0     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.1)

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                    6  E PARTIAL DECAY MODES

                                                      DECAY MASSES
P1      E INTO K K*(892)                              497+ 891
P2      E INTO K KBAR PI                              497+ 497+ 139
P3      E INTO PI PI RHO                              134+ 134+ 770
P4      E INTO DELTA PI                               970+ 139
P5      E INTO ETA PI PI                              548+ 139+ 139

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                    6  E BRANCHING RATIOS

R1      E INTO (KBAR K*(892) + C.C.)/(K KBAR PI)      (P1)/(P2)
R1            .50      .10        BAILLON   67 HBC     0.0 PBAR P         11/66

R2      E INTO (PI PI RHO) / (K KBAR PI)              (P3)/(P2)
R2           (2.0)  OR LESS       DAHL      67 HBC   0  1.6-4.2 PI- P .10/66

R3      E INTO (ETA 2 PI)/(K KBAR PI)                 (P5)/(P2)
R3           (1.5)  OR LESS  CL=.95  FOSTER    68 HBC   - 0.0 PBAR P        9/69
R3            1.5       0.8       DEFOIX    72 HBC     0.7 PBAR P          1/73*

R4      E INTO (DELTA PI)/(ETA PI PI)                 (P4)/(P5)
R4            0.4       0.2       DEFOIX    72 HBC     0.7 PBAR P,7 PI    1/73*

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                         REFERENCES FOR E

BAILLON  67 NC 50A  393      +EDWARDS+D.ANDLAU+ASTIER+  (CERN+COEF+IRAD)
BARASH   67 PR 156  1399     BARASH,KIRSCH,MILLER,TAN           (COLUMBIA)
DAHL     67 PR 163 1377      +HARDY+HESS+KIRZ+MILLER               (LRL)I JP
   ALSO 65 PRL 14 1074       MILLER,CHUNG,DAHL,HESS,HARDY,KIRZ+(LRL+UCB)
FRENCH   67 NC 52A 438       +KINSON+MCDONALD+RIDDIFORD+       (CERN+BIRM)

FOSTER   68 NP B 8 174       +GAVILLET,LABROSSE,MONTANET,+     (CERN+CDEF)
BETTINI  69 NC 62 A 1038     +CRESTI,LIMENTANI,BERTAUZA,BIGI+(PADO+PISA)IC
LORSTAD  69 NP B 14 63       B.LORSTAD,D.ANDLAU,ASTIER,+       (CDEF+CERN)  JP
DEVONS   71 PRL 27 1614      +KOZLOWSKI,HORWITZ,+              (COLU+SYRA)

CHAPMAN  72 NP B 42 1        +CHURCH,LYS,MURPHY,RING,VANDER VELDE (MICH)
DEFOIX   72 NP B 44 125      +NASCIMENTO,BIZZARRI,+            (CDEF+CERN)
DUBOC    72 NP B 46 429      +GOLDBERG,MAKOWSKI,DONALD,+       (LPNP+LIVP)

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X_0(1430) $\rightarrow K_S K_S, \rho^0\rho^0$

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29  X (1430,JPG=    ) I=0

EVIDENCE NOT COMPELLING.OMITTED FROM TABLE.
PEAKS SEEN IN (KS KS) SPECTRA QUOTED UNDER
X(1440) (I=1) AS WELL.

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                    29  X(1430) MASS (MEV)

M     -------RHOO RHOO MODE-------
M         (1410.0)                BETTINI   66 DBC   0  0. PBARP TO 5PR  9/66

M     -------KS KS MODE ----------
M    B    POSSIBLY SEEN           ABRAMS    67 HBC    4.25 K- P           5/67
M    B    THE AUTHORS ASSOCIATE THE PEAK WITH THE F PRIME, BUT BACKGROUND
M    B    ESTIMATION IS DIFFICULT
M         1412.      23.          BARLOW    67 HBC    1.2 PBAR P          5/67
M         1439.0      5.0     6.0 BEUSCH    67 OSPK   5,7,12 PI-P         9/67
M         . . . . . . . . . .
M    AVG  1437.5      5.3    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

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                    29  X(1430) WIDTH (MEV)

W     -------RHOO RHOO MODE-------
W          (90.0)                 BETTINI   66 DBC   0 0. PBAR P TO 5PR  9/66

W     -------KS KS MODE ----------
W          100.      70.          BARLOW    67 HBC    1.2 PBAR P          5/67
W           43.0     17.0    18.0 BEUSCH    67 OSPK   5,7,12 PI-P         9/67
W         . . . . . . . . . .
W    AVG    46.4     17.0    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

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                         REFERENCES FOR X(1430)

BETTINI  66 NC 42A 695       +CRESTI,LIMENTANI,LORIA,PERUZZO+(PADO+PISA)
ABRAMS   67 PRL 18 620       +KEHOE,GLASSER,SECHI-ZORN,WOLSKY (MARYLAND)
BARLOW   67 NC  50 A  701    +MONTANET,D-ANDLAU+   (CERN+CDEF+IRAD+LIVP)
BEUSCH   67 PL 25 B 357      +FISCHER,GOBBI,ASTBU+             (ETHZ+CERN)
DONALD   69 NP B 11 551      +EDWARDS,BURAN,BETTINI,+    (LIVP+OSLO+PADO)

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X_1(1440) $\rightarrow K_S K_S$

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38  X (1440,JPG=    ) I=1

EVIDENCE NOT COMPELLING.OMITTED FROM TABLE.
PEAKS SEEN IN (KS KS) SPECTRA QUOTED UNDER
X(1430) (I=0) AS WELL.

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                    38  X(1440) MASS (MEV)

M    B    POSSIBLY SEEN                ABRAMS    67 HBC    4.25 K- P          5/67
M    B    THE AUTHORS ASSOCIATE THE PEAK WITH THE F PRIME, BUT BACKGROUND
M    B    ESTIMATION IS DIFFICULT
M         1412.      23.               BARLOW    67 HBC    1.2 PBAR P         5/67
M         1439.0      5.0        6.0   BEUSCH    67 OSPK   5,7,12 PI-P        9/67
M        (1425.0)                      FOLEY     71 CNTR - 20.3 PI- P,K- KS   2/71
M        (1405.)                       DEFOIX    72 HBC  0 0.7 PBAR P,7 PI    2/73*
M         . . . . . . . . . .
M    AVG  1437.5      5.3    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

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                    38  X(1440) WIDTH (MEV)

W          100.      70.               BARLOW    67 HBC    1.2 PBAR P         5/67
W           43.0     17.0       18.0   BEUSCH    67 OSPK   5,7,12 PI-P        9/67
W         (20.0)  OR LESS              FOLEY     71 CNTR - 20.3 PI- P,K- KS   2/71
W         (40.)                        DEFOIX    72 HBC  0 0.7 PBAR P,7 PI    2/73*
W         . . . . . . . . . .
W    AVG    46.4     17.0    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

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                         REFERENCES FOR X(1440)

ABRAMS   67 PRL 18 620        +KEHOE,GLASSER,SECHI-ZORN,WOLSKY (MARYLAND)
BARLOW   67 NC  50 A  701     +MONTANET,D'ANDLAU+   (CERN+CDEF+IRAD+LIVP)
BEUSCH   67 PL 25 B 357       +FISCHER,GOBBI,ASTBURY+           (ETHZ+CERN)
FOLEY    71 PRL 26 413        +LOVE,OZAKI,PLATNER,LINDENBAUM,+ (BNL+CUNY)
DEFOIX   72  SUBMITTED TO PL  +DOBRZYNSKI,ESPIGAT,NASCIMENTO,+      (COEF)

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f′(1514)

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13  F PRIME (1514,JPG=2++) I=0

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                    13  F PRIME MASS (MEV)

M         14(1480.0)                CRENNELL  66 HBC     6.0 PI- P         8/66
M    B     5(1460.)    (10.)        ABRAMS    67 HBC    4.25 K- P          5/67
M    B    BACKGROUND ESTIMATION DIFFICULT.                                 5/67
M            1515.0     7.0         AMMAR     67 HBC     5.5 K-P           9/67
M    S    70(1513.0)   (7.0)        BARNES    67 HBC    4.6, 5. K- P     12/72*
M    S    SUPERSEDED BY AGUILAR 72
M       100 1519.       7.          AGUILAR   72 HBC    3.9,4.6 K- P     12/72*
M        46 1514.       4.          COLLEY    72 HBC    10.K+ P          12/72*
M        47 1521.       7.          VIDEAU    72 HBC    4.K- P,L FPRIME  12/72*
M           . . . . . . . . . .
M    AVG     1516.1     2.8    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

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                    13  F PRIME WIDTH (MEV)

W    B     5  (53.)    (18.)        ABRAMS    67 HBC    4.25 K- P          5/67
W    B    BACKGROUND ESTIMATION DIFFICULT.                                 5/67
W            35.0      25.0         AMMAR     67 HBC     5.5 K-P           9/67
W    S    70  (87.0)   (15.0)       BARNES    67 HBC    4.6, 5. K- P     12/72*
W    S    SUPERSEDED BY AGUILAR 72
W       100    69.     22.          AGUILAR   72 HBC    3.9,4.6 K- P     12/72*
W        46    28.     15.          COLLEY    72 HBC    10.K+ P          12/72*
W    E   47    40.     20.          VIDEAU    72 HBC    4.K- P,L FPRIME  12/72*
W    E    ERROR INCREASED BY US.SEE TYPED NOTE ON K* MASS.                12/72*
W           . . . . . . . . . .
W    AVG       39.9     9.7    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

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                    13  F PRIME PARTIAL DECAY MODES

                                                      DECAY MASSES
P1      F PRIME INTO PI+ PI-                          139+ 139
P2      F PRIME INTO K KBAR                           497+ 497
P3      F PRIME INTO K K*(892)                        493+ 891
P4      F PRIME INTO ETA ETA                          548+ 548
P5      F PRIME INTO PI PI ETA                        139+ 139+ 548
P6      F PRIME INTO PI K KBAR                        139+ 497+ 497
P7      F PRIME INTO PI+ PI+ PI- PI-                  139+ 139+ 139+ 139

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                    13  F PRIME BRANCHING RATIOS

R1      F PRIME INTO (PI+ PI-)/(K KBAR)                   (P1)/(P2)
R1            (0.2)  OR LESS  CL=.67  AMMAR     67 HBC     5.5 K-P          9/67
R1            (0.36) OR LESS  CL=.95  AGUILAR   72 HBC    3.9,4.6 K- P    12/72*

R3      F PRIME INTO (ETA ETA)/(K KBAR)                   (P4)/(P2)
R3            (0.50) OR LESS          BARNES    67 HBC     4.6, 5.0 K- P  10/67

R4      F PRIME INTO (PI PI ETA)/(K KBAR)                 (P5)/(P2)
R4            (0.3)  OR LESS  CL=.67  AMMAR     67 HBC                    10/67
R4   A        (0.25)    (0.13)        BARNES    67 HBC     4.6, 5.0 K- P  10/67
R4   A   SUPERSEDED BY AGUILAR 72
R4            (0.41) OR LESS  CL=.95  AGUILAR   72 HBC    3.9,4.6 K- P    12/72*

R5      F PRIME INTO (PI K KBAR + K K*(892))/(K KBAR)    (P6+P3)/(P2)
R5            (0.4)  OR LESS  CL=.67  AMMAR     67 HBC                    10/67
R5            (0.35) OR LESS  CL=.95  AGUILAR   72 HBC    3.9,4.6 K- P    12/72*

R6      F PRIME INTO (PI+ PI+ PI- PI-)/(K KBAR)           (P7)/(P2)
R6            (0.32) OR LESS  CL=.95  AGUILAR   72 HBC    3.9,4.6 K- P    12/72*

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                         REFERENCES FOR F PRIME

BARNES    65 PRL 15 322        +CULWICK,GUIDONI,KALBFLEISCH,GOZ+(BNL+SYRA)

CRENNELL 66 PRL  16  1025      + KALBFLEISCH,LAI,SCARR,SCHUMANN +    (BNL)I

ABRAMS   67 PRL 18 620         +KEHOE,GLASSER,SECHI-ZORN,WOLSKY (MARYLAND)
AMMAR    67 PRL  19  1071      +DAVIS,HWANG,DAGAN,DERRICK +     (NWES+ANL)  JP
BARNES   67 PRL  19  964       +DORNAN,GOLDBERG,LEITNER +   (BNL+SYRACUSE)ICJP
ALITTI   68 PRL 21 1705        +BARNES,CRENNELL,FLAMINIO,GOLDBERG,+  (BNL)

LORSTAD  69 NP B 14 63         B.LORSTAD,D.ANDLAU,ASTIER,+      (CDEF+CERN)  JP
SCOTTER  69 NC 62 A 1057       +ERSKINE,PALER,+  (BIRM+GLAS+LOIC+MPIM+OXF)
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Data Card Listings

For notation, see key at front of Listings.

Mesons

f'(1514), $F_1(1540)$, $\rho'(1600)$, $A_3(1640)$


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AGUILAR   72 PR D 6 29          AGUILAR-BENITEZ,CHUNG,EISNER,SAMIOS   (BNL)
COLLEY    72 NP B 50 1          +JOBES,RIDDIFORD,GRIFFITHS,+     (BIRM+GLAS)
VIDEAU    72 PL 41 B 213        +VIDEAU,ROUGE,BARRELET,DEBRION,+(EPOL+SACL)
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$F_1(1540) \to K\bar{K}\pi$

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47  F1 (1540,JPG=   ) I=1

JP = 2-,1+ FAVORED .
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                      47  F1 MASS (MEV)

M        10(1490.0)   (20.0)            ADERHOLZ  69 HBC  +   8 PI+ P,KKBARPI.11/69
M       142 1540.0     5.0              AGUILAR   69 HBC    0.7PBARP,KKBARPI 11/69
M        25(1543.0)   (3.0)             DUBOC     71 HBC   0 1.1-1.2 PBAR P . 2/72
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                      47  F1 WIDTH (MEV)

W       10  (85.0)   (39.0)             ADERHOLZ  69 HBC  +   8 PI+ P,KKBARPI 11/69
W      142   40.0     15.0              AGUILAR   69 HBC    0.7PBARP,KKBARPI 11/69
W       25  (16.0)   (10.0)             DUBOC     71 HBC   0 1.1-1.2 PBAR P   2/72
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                      47  F1 PARTIAL DECAY MODES

                                                         DECAY MASSES
P1     F1 INTO K KBAR PI                                 134+ 497+ 497
P2     F1 INTO K*(892) KBAR                              891+ 497
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                            REFERENCES FOR F1
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ADERHOLZ 69 NP B 11 259       +BARTSCH,+          (AACH+BERL+CERN+KRAK+WARS)
AGUILAR  69 PL 29 B 379       +BARLOW,JACOBS,D ANDLAU,ASTIER+ (CERN+CDEF)
AGUILAR  69 NP B 14 195       +BARLOW,JACOBS,D ANDLAU,ASTIER+ (CERN+CDEF)
DUBOC    71 PL 34 B 343       +GOLDBERG,MAKOWSKI,TOUCHARD,+    (IPNP+LIVP)

CHAPMAN  72 NP B 42 1.        +CHURCH,LYS,MURPHY,RING,VANDER VELDE (MICH)
DUBOC    72 NP B 46 429       +GOLDBERG,MAKOWSKI,DONALD,+      (LPNP+LIVP)
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$\rho'(1600) \to 4\pi$

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65  RHO PRIME(1600,JPG=1-+) I=1
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The ρ', long-sought by looking for its 2π decay, has been seen clearly only in the reaction

$$\gamma(\text{real or virtual}) \to \rho'^0 \to \rho^0\epsilon^0 \to 4\pi.$$

There is some evidence from ALVENSLEBEN 71 and BULOS 71 for a 2π bump far out on the ρ tail, but interpretation is difficult. EISENBERG 72 claim to establish a width of less than 2 MeV for $\rho' \to 2\pi$. This is not easily put in the format of the data cards below, so it is summarized here: Their 5 GeV/c π^+p experiment yields 5600 $\rho\Delta^{++}$ and <37 $\rho'\Delta^{++}$; i.e., production ratios are >100:1. With minor corrections, the OPE model then gives a ratio of coupling constants squared for the 2π decay of ρ' and ρ to be $g^2(\rho')/g^2(\rho) < 0.02$, which then yields the surprising $\Gamma(\rho' \to 2\pi) < 2$ MeV. If no 2π mode is found, MORTARA 72 suggests that the ρ' is just a ρϵ threshold on the tail of the ρ, but again EISENBERG 72 claim to refute this.

Mass and width values punched below are only indicative, because for such a broad peak they are extremely dependent on the parametrization chosen. For reviews, see DIEBOLD 72 and SILVESTRINI 72.

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                      65  RHO PRIME MASS (MEV)

M          (1600.)   APPROX.            BARBARI1  72 OSPK  0 E+ E- TO 4 PI      1/73*
M       400 1430.      50.              BINGHAM   72  HBC  0 9.3 GAM P,P 4PI   12/72*
M           1586.      22.              DAVIER    72 STRC  0 4.5-18. G P,P4PI  12/72*
M    S  400(1500.)   M.OF PEAK 400/40   SMADJA    72  HBC  0 9.3 GAM P,P 4PI   12/72*
M           . . . . . . . . .
M    AVG    1560.7     57.5     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 2.9)
     S   LATER FITS GIVEN BY BINGHAM 72
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                      65  RHO PRIME WIDTH (MEV)

W       400  650.      100.             BINGHAM   72  HBC  0 9.3 GAM P,P 4PI   12/72*
W            303.       64.             DAVIER    72 STRC  0 4.5-18. G P,P4PI  12/72*
W    S  400 (600)    FWHM       400/40  SMADJA    72  HBC  0 9.3 GAM P,P 4PI   12/72*
W    S   EXPTL. FULL WIDTH AT HALF MAX.  LATER FITS GIVEN BY BINGHAM 72
W          (350.)    APPROX.            CERADINI  73 OSPK  0 E+ E- TO 4 PI      1/73*
W           . . . . . . . . . .
W    AVG     403.8    157.5     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 2.9)
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                      65  RHO PRIME PARTIAL DECAY MODES

                                                         DECAY MASSES
P1     RHO PRIME INTO RHO PI PI                          139+ 139+ 770
P2     NEUTRAL RHO PRIME INTO ALL CHARGED 4 PI MODES     139+ 139+ 139+ 139
P3     RHO PRIME INTO RHO RHO                            770+ 770
P4     RHO PRIME INTO PI PI                              139+ 139
P5     RHO PRIME INTO K BAR K                            493+ 493
P6     RHO PRIME INTO PI OMEGA                           139+ 783
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                      65  RHO PRIME BRANCHING RATIOS

R1     RHO PRIME INTO (RHO PI+ PI-)/(4 PI, ALL CHARGED) (P1)/(P2)
R1 S       DOMINANT                     BARBARI1  72 OSPK  0 E+E- TO 4 PI       1/73*
R1 S         (.80)                      BINGHAM   72  HBC  0 9.3 GAM P,P 4PI    1/73*
R1 S       DOMINANT                     DAVIER    72 STRC  0 4.5-18. G P,P4PI   1/73*
R1 S    THE PI PI SYSTEM IS IN S WAVE                                           1/73*

R2     RHO PRIME INTO (RHO 0 RHO 0)/(RHO 0 PI+ PI-)      (P3)/(P1)
R2           NONE    (FORBIDDEN BY I=1)BINGHAM   72  HBC  0 9.3 GAM P,P 4PI     1/73*

R3     RHO PRIME INTO (PI+ PI-)/(4 PI, ALL CHARGED)      (P4)/(P2)
R3            (.2)  OR LESS  2 SIGMA   BINGHAM   72  HBC  0 9.3 GAM P,P 2PI     1/73*
R3  E         (.01) OR LESS  2 SIGMA   EISENBERG 72  HBC 0 5 PI+P,2 OR 4 PI     1/73*
R3  E   SEE DISCUSSION IN TYPED MINI-REVIEW ABOVE.                              1/73*

R4     RHO PRIME INTO (K BAR K)/(4 PI, ALL CHARGED)      (P5)/(P2)
R4            (.04) OR LESS  2 SIGMA   BINGHAM   72  HBC  0 9.3 GAM P           1/73*
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                         REFERENCES FOR RHO PRIME
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DAVIER   69 SLAC PUB 666       +DERADO, FRIES, LIU, MOZLEY, ODIAN + (SLAC) G

ALVENSLE 71 PRL 26 273         ALVENSLEBEN,BECKER,BERTRAM,CHEN,+(DESY+MIT) G
BRAUN    71 NP B30 213         +FRIDMAN, GERBER, GIVERNAUD,+  (STRASBOURB) G
BULOS    71 PRL 26 149         +BUSZA,KEHOE,BENISTON,+  (SLAC+UMD+IBM+LBL) G

BACCI    72 PL 38B 551         +PENSO,SALVINI,STELLA,BALDINI-CE(ROMA+FRAS) JPC
BARBARI1 72 LNC 3 689          BARBARINO,CERADINI,+    (FRAS+ROMA+PADO+UMD)IGJP
BARBARI2 72  BAT.CONF.PAP.561  BARBARINO,CERADINI,+    (FRAS+ROMA+PADO+UMD)
BARTOLI  72 PR D 6 2374        +FELICETTI,OGREN,+           (FRAS+ROMA+NAPL)IGJP
BINGHAM  72 PL 41B 635         +RABIN,ROSENFELD,SMADJA,YOST+(LBL,UCB,SLAC)IGJP
BRAMON   72 LNC 3 693          +GRECO (THEORETICAL PAPER)          (FRASCATI)
DAVIER   72  BAT.CONF.PAP.797  +DERADO,FRIES,LIU,MOZLEY,ODIAN,PARK,+(SLAC)
DIEBOLD  72  BATAV.CONF.       R.DIEBOLD  RAPPORTEUR TALK               (ANL)
EISENBE1 72 PR D 5 15          EISENBERG,BALLAM,DAGAN,+     (REHO+SLAC+TELA)
EISENBER 72  PREP. WIS 72/41-PH, PL(TO BE PUBL. 73), +KARSHON, +++ (REHO)
MORTARA  72  COO-1195-249      D.W.MORTARA                              (ILL)
SILVESTR 72  BATAV.CONF.       V.SILVESTRINI RAPPORTEUR TALK      (FRASCATI)
SMADJA   72 PHIL.CONF.PROC349  +BINGHAM,FRETTER,BALLAM,CHADWICK+(LBL+SLAC)

CERADINI 73  BAT.CONF.PAP.560(PL 1973)+CONVERSI,D'AN(FRAS+ROMA+PADO+MARY)IGJP
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$A_3(1640)$

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34  A3 (1640, JPG=2--) I = 1
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The $A_3(1640)$ is seen as a bump in the diffraction-like process $\pi N \to (\pi\pi\pi)N$. The dominant effect is a 300-400 MeV wide enhancement in the $J^P = 2^-$ fπ S-wave system, starting from fπ threshold. Neither additional (narrower) structure in the 3π mass distribution, nor other decay modes, have been clearly established. There appears to be little variation of the $J^P = 2^-$ fπ phase in the A_3 mass region (ASCOLI 72). The situation thus resembles that of the A_1.

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Mesons
$A_3(1640)$, $\omega(1675)$

Data Card Listings
For notation, see key at front of Listings.

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                    34  A3 MASS (MEV)

M        30(1600.0)                         FORINO    65 DBC     04.5 PI+ D        10/66
M        20 1630.0       30.0               VETLITSKY 66 HBC   -  4.7 PI- P
M           1630.        10.                BALTAY    68 HBC   +  7, 8.5 PI+ P      6/68
M           1660.0       16.0               BARTSCH   68 HBC   +  8. PI+ P,3PI P    8/69
M           1610.        19.                LAMSA     68 HBC   -  8.0 PI-P, PI-F   11/67
M       297 1673.0       40.0               ARMENISE  69 DBC   +  5.1 PI+D,3PI++-   5/70
M          (1680.)      (20.0)              CASO      69 HBC   -  11 PI- P          5/70
M           1660.0       20.0               CASO      69 HBC   -  11 PI-P, PI-F     5/70
M           1645.0       10.0               CRENNELL  70 HBC   -  6. PI- P,F PI     5/70
M   M      (1633.0)     (12.0)              MIYASHITA 70 HBC   -  6.7 PI-P,PI-F     1/71
M   M       BACKGROUND SUBTRACTION DIFFICULT.
M          (1672.0)                         BEKETOV   71 HBC   -  4.45 PI- P       11/71
M           1600.        50.                PALER     71 DBC   + 13.PI+ D,D(3PI)+.11/71
M  P        1660.        10.                ASCOLI    72 HBC   - 5.-25.PI- P,P A3 12/72*
M  P     FROM A FIT TO JP=2- F PI
M       260 1660.        25.                CASO      72 HBC   + 11.7 PI+ P        11/71
M   F      (1658.)      (8.)                HARRISON  72 HBC   - 13.,20. PI- P     12/72*
M   F    FIT ASSUMES AN ADDITIONAL PEAK AT 1830 MEV.                              12/72*
M   F    EVIDENCE FOR A SUBSTANTIAL DECAY INTO 3PI CLAIMED
M           . . . . . . . . . .
M   AVG     1645.1        5.5      AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.1)

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                    34  A3 WIDTH (MEV)

W        20 (100.)                          VETLITSKY 66 HBC   - 4.7 PI-P           6/66
W            70.         40.                BALTAY    68 HBC   +  7, 8.5 PI+ P      6/68
W           115.0        45.0               BARTSCH   68 HBC   +  8. PI+ P,3PI P    8/69
W           100.         50.        30.     LAMSA     68 HBC   -  8.0 PI-P  PI-F   11/67
W   A   297 (240.0)     (50.0)              ARMENISE  69 DBC   +  5.1 PI+D,3PI++-   5/70
W   A    BACKGROUND SUBTRACTION MODEL-DEPENDENT.                                    5/70
W           (130.)                          CASO      69 HBC   -  11 PI- P          6/68
W           (150.0)                         CASO      69 HBC   - 11.0 PI-P,PI- F    6/68
W            130.0       30.0               CRENNELL  70 HBC   -  6. PI- P,F PI     5/70
W   M       (37.0)      (24.0)              MIYASHITA 70 HBC   -  6.7 PI-P,PI-F     1/71
W   M       BACKGROUND SUBTRACTION DIFFICULT.
W           (128.0)                         BEKETOV   71 HBC   -  4.45 PI- P       11/71
W            220.        80.                PALER     71 DBC   + 13.PI+ D,D(3PI)+.11/71
W  P         270.        60.                ASCOLI    72 HBC   - 5.-25.PI- P,P A3 12/72*
W  P     FROM A FIT TO JP=2- F PI
W   J        200. TO 400.                   CASO      72 HBC   + 11.7 PI+ P         1/72
W   J        FROM PARTIAL-WAVE ANALYSIS,FOR JP=2-(F PI)-STATE
W       260  190.        100.               CASO      72 HBC   + 11.7 PI+ P        11/71
W   F       (53.)       (20.)      (16.)    HARRISON  72 HBC   - 13.,20. PI- P     12/72*
W   F    FIT ASSUMES AN ADDITIONAL PEAK AT 1830 MEV.                              12/72*
W   F    EVIDENCE FOR A SUBSTANTIAL DECAY INTO 3PI CLAIMED
W           . . . . . . . . . .
W   AVG      128.6       22.2      AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.3)

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                    34  A3 PARTIAL DECAY MODES

                                                               DECAY MASSES
P1       A3 INTO 3 PI                                         134+ 134+ 134
P2       A3 INTO RHO PI                                       134+ 770
P3       A3 INTO ETA PI                                       134+ 548
P4       A3 INTO 5 PI
P5       A3 INTO K K*(892)                                    497+ 891
P6       A3 INTO K KBAR PI                                    497+ 497+ 134
P7       A3 INTO K KBAR                                       497+ 497
P8       A3 INTO F PI                                        1270+ 134
P9       A3 INTO OMEGA PI PI                                  783+ 134+ 134

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                    34  A3 BRANCHING RATIOS

R2       A3+- INTO (PI+- RHO0)/(ALL PI+- PI+ PI-)             (P2C)/(P1C)
R2             (0.3)  OR LESS           BARTSCH   68 HBC   +  8. PI+ P,3PI P    8/69
R2             (0.4)  OR LESS           FERBEL    68 RVUE +-                  . 9/68
R2             (.18)  OR LESS  CL=.95   PALER     71 DBC   + 13.P++ D,D(3P+)+ 11/71

R3       A3+- INTO (PI+- F)/(ALL PI+- PI+ PI-)                (P8)/(P1C)
R3                    (WITH F INTO PI+ PI-)
R3              INDICATION SEEN         LUBATTI   66 HLBC     16 PI-           11/66
R3             (0.59)FOR JP=2-          BARTSCH   68 HBC   +  8. PI+ P,3PI P    8/69
R3             (0.51)FOR JP=1+          BARTSCH   68 HBC   +  8. PI+ P,3PI P    8/69
R3             (0.20)FOR JP=0-          BARTSCH   68 HBC   +  8. PI+ P,3PI P    8/69
R3              0.35       0.20         BALTAY    68 HBC   + 7-8.5 PI+P         5/68
R3              CONSISTENT WITH 1.0     CASO      68 HBC   -  11 PI- P        . 6/68
R3             (0.76)     (0.24)   (0.34) ARMENISE 69 DBC  +  5.1 PI+D,3PI++-   5/70
R3              CONSISTENT WITH 1.0     CRENNELL  70 HBC   -  6. PI- P,F PI   . 5/70
R3             (.85)  OR MORE  CL=.95   PALER     71 DBC   + 13.P++ D,D(3P+)+ 11/71

R5       A3+- INTO (PI+- ETA)/(ALL PI+- PI+ PI-)              (P3)/(P1C)
R5                    (ALL ETA DECAYS)
R5             (0.09) OR LESS           BALTAY    68 HBC   + 7-8.5 PI+P         5/68
R5             (0.10) OR LESS           CRENNELL  70 HBC   -  6. PI- P,F PI     5/70

R6       A3+- INTO (PI+- 2PI+ 2PI-)/(ALL PI+- PI+ PI-)        (P4C)/(P1C)
R6             (0.1)  OR LESS           BALTAY    68 HBC   + 7,8.5 PI+ P        6/68
R6             (0.10) OR LESS           CRENNELL  70 HBC   -  6. P+- P,F P+     5/70

R8       A3+- INTO (RHO PI)/(F PI)                            (P2)/(P8)
R8              0.03       0.37      0.03 CASO    69 HBC   -  11 PI- P          5/70

R9       A3+- INTO (PI+- PI+ PI-)/(F PI)                      (P1C-P8)/(P8)
R9              0.06       0.47      0.06 CASO    69 HBC   -  11 PI- P          5/70
R9            . POSSIBLY SEEN           HARRISON  72 HBC   - 13.,20. PI- P     12/72*

R10      A3+- INTO (UNCORREL.PI+- PI+ PI-)/(ALL PI+- PI+ PI-)
R10 M          (.05)  OR LESS  CL=.95   PALER     71 DBC   + 13. PI+D,D(3PI)+ 11/71
R10 M        MODEL DEPENDENT FIT                                               11/71

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REFERENCES FOR A3


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FORINO    65 PL 19 68          +GESSAROLI+        (BGNA+BARI+FIRZ+ORSA+SACL)
FOCACCI   66 PRL  17  890      CERN MISSING MASS SPECTROMETER GROUP (CERN)
LEVRAT    66 PL   22  714      CERN MISSING MASS SPECTROMETER GROUP (CERN)
LUBATTI   66 THESIS BERKELEY   H.J.LUBATTI                        (LRL)1-2-
VETLITSK  66 PL   21  579      VETLITSKY,GUSZAVIN,KLIGER,ZOLGANOV+  (ITEP)
DANYSZ    67 NC 51 A 801       DANYSZ+FRENCH+SIMAK                  (CERN)
DUBAL     67 NP 83 435         CERN MISSING MASS SPECTROMETER GROUP (CERN)
   ALSO   68 THESIS 1456       L.DUBAL                            (GENEVE)

BALTAY    68 PRL 20 887        +KUNG+YEH+FERBEL+     (COLU+ROCH+RUTG+YALE)I=1
BARTSCH   68 NP B 7 345        +KEPPEL,KRAUS,+              (AACH+BERL+CERN) JP
CASO      68 NC 54 A 983       +CONTE+CORDS+DIAZ+  (GENOVA+HAMB+MILA+SACL)
FERBEL    68 PHILA.CONF.335    T.FERBEL                        (ROCHESTER)
IOFFREDO  68 PRL 21 1212       +BRANDENBURG,BRENNER,EISENSTEIN+  (HARVARD)
LAMSA     68 PR 166 1395       +CASON+BISWAS+DERADO+GROVES+     (NOTREDAME)
YOST      68  UMD  T.REPORT849 +YODH,EINSCHLAG,DAY,GLASSER            (UMD)

ARMENISE  69 LNC 2 501         +GHIDINI,FORINO,CARTACCI+  (BARI+BGNA+FIRZ)
BARNES    69 PRL 23 142        +CHUNG,EISNER,FLAMINIO,+               (BNL)
CASO      69 LNC 2 437         +CONTE,TOMASINI,CANTORE+   (GENO+MILA+SACL)
   ALSO   68 CASO

BRANDENB  70 NP B16 369        +BRENNER,IOFFREDO,JOHNSON,KIM+     (HARVARD)
CRENNELL  70 PRL 24 781        +KARSHON,LAI,SCARR,SIMS                (BNL)
CHIEN1    70  TORONTO PREPRINT +CHAO,JOHNSTON,PRENTICE,WALKER  (TNTO+WISC)
CHIEN2    70 PHILAD.CONF.P.275 C.Y.CHIEN, REVIEW           (JOHNS HOPKINS)
MIYASHIT  70 PR D 1 771        MIYASHITA,VON KROGH,KOPELMAN,LIBBY    (COLO)

BEKETOV   71 SJNP 4 765        +SOMBKOWSKY,KONOWALOV,KRUTSCHININ,+  (ITEP) JP
CLAYTON   71  PREPRINT         +MASON,MUIRHEAD,RIGOPOULOS,+     (LIVP+ATEN)
PALER     71 PRL 26 1675       +BADEWITZ,BARTON,MILLER,PALFREY,TEBES(PURD)

ALEXANDE  72 NP B 45 29        ALEXANDER,BAR-NIR,BEVARY,DAGAN,+      (TELA)
ARMENISE  72 LNC 4 201         +FORINO,CARTACCI,+         (BARI+BGNA+FIRZ)
ASCOLI    72  PREP.COO-1195233 ILL+TNTO+GENO+HAMB+MILA+SACL+HARV+ COLLAB.  JP
ASCOLI    72 PHIL.CONF.PROC.   INTERNAT.COLLABORATION                (ILL+)
CASO      72 NP B 36 349       +MADDOCK,BASSLER+(DURH+GENO+DESY+MILA+SACL)
HARRISON  72 PRL 28 775        +HEYDA,JOHNSON,KIM,LAW,MUELLER,+      (HARV)
SALZBERG  72 NP B 41 397       +HARRISON,HEYDA,JOHNSON,KIM,LAW,+     (HARV)
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$\omega(1675)$ $\to \rho^0\pi^0$

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45  OMEGA (1675,JPG=  -) I=0, FORMERLY PHI(1675).
NAME CHANGED 1973.

THIS 3PI BUMP OVERLAPS IN MASS WITH THE A3, BUT
IN SOME EXPTS. ONE CAN ESTABLISH THAT THE
ENHANCEMENT IS (RHO 0 PI) INSTEAD OF (F PI),
SO THE OMEGA(1675) AND A3 HAVE DIFFERENT ISOSPIN.
MATTHEWS 71 SUGGEST JP=NORMAL, A POSSIBLE
RECURRENCE OF OMEGA(784).

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                    45  OMEGA(1675) MASS (MEV)

M          1636.0      20.0           ARMENISE  68 DBC    0 5.1 PI+D          9/68
M          1670.0      20.0           KENYON    69 DBC     8 PI+ D,3PI 2P     8/69
M         (1640.00)                   ARMENISE  70 DBC     9. PI+ D           1/71
M   G     (1616.0)    (30.0)          GORDON    70 DBC    0 4.2 PI+ D         1/71
M      100 1679.0      17.0           MATTHEWS  71 HBC    06.95 PI D,2P 3PI   1/71
M   G   NOT CERTAIN IF OMEGA(1675) OBSERVED IN THIS EXPERIMENT
M          . . . . . . . . . .
M   AVG    1663.6      12.9      AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.2)

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                    45  OMEGA(1675) WIDTH (MEV)

W           112.0      60.0           ARMENISE  68 DBC    0 5.1 PI+D          9/68
W           100.0      40.0           KENYON    69 DBC     8 PI+ D,3PI 2P     8/69
W   G      (188.0)    (47.0)          GORDON    70 DBC    0 4.2 PI+ D         1/71
W      100  155.0      20.0           MATTHEWS  71 HBC    06.95 PI D,2P 3PI   1/71
W   G   NOT CERTAIN IF OMEGA(1675) OBSERVED IN THIS EXPERIMENT
W          . . . . . . . . . .
W   AVG     141.4      17.1      AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

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                    45  OMEGA(1675) PARTIAL DECAY MODES

                                                          DECAY MASSES
P1       OMEGA(1675) INTO 3 PI                           134+ 134+ 134
P2       OMEGA(1675) INTO 5 PI                           134+ 134+ 134+ 134
P3       OMEGA(1675) INTO RHO PI                         770+ 134

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                    45  OMEGA(1675) BRANCHING RATIOS

R1       OMEGA(1675) INTO (5 PI)/(3 PI)                  (P2)/(P1)
R1             0.10      0.10         KENYON    69 DBC    0 8. PI + D         8/69

R2       OMEGA(1675) INTO (RHO PI)/(3 PI)                (P3)/(P1)
R2  G         (0.75)    (0.11)        GORDON    70 DBC    0 4.2 PI+ D         1/71
R2      100   (0.70) OR MORE          MATTHEWS  71 HBC    0 6.95 PI D,2P3PI 11/71
R2  G   NOT CERTAIN IF OMEGA(1675) OBSERVED IN THIS EXPERIMENT

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                    45  OMEGA(1675)  CROSS SECTIONS

CS              FOR A COMPILATION SEE MATTHEWS 71 HBC     06.95 PI D,2P 3PI  1/71

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REFERENCES FOR OMEGA(1675)


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ARMENISE  68 PL 26B 336        +GHIDINI,FORINO+ (BARI+BGNA  +FIRZ  +ORSAY)
KENYON    69 PRL 23 146        +KINSON,SCARR,+             (BNL+UCND+ORNL)

ARMENISE  70 LNC 4 199         +GHIDINI,FORINO,CARTACCI,+ (BARI+BGNA+FIRZ)
GORDON    70  COO 1195 179     THESIS,ILLINOIS                        (ILL)

MATTHEWS  71 PR D 3 2561       +PRENTICE,YOON,CARROLL,+         (TNTO+WISC)
MATTHEW1  71 LNC 1 361         +PRENTICE,YOON,CARROLL,+         (TNTO+WISC)
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0 0 0 0 3 6 0 4 8 1 4

Data Card Listings

For notation, see key at front of Listings.

g(1680)

15 G (1680,JPG =.3-+) I=1

This entry contains the 2π, 4π, $\omega\pi$, $K\bar{K}$ and $K\bar{K}\pi$ peaks in the region of 1700 MeV. The spin-parity determination and the mass and width in the Meson Table come from the 2π decay mode. Analyses of 2π using OPE models suggest elasticity considerably less than 1 (BARTSCH 70, MATTHEWS 71). On the other hand, the discrepancies in masses, widths, and branching ratios indicate that there may be more than one $I^G = 1^+$ meson in this region (see BARNHAM 70, HOLMES 72). For convenience we have collected all the data here under a common entry, without implying that they are necessarily all related. For a review see BARTSCH 70.

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15 G MASS (MEV)

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M      PI+ PI- MODE
M
M           1700.0     100.0            BELLINI   65 HLBC   0 6.1 PI-P           6/66
M          (1640.0)                     FORINO    65 DBC    0 4.5 PI+D           6/66
M           1670.0      30.0            GOLDBERG  65 HBC    0 6 PI+D, 8 PI-P
M          (1683.)     (13.)            ARMENISE  68 DBC    0 5.1 PI+ D          6/68
M           1720.0      20.0            CRENNELL  68 HBC    0 6.0 PI- P         12/68
M          (1655.0)    (10.0)           JOHNSTON  68 HBC    0 7.0 PI- P          6/68
M          (1750.0)                     CASO      69 HBC    0 11. PI- P,N2PI     8/69
M           1737.0      23.0            ARMENISE  70 DBC    0 9 PI+ N            1/71
M   T       1687.       21.             STUNTEBEC 70 HDBC  0 8. PI-P,5.4 PI+D   2/72
M   T     FROM FIT WITH SINGLE BW
M    L     (1655.)      (4.)            STUNTEBEC 70 HDBC  0 8. PI-P,5.4 PI+D   2/72
M    L    FROM FIT WITH 2 BW
M    H     (1764.)     (15.)            STUNTEBEC 70 HDBC  0 8. PI-P,5.4 PI+D   2/72
M    H    FROM FIT WITH 2 BW
M           1678.       12.             MATTHEWS  71 DBC   0  7. PI+ N          2/72
M           1652.       13.             MATTHEWS  71 HBC   0  7. PI- P          2/72
M           . . . . . . . . .
M   AVG     1681.7      12.0     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.7)
                               (SEE IDEOGRAM BELOW )
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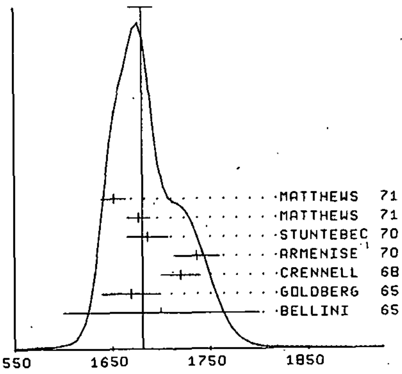
WEIGHTED AVERAGE = 1681.7 ± 12.0
ERROR SCALED BY 1.7



G MASS (MEV), PI+ PI- MODE

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M      (2PI)+- MODE
M
M           1640.0      25.0            CRENNELL  68 HBC   -  6.0 PI- P         12/68
M          (1600.)                      BARISH    69 HBC   -  8 PI- P            5/70
M     122 1650.0        35.0            BARTSCH   70 HBC   +  8 PI+ P,2 PI       5/70
M          (1652.0)    (15.0)           KRAMER    70 HBC   +  13.1 PI+ P,2PI    11/70
M           . . . . . . . . .
M   AVG     1643.4      20.3     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

M      K KBAR + K KBAR PI MODE
M
M          (1675.)                      EHRLICH   66 HBC   +-  7.9 PI-P,K KBAR  2/72
M   K      (1700.)                      FRENCH    67 HBC     0 3,3.6 PBAR P     7/67
M   K   OBSERVED IN NEUTRAL(K* KBAR) MODE  (G-PARITY UNKNOWN)
M   F      (1740.)                      FRENCH    67 HBC   (KO K+-) 3-4 PBAR P  7/67
M   F       SEE FIG. 9 OF FRENCH 67
M           1640.0      20.0     25.0   CRENNELL  68 HBC   +-  6.0 PI-P,KBAR K 12/68
M       13(1650.0)                      ADERHOLZ  69 HBC   +   8 PI+ P,K+KO     8/69
M           1690.0      16.0            ADERHOLZ  69 HBC   +   8 PI+ P,KKBARPI  8/69
M           . . . . . . . . .
M   AVG     1673.2      23.6     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.8)
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M      (4PI)+- MODE
M
M           1720.       15.             BALTAY    68 HBC   +   7, 8.5 PI+ P     6/68
M           1710.       23.             BISWAS    68 HBC   -    8. PI- P        2/72
M   J      (1675.0)    (10.0)           JOHNSTON  68 HBC   -  7.0 PI- P         6/68
M   B      (1627.)     (12.)    (17.)   BARNHAM   70 HBC   +  10 K+ P,RHO PIPI  1/73*
M   B   INCLUDED IN HOLMES 72
M     144 1680.0        40.0            BARTSCH   70 HBC   +  8 PI+ P,4 PI      4/71
M      90(1640.0)      (20.0)           BARTSCH   70 HBC   +  8 PI+ P,A2 PI     4/71
M     102(1689.0)      (20.0)           BARTSCH   70 HBC   +  8 PI+ P,2 RHO     4/71
M           1705.0      21.0            CASO      70 HBC   - 11.2PI-P,RHO 2PI   5/70
M          (1700.)                      BALLAM    71 HBC   -  16. PI- P         2/72
M     300(1710.)                        ARMENISE  72 HBC   -  9.1 PI- P,P 4PI  12/72*
M           1630.       15.             HOLMES    72 HBC   +  10.-12. K+ P      1/73*
M           . . . . . . . . .
M   AVG     1685.0      19.6     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 2.3)

M      (4PI)0 MODE
M
M   R    80 1717.        7.             DANYSZ    67 HBC    OSEE NOTE R BELOW   5/67
M   R    SEEN IN 2.5-3 PBAR P. 2PI+2PI-,WITH 0,1,2 PI+PI- PAIRS IN RHOO BAND
M    M     (1700.0)                     MAURER    70 HBC    05.7 PBAR P,7 PI    2/71
M    M     (1700.0)                     BRAUN     71 HBC    05.7 PBAR P,7 PI   11/71
M    M   SEEN IN 2 RHOO, NOT IN 4 PI OUTSIDE RHO BANDS,

M      OMEGA PI  MODE
M
M           1654.       24.             BARNHAM   70 HBC   +  10 K+ P,OMEGA PI  6/70
M           1630.0      11.0            CASO      70 HBC   - 11.2PI-P,PI OMEG   5/70
M           . . . . . . . . .
M   AVG     1634.2      10.0     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

M       R PEAKS FROM MMS. (FOR DIFFICULTIES WITH MMS EXPT SEE A2 MINIREVIEW)  1/73*
M
M   NR1    (1632.)     (15.)            FOCACCI   66 MMS   -   7-12 PI-P,P MMS 12/72*
M   NR2    (1700.)     (15.)            FOCACCI   66 MMS   -   7-12 PI-P,P MMS 12/72*
M   NR3    (1748.)     (15.)            FOCACCI   66 MMS   -   7-12 PI-P,P MMS 12/72*
M   N     NOT SEEN BY BOWEN 72
M    R     (1700.0)    (47.0)           ANDERSON  69 MMS   -  16 PI- P,BACKW    8/69
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15 G WIDTH (MEV)

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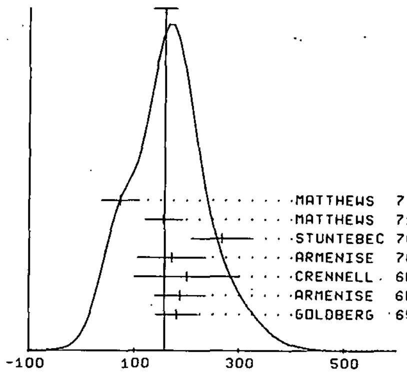
W      PI+ PI- MODE
W
W           (40.0)                      FORINO    65 DBC    0 4.5 PI+D           6/66
W           180.0       40.0            GOLDBERG  65 HBC    0 6 PI+D, 8 PI-P
W           188.        49.             ARMENISE  68 DBC    0 5.1 PI+ D          6/68
W           200.0      100.0            CRENNELL  68 HBC    0 6.0 PI- P         12/68
W           (80.0)     (20.0)           JOHNSTON  68 HBC    0 7.0 PI- P          6/68
W          (200.0)                      CASO      69 HBC    0 11. PI- P,N2PI     8/69
W           171.0       65.0            ARMENISE  70 DBC    0 9 PI+ D            1/71
W   T       267.        72.      46.    STUNTEBEC 70 HDBC  0 8. PI-P,5.4 PI+D   2/72
W   T     FROM FIT WITH SINGLE BW
W    L      (20.)       (8.)            STUNTEBEC 70 HDBC  0 8. PI-P,5.4 PI+D   2/72
W    L    FROM FIT WITH 2 BW
W    H      (87.)      (14.)    (20.)   STUNTEBEC 70 HDBC  0 8. PI-P,5.4 PI+D   2/72
W    H    FROM FIT WITH 2 BW
W           156.        36.             MATTHEWS  71 DBC   0  7. PI+ N          2/72
W            73.        36.             MATTHEWS  71 HBC   0  7. PI- P          2/72
W           . . . . . . . . .
W   AVG     157.3       22.7     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.3)
                               (SEE IDEOGRAM BELOW )
```

WEIGHTED AVERAGE = 157.3 ± 22.7
ERROR SCALED BY 1.3



G WIDTH (MEV), PI+ PI- MODE

```
W      (2PI)+- MODE
W
W           200.0      100.0            CRENNELL  68 HBC   -  6.0 PI- P         12/68
W          (200.)                       BARISH    69 HBC   -  8 PI- P            5/70
W     122   180.0       30.0            BARTSCH   70 HBC   +  8 PI+ P,2 PI       5/70
W           (40.0)     (32.0)           KRAMER    70 HBC   +  13.1 PI+ P,2PI    11/70
W           . . . . . . . . .
W   AVG     181.7       28.7     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

W      K KBAR + K KBAR PI MODE
W
W   F      (120.)   APPROX.             FRENCH    67 HBC   (KO K+-) 3-4 PBAR P 11/69
W   F       ABOVE VALUE ESTIMATED FROM FIG. 9 OF FRENCH 67
W            79.0       70.0     25.0   CRENNELL  68 HBC   +-  6.0 PI-P,KBAR K 12/68
W       13 (100.0)                      ADERHOLZ  69 HBC   +   8 PI+ P,K+KO     8/69
W           112.0       60.0            ADERHOLZ  69 HBC   +   8 PI+ P,KKBARPI  8/69
W           . . . . . . . . .
W   AVG      91.7       37.2     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
```

Mesons
g(1680), X(1690), X^-(1795)

Data Card Listings
For notation, see key at front of Listings.

```
W       (4PI)+- MODE
W
W              100.       35.                BALTAY     68 HBC   +   7, 8.5 PI+ P       6/68
W              162.       58.      40.       BISWAS     68 HBC   -   8. PI- P           2/72
W    J         (90.0)     (20.0)             JOHNSTON   68 HBC    -  7.0 PI- P          6/68
W    J       NOT SEPARATED FROM 2 PI DECAY
W    B         (72.)      (29.)    (20.)     BARNHAM    70 HBC   +  10 K+ P,RHO PIPI   1/73*
W    B     INCLUDED IN HOLMES 72
W         144  135.0      30.0               BARTSCH    70 HBC   +  8 PI+ P,4 PI       4/71
W          90 (180.0)     (30.0)             BARTSCH    70 HBC   +  8 PI+ P,A2 PI      4/71
W         102 (160.0)     (30.0)             BARTSCH    70 HBC   +  8 PI+ P,2 RHO
W              (160.0)                       CASO       70 HBC   - 11.2PI-P,RHO 2PI    5/70
W         300 (200.)                         ARMENISE   72 HBC   -  9.1 PI- P,P 4PI   12/72*
W              130.       30.                HOLMES     72 HBC   +  10.-12. K+ P       1/73*
W              . . . . . . . . . .
W    AVG       128.4      17.0      AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

W       (4PI)0 MODE
W
W    R  80     (40.)      (12.)              DANYSZ     67 HBC     OSEE NOTE R BELOW.  5/67
W    R     SEEN IN 2.5-3 PBAR P. 2PI+2PI-,WITH 0,1,2 PI+PI- PAIRS IN RHOO BAND

W       OMEGA PI  MODE
W
W              130.       73.      43.       BARNHAM    70 HBC   +  10 K+ P,OMEGA PI   6/70
W              (60.0)                        CASO       70 HBC   - 11.2PI-P,PI OMEG    5/70

W        R PEAKS FROM MMS. (FOR DIFFICULTIES WITH MMS EXPT SEE A2 MINIREVIEW)          1/73*
W
W   NR1        (21.)      OR LESS            FOCACCI    66 MMS   -   7-12 PI-P,P MMS 12/72*
W   NR2        (30.)      OR LESS            FOCACCI    66 MMS   -   7-12 PI-P,P MMS 12/72*
W   NR3        (38.)      OR LESS            FOCACCI    66 MMS   -   7-12 PI-P,P MMS 12/72*
W   N      NOT SEEN BY BOWEN 72
W    R        (195.0)                        ANDERSON   69 MMS   -  16 PI- P,BACKW      8/69

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                     15  G PARTIAL DECAY MODES

                                                               DECAY MASSES
P1      G INTO PI PI                                           139+ 139
P2      G INTO 4PI                                             139+ 139+ 139+ 139
P3      G INTO 2 RHO                                           770+ 770
P4      G INTO PI PI RHO                                       139+ 139+ 770
P5      G INTO A2 PI                                          1310+ 139
P6      G INTO K KBAR                                          497+ 497
P7      G INTO OMEGA PI                                        139+ 783
P8      G INTO K KBAR PI                                       497+ 497+ 139
P9      G INTO PHI PI                                         1019+ 139
------ --------- --------- --------- --------- --------- --------- --------

                     15  G BRANCHING RATIOS

R1      G INTO (2PI)/TOTAL                                 (P1)
R1  P          (0.4)                    BARTSCH   70 HBC  + 8. PI+ P           2/72
R1  P          (0.22)    (0.04)         MATTHEWS  71 HDBC O 7. PI+N,PI-P       2/72
R1  P    OPE MODEL USED IN THIS ESTIMATION

R2      G INTO (PI+- PI0) / (ALL PI+- PI+ PI- PI0)  .      (P1)/(P2C)
R2  D          (0.08) OR LESS           BALTAY    68 HBC  +   7-8.5 PI+ P      6/68
R2  D          USING DATA OF DEUTSCHMANN 65 ON PI+P TO PI+ PI0 P               6/68
R2             0.8       0.2            JOHNSTON  68 HBC  -   7. PI- P         2/72
R2             0.8       0.15           BARTSCH   70 HBC  + 8. PI+ P           2/72
R2             (0.12) OR LESS           BALLAM    71 HBC  -   16. PI- P        2/72
R2             (0.2)  OR LESS           HOLMES    72 HBC  + 10.-12. K+ P       1/73*
R2             . . . . . . . . . .
R2  AVG        0.80      0.12     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

R3      G+- INTO (2PI)/(2RHO)                              (P1)/(P3)
R3             (0.48) OR LESS           BISWAS    68 HBC  -   8. PI- P         2/72

R4      G+- INTO (K KBAR)/(2PI)                            (P6)/(P1)
R4             INDICATION SEEN          EHRLICH   66 HBC  +-0 7.9 PI- P        3/67
R4             INDICATION SEEN          ABRAMS    67 HBC    0 4.25 K- P        6/67
R4             0.08      0.08     0.03  CRENNELL  68 HBC      6.0 PI- P       12/68
R4             0.08      0.03           BARTSCH   70 HBC  +   8. PI+ P         1/71
R4             . . . . . . . . . .
R4  AVG        0.080     0.026    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

R5      G+- INTO (K KBAR PI)/(2PI)                         (P8)/(P1)
R5             0.10      0.03           BARTSCH   70 HBC  + 8. PI+ P           2/72

R6      G+- INTO (RHO 2PI)/(ALL 4PI)                       (P4)/(P2)
R6             CONSISTENT WITH 1.       CASO      68 HBC  -  11 PI- P          6/68
R6             1.        0.15           BARTSCH   70 HBC  + 8. PI+ P           2/72
R6             0.88      0.15           BALLAM    71 HBC  -   16. PI- P        2/72
R6             . . . . . . . . . .
R6  AVG        0.94      0.11     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

R7      G+- INTO (2RHO)/(ALL 4PI)                          (P3)/(P2)
R7             SEEN                     DANYSZ    67 HBC    0 3-4 PBAR P       5/68
R7             SEEN                     BALTAY    68 HBC  +   7,8.5 PI+ P      6/68
R7             (0.63) OR MORE           BISWAS    68 HBC  -   8. PI- P         2/72
R7             SEEN                     JOHNSTON  68 HBC  -  7 PI-P            6/68
R7             0.7       0.15           BARTSCH   70 HBC  + 8. PI+ P           2/72
R7             (0.92)                   ARMENISE  72 HBC  -  9.1 PI- P,P 4PI  12/72*

R8      G+- INTO (2 RHO)/(ALL RHO 2PI)                     (P3)/(P4)
R8             0.48      0.16           CASO      68 HBC  -  11 PI- P          6/68
R8             (0.75) OR MORE           BISWAS    68 HBC  -   8. PI- P         2/72

R9      G+- INTO (PI+- A20)/(ALL 4PI)
R9                        (WITH A20 INTO (PI+ PI- PI0))
R9             0.40      0.20           BALTAY    68 HBC  +   7,8.5 PI+P       6/68
R9             NOT SEEN                 JOHNSTON  68 HBC  -  7 PI- P           6/68
R9             (0.6)     (0.15)         BARTSCH   70 HBC  + 8. PI+ P           2/72

R10     G+- INTO (PI OMEGA)/(ALL 4PI)                      (P7)/(P2)
R10                       (WITH OMEGA INTO(PI+ PI- PI0))
R10            0.25      0.10           BALTAY    68 HBC  +   7-8.5 PI+P       5/68
R10             .25      0.10           JOHNSTON  68 HBC  -   7.0 PI- P        6/68
R10            0.12       0.07          BALLAM    71 HBC  -   16. PI- P        2/72
R10            . . . . . . . . . .
R10 AVG        0.184     0.050    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

R11     G+- INTO (PI PHI)/(ALL 4PI)                        (P9)/(P2)
R11            (0.11) OR LESS           BALTAY    68 HBC  +   7,8.5 PI+P       6/68

R12     G+- INTO (PI+- 2PI+ 2PI- PI0)/(ALL PI+- PI+ PI- PI0)
R12            (0.15) OR LESS           BALTAY    68 HBC  +   7,8.5 PI+ P      6/68

R13     R FRACTION INTO ONE / THREE / FIVE OR MORE CHARGED TRACKS
R13 R1        (0.37)/    (0.59)/  0.04  FOCACCI    66 MMS   -    7-12 PI-P,P MMS  2/72
R13 R2        (0.42)/    (0.56)/  0.01  FOCACCI    66 MMS   -    7-12 PI-P,P MMS  2/72
R13 R3        (0.14)/    (0.80)/  0.05  FOCACCI    66 MMS   -    7-12 PI-P,P MMS  2/72

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                          REFERENCES FOR G

BELLINI  65 NC 40 A 948       BELLINI,DI CORATO,DUIMIO,FIORINI    (MILANO)
DEUTSCHM 65 PL 18 351         M.DEUTSCHMANN ET AL      (AACHEN+BERLIN+CERN)
FORINO   65 PL 19 65          FORINO,GESSAROLI +    (BOLOGNA+ORSAY+SACLAY)
GOLDBERG 65 PL 17 354         GOLDBERG+ (CERN+EPOL+ORSAY+MILANO+CEA-SACL)

EHRLICH  66 PR 152 1194       R. EHRLICH,W.SELOVE,H.YUTA     (PENNSYLVANIA)
FOCACCI  66 PRL  17  890      CERN MISSING MASS SPECTROMETER GROUP (CERN)
LEVRAT   66 PL   22  714      CERN MISSING MASS SPECTROMETER GROUP (CERN)
SEGUINOT 66 PL 19 712         CERN MISSING MASS SPECTROMETER GROUP (CERN)

ABRAMS   67 PRL 18 620        +KEHOE+GLASSER+SECHI-ZORN+WOLSKY (MARYLAND)
DANYSZ   67 PL 24B 309        +FRENCH+KINSON+SIMAK+        (CERN+LIVERPOOL)
DUBAL    67 NP B3 435         +FOCACCI+KIENZLE+LECHANOINE+LEVRAT+   (CERN)
   ALSO  68 THESIS 1456       L.DUBAL                             (GENEVE)
FRENCH   67 NC 52A 442        +KINSON+MCDONALD+RIDDIFORD+       (CERN+BIRM)

ARMENISE 68 NC 54 A 999       +FORINO+CARTACCI+(BARI+BGNA +FIRENZE+ORSAY)I
BALTAY   68 PRL 20 887        +KUNG+YEH+FERBEL+       (COLU+ROCH+RUTG+YALE)I=1
BISWAS   68 PRL 21 50         +CASON,DZIERBA,GROVES,KENNEY,+          (NDAM)
BOESEBEC 68 NP B 4 501        BOESEBECK,DEUTSCHMANN,+(AACHEN+BERLIN+CERN)
CASO     68 NC 54 A 983       +CONTE+CORDS+DIAZ+  (GENOVA+HAMB+MILA+SACL)
CRENNELL 68 PL 28 B 136       +KARSHON,LAI,SCARR,SKILLICORN           (BNL)
JOHNSTON 68 PRL 20 1414       +PRENTICE,STEENBERG,YOON     (TORONTO+WISC)IJP

ADERHOLZ 69 NP B 11 259       +BARTSCH,+          (AACH+BERL+CERN+JAGL+WARS)
ANDERSON 69 PRL 22 1390       +COLLINS,BLIEDEN+                  (BNL+CARN)
BARISH   69 PR 184  1375      +SELOVE,BISWAS,CASON,+       (PENN+NDAM+ROCH)
CASO     69 NC 62 A 755       +CONTE,BENZ,+     (GENO+DESY+HAMB+MILA+SACL)
VETLITSK 69 SJNP 9 461        +GUZHAVIN,KLIGER,KOLGANOV,LEBEDEV+      (ITEP)

ARMENISE 70 LNC 4  199        +GHIDINI,FORINO,CARTACCI,+ (BARI+BGNA+FIRZ)
BARNHAM  70 PRL 24 1083       +COLLEY,JOBES,KENYON,PATHAK,RIDDIFORD(BIRM)
BARTSCH  70 NP B 22 109       +KRAUS,TSANOS,GROTE,KOTZAN+(AACH+BERL+CERN)
CASO     70 LNC 3 707         +CONTE,TOMASINI,CORDS+(GENO+HAMB+MILA+SACL)
KRAMER   70 PRL 25 396        +BARTON,GUTAY,LICHTMAN,MILLER,+      (PURDUE)
MAURER   70  THESIS NO.588    G.MAURER                         (STRASBOURG)
STUNTEBE 70 PL 32 B 391       STUNTEBECK,KENNEY,DEERY,BISWAS,CASON+(NDAM)

BALLAM   71 PR D 3 2606       +CHADWICK,GUIRAGOSSIAN,JOHNSON,+       (SLAC)
BRAUN    71 NP B 30 213       +FRIDMAN,GERBER,GIVERNAUD,KAHN,+       (STRB)
GRAYER   71 PL 35 B 610       +HYAMS,JONES,SCHLEIN,BLUM,+     (CERN+MPIM)JP3-
MATTHEWS 71 NP B 331          +PRENTICE,YOON,CARROLL,+        (TNTO+WISC)JP3-

ARMENISE 72 LNC 4 205         +FORINO,CARTACCI,+          (BARI+BGNA+FIRZ)
BOWEN    72 PRL 29 890        +EARLES,FAISSLER,BLIEDEN,+        (NEAS+STON)
CLAYTON  72 NP B 47 81        +MASON,MUIRHEAD,RIGOPOULOS,+      (LIVP+PATR)
GRAYER   72 PHIL.CONF.PROC. 5 +HYAMS,JONES,SCHLEIN,BLUM,DIETL+(CERN+MPIM)
HOLMES   72 PR D 6 3336       +FERBEL,SLATTERY,WERNER                (ROCH)

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X(1690) →ωππ

```
64  X(1690)

THIS ENTRY CONTAINS (OMEGA PI PI) PEAKS AROUND
1690 MEV. EVIDENCE NOT COMPELLING. OMITTED FROM TABLE.

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                  64  X(1690) MASS (MEV)

M            1689.       10.              DANYSZ    67 HBC    0 3,3.6 PBAR P      1/73*
M            1670.0      18.0             YOST      68 HBC    04.3 K-P,LMBD.5PI   1/73*
M            1695.0      20.0             BARNES    69 HBC    0 4.6 K-P,OMEG2PI   1/73*
M            . . . . . . . . . .
M    AVG     1686.2       8.0     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

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                  64  X(1690) WIDTH (MEV)

W              38.       18.              DANYSZ    67 HBC    0 3,3.6 PBAR P      1/73*
W              50.0      15.0             YOST      68 HBC    04.3 K-P,LMBD.5PI   1/73*
W              90.       20.              BARNES    69 HBC    0 4.6 K-P,OMEG2PI   1/73*
W              . . . . . . . . . .
W    AVG       56.3      14.2     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.4)

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                      REFERENCES FOR X(1690)

DANYSZ   67 NC 51 A 801       DANYSZ+FRENCH+SIMAK                    (CERN)
YOST     68  UMD  T.REPORT849 +YODH,EINSCHLAG,DAY,GLASSER             (UMD)
BARNES   69 PRL 23 142        +CHUNG,EISNER,FLAMINIO,+                (BNL)

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X^-(1795)

```
63  X- (1795,JPG=   ) I=1

SEEN AS A (PBAR N) BOUND STATE IN PBAR D ANNIHILATIONS
AT REST. NEEDS FURTHER CONFIRMATION.OMITTED FROM TABLE.
BOGDANOVA 72 PREDICT A VECTOR MESON
AT THIS ENERGY.

------ --------- --------- --------- --------- --------- --------- --------

                  63  X-(1795) MASS (MEV)

M    D     1794.5     1.4               GRAY       71 DBC  -  0.PBAR D           1/72
M    D     DECAYS TO FOUR OR MORE PIONS

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                  63  X-(1795) WIDTH(MEV)

W    D      (8.)    OR LESS  CL=.95   GRAY       71 DBC  -  0.PBAR D           1/72
W    D     DECAYS TO FOUR OR MORE PIONS.

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0 0 0 0 3 6 0 4 0 1 5

Data Card Listings

For notation, see key at front of Listings.

Mesons

$X^-(1795)$, $\eta/\rho(1830)$, $\omega/\pi(1830)$, $S(1930)$, $\rho(\sim2100)$


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                              REFERENCES FOR X-(1795)

GRAY      71 PRL 26 1491         +HAGERT,KALOGEROPOULOS                  (SYRA)
BOGDANOV  72 PRL 28 1418         BOGDANOVA,DALKAROV,SHAPIRO              (ITEP)
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$\eta/\rho(1830)$ $\rightarrow 4\pi, K^*\bar{K}$

```
42  ETA/RHO (1830, JPG=   +)

THIS ENTRY CONTAINS 4PI AND K KBAR PI PEAKS
AROUND 1830 MEV. OMITTED FROM TABLE.
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```
                    42  ETA/RHO(1830) MASS (MEV)

M       110 1832.       6.         DANYSZ    67 HBC    OSEE NOTE R BELOW  5/67
M   R       SEEN IN 2.5-3. PBAR P. 2PI+2PI-, WITH 0,1,2 PI+PI- PAIRS
M   R                                                  IN RHOO BAND
M           1820.       12.        FRENCH    67 HBC    OSEE NOTE K BELOW  7/67
M   K       SEEN IN 3.-3.6 PBAR P TO (KS KO PIO...). G PARITY UNKNOWN
M           . . . . . . . . .
M   AVG     1829.6      5.4     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
```

```
                    42  ETA/RHO(1830) WIDTH (MEV)

W       110  42.        11.        DANYSZ    67 HBC    OSEE NOTE R BELOW  5/67
W   R       SEEN IN 2.5-3. PBAR P. 2PI+2PI-, WITH 0,1,2 PI+PI- PAIRS
W   R                                                  IN RHOO BAND
W            50.        23.        FRENCH    67 HBC    OSEE NOTE K BELOW  7/67
W   K       SEEN IN 3.-3.6 PBAR P TO (KS KO PIO...). G PARITY UNKNOWN
W           . . . . . . . . .
W   AVG      43.5       9.9     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
```

```
                    42  ETA/RHO(1830) PARTIAL DECAY MODES

                                                        DECAY MASSES
P1     ETA/RHO(1830) INTO 4 PI                          139+ 139+ 139+ 139
P2     ETA/RHO(1830) INTO RHO PI PI                     139+ 139+ 770
P3     ETA/RHO(1830) INTO RHO RHO                       770+ 770
P4     ETA/RHO(1830) INTO K KBAR PI                     134+ 497+ 497
```


```
                         REFERENCES FOR ETA/RHO(1830)

DANYSZ    67 PL 24B 309       +FRENCH+KINSON+SIMAK+        (CERN+LIVERPOOL)
FRENCH    67 NC 52A 442       +KINSON+MCDONALD+RIDDIFORD+      (CERN+BIRM)
CLAYTON   72 NP B 47 81       +MASON,MUIRHEAD,RIGOPOULOS,+     (LIVP+PATR)
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$\omega/\pi(1830)$ $\rightarrow \omega\pi\pi, K^*\bar{K}$

```
43  OMEGA/PI (1830,JPG=  -)

THIS ENTRY CONTAINS OMEGA PI PI AND K KBAR PI PEAKS
AROUND 1830 MEV. I=1 IF (OMEGA RHO) MODE EXISTS.
THE KS KO PI PEAK, IF PRESENT AND EVEN IF NOT PART
OF ETA/RHO(1830), IS ONLY A MINOR MODE.
OMITTED FROM TABLE.
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```
                    43  OMEGA/PI(1830) MASS (MEV)

M   O      (1848.)     (11.)        DANYSZ    67 HBC    0 3,3.6 PBAR P     7/67
M   O       OBSERVED IN (OMEGA PI+ PI-) (AND POSSIBLY (OMEGA RHO(0))) MODE
M   K      (1820.)     (12.)        FRENCH    67 HBC    0 3,3.6 PBAR P     7/67
M   K       OBSERVED IN (KS KO PIO...) MODE  (G-PARITY UNKNOWN)
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```
                    43  OMEGA/PI(1830) WIDTH (MEV)

W   O       (67.)      (27.)        DANYSZ    67 HBC    0 3,3.6 PBAR P     7/67
W   O        OBSERVED IN (OMEGA PI+ PI-) (AND POSSIBLY (OMEGA RHO(0))) MODE
W   K       (50.)      (20.)        FRENCH    67 HBC    0 3-4 PBAR P       7/67
W   K        OBSERVED IN (KS KO PIO...) MODE  (G-PARITY UNKNOWN)
```

```
                    43  OMEGA/PI(1830) PARTIAL DECAY MODES

                                                        DECAY MASSES
P1     OMEGA/PI(1830) INTO 4 PI                         139+ 139+ 139+ 139
P2     OMEGA/PI(1830) INTO OMEGA PI PI                  139+ 139+ 783
P3     OMEGA/PI(1830) INTO 2 RHO                        783+ 770
P4     OMEGA/PI(1830) INTO K KBAR PI                    139+ 497+ 497
```


```
                         REFERENCES FOR OMEGA/PI(1830)

DANYSZ    67 NC 51A 801       DANYSZ+FRENCH+SIMAK                  (CERN)
FRENCH    67 NC 52A 442       +KINSON+MCDONALD+RIDDIFORD+      (CERN+BIRM)
CLAYTON   72 NP B 47 81       +MASON,MUIRHEAD,RIGOPOULOS,+     (LIVP+PATR)
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S(1930) REGION $\rightarrow$

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31  S (1930,JPG=  )

THIS ENTRY CONTAINS THE STRUCTURE OBSERVED IN
PBAR P BACKWARD ELASTIC SCATTERING AND VARIOUS
PEAKS NEAR 1970 MEV. OMITTED FROM TABLE.
FOR REVIEW SEE DIEBOLD 72.
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```
                    31  S MASS (MEV)

M   N      (1929.0)    (14.0)        CHIKOVANI 66 MMSP  -  12.0 PI-P         12/72*
M   N   NOT SEEN BY BOWEN 72
M           1900.       40.          BOESEBECK 68 HBC   +   8 PI+ P,PI+ PIO   6/68
M   A       1973.0      15.0         CASO      70 HBC   - 11.2PI- P,NOTE C    5/70
M   A       SEEN IN RHO- PI+ PI- (OMEGA AND ETA ANTISELECTED IN 4 PI SYSTEM)  5/70
M    K      1975.0      12.0         KRAMER    70 HBC   +  13.1 PI+ P,2PI    11/70
M    K      HAS IG=1+ FROM ABSENCE OF PI+PI+ PEAK. THUS JP=(ODD)-.           11/70
M   C      (1940.)     (8.)          CLINE     70 HBC   0  .25-.74 PBAR P     2/72
M   C      (1939.)                   D*ANDLAU  71 HBC   0  .37-.65 PBAR P     2/72
M   C   FROM FIT OF A SINGLE BW FORMULA TO THE PBAR P BACKWARD ELASTIC
M   C   CROSS SECTION  / COS(THETA) IN (-.9,-1.0) /.  SOME INDICATIONS
M   C   OF AN ADDITIONAL STRUCTURE IN BOTH DATA.
M   C   RESONANT INTERPRETATION QUESTIONED BY LYS 70 AND BIZZARRI 72 .
M   B      (1968.)                   BENVENUTI 71 HBC   0  .1 - .8 PBAR P     2/72
M   B   SEEN AS A BUMP IN THE PBAR P - KS KL  CROSS SECTION WITH JPC=1--.
M   B   BASED ON ONLY 71 EVENTS OF THIS REACTION.
M   B . NOT SEEN BY CARSON 72 WITH 69 EVENTS.                                12/72*
M           . . . . . . . . .
M       AVERAGE MEANINGLESS (SCALE FACTOR = 1.3)
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```
                    31  S WIDTH (MEV)

W   N       (35.0)   OR LESS         CHIKOVANI 66 MMSP  -  12.0 PI-P         12/72*
W   N   NOT SEEN BY BOWEN 72
W           216.       105.          BOESEBECK 68 HBC   +   8 PI+ P,PI+ PIO   6/68
W   A       (80.0)                   CASO      70 HBC   - 11.2PI- P,NOTE C    5/70
W   A     SEEN IN RHO- PI+ PI- (OMEGA AND ETA ANTISELECTED IN 4 PI SYSTEM)   5/70
W    K      (52.0)   OR LESS  CL=.90  KRAMER   70 HBC   +  13.1 PI+ P,2PI    11/70
W    K     HAS IG=1+ FROM ABSENCE OF PI+PI+ PEAK. THUS JP=(ODD)-.            11/70
W   C       (49.)      (9.)          CLINE     70 HBC   0  .25-.74 PBAR P     2/72
W   C       (63.)                    D*ANDLAU  71 HBC   0  .37-.65 PBAR P     2/72
W   C   SEE REMARKS UNDER MASS ABOVE
W   B       (35.)                    BENVENUTI 71 HBC   0  .1 - .8 PBAR P     2/72
W   B   SEE REMARKS UNDER MASS ABOVE
```

```
                    31  S PARTIAL DECAY MODES

                                                        DECAY MASSES
P1     S INTO PI+ PI-                                   139+ 139
P2     S INTO PBAR P                                    938+ 938
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                         REFERENCES FOR S

CHIKOVAN  66 PL  22  233        CERN MISSING MASS SPECTROMETER GROUP (CERN)
FOCACCI   66 PRL  17  890       CERN MISSING MASS SPECTROMETER GROUP (CERN)
BOESEBEC  68 NP B 4 501         BOESEBECK,DEUTSCHMANN,+(AACHEN+BERLIN+CERN)
CLINE     68 PRL 21 1268        +ENGLISH,REEDER,TERRELL,TWITTY  (WISCONSIN)

CASO      70 LNC 3  707         +CORDS,COSTA,+    (GENO,DESY,HAMB,MILA,SACL)
CLINE     70  PREPRINT          D.CLINE,J.ENGLISH,D.D.REEDER         (WISC)J
KRAMER    70 PRL 25 396         +BARTON,GUTAY,LICHTMAN,MILLER,+    (PURDUE)
LYS       70  PREPRINT          J.LYS                                (MICH)

BENVENUT  71 PRL 27 283         BENVENUTI,CLINE,RUTZ,REEDER,SCHERER  (WISC)
CLINE     71  REVIEW            D.CLINE,TALK AT ANL WORKSHOP JULY 71 (WISC)
D*ANDLAU  71  PREPRINT          +ASTIER,PETRI,+                 (CDEF+PISA)
PINSKI    71 PRL 27 1548        STEPHEN S. PINSKY             (UTAH+ARGONNE)

BIZZARRI  72 PR D 6 160         +GUIDONI,MARZANO,CASTELLI,+     (ROMA+TRST)
BOWEN 1   72 PRL 29 890         +EARLES,FAISSLER,BLIEDEN,+      (NEAS+STON)
BOWEN     72  PREP.NUB 2167     +EARLES,FAISSLER,GARELICK,GETTNER,+ (NEAS)
CARSON    72  BAT.CONF.PAP.498  +BUTTON-SHAFER,YAMAMOTO,+       (MASA+TOKY)
DIEBOLD   72  BATAV.CONF.       R.DIEBOLD  RAPPORTEUR TALK           (ANL)
KIENZLE   72  PHIL.CONF.PROC207 W.KIENZLE                           (CERN)
WOHLMUT   72  BAT.CONF.PAP.275  +YEE,JOHNSON,PETERS,STENGER       (HAWAII)
```


$\rho(\sim2100)$ REGION $\rightarrow$

```
51  RHO (2100, JPG=  +) I=1

NICHOLSON 69 SUGGEST IG=1+,JP=3- FROM  ANALYSIS OF
DIFFERENTIAL CROSS-SECTIONS FOR PBAR PI -- 2PI.
NOT SUPPORTED BY EHRLICH 72.
OMITTED FROM TABLE.
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```
                    51  RHO (2100) MASS (MEV)

M           2086.0      38.0          ANDERSON  69 MMS   -  16 PI- P,BACKW    8/69
M          (2120.)                    NICHOLSON 69 CNTR  0 .7-2.4 PB P,2PI    9/69
M        50(2070.)                    TAKAHASHI 72 HBC     8. PI- P,N 2PI     1/73*
```

```
                    51  RHO (2100) WIDTH (MEV)

W          (150.0)                    ANDERSON  69 MMS   -  16 PI- P,BACKW    8/69
W   N      (249.)                     NICHOLSON 69 CNTR  0 .7-2.4 PB P,2PI    9/69
W   N       THE WIDTH INCLUDES RESOLUTION.
W        50 (160.)                    TAKAHASHI 72 HBC     8. PI- P,N 2PI     1/73*
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```
                         REFERENCES FOR RHO(2100)

ANDERSON  69 PRL 22 1390       +COLLINS,BLIEDEN+                 (BNL+CARN)
NICHOLSO  69 PRL 23 603        NICHOLSON,BARISH,DELORME,+   (CIT+ROCH+BNL)

EHRLICH   72 PRL 28 1147       +ETKIN,GLODIS,HUGHES,KONDO,LU,MORI,+ (YALE)
TAKAHASH  72 PR D 6 1266       TAKAHASHI,BARISH,+       (TOHO+PENN+NDAM+ANL)
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Mesons
T(2200), ρ(~2275), U(2360)

Data Card Listings
For notation, see key at front of Listings.

T(2200) REGION →

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32  T (2200,JPG=   )

THIS ENTRY CONTAINS VARIOUS PEAKS NEAR 2200 MEV.
OMITTED FROM TABLE.
FOR REVIEWS SEE BERTANZA 72, DIEBOLD 72.
------ --------- --------- --------- --------- --------- --------- --------

                 32  T MASS (MEV)

M        S CHANNEL NBAR N
M  B       2190.     10.          ABRAMS    70 CNTR   S CHANNEL NBAR N  1/73*
M  B     SEEN AS BUMP IN I=1 STATE. SEE ALSO COOPER 68.
M  B       BRICMAN (69) SEES NO BUMP, SPIN LESS THAN 5 IS SO EXCLUDED
M  K      (2190.0)                KALBFLEIS 69 HBC    0 S-CHANNEL PBARP  7/69
M  K       SEEN IN PBAR P TO RHOO RHOO PIO. IG=1-.
M  K     NOT SEEN BY DONALD 72.                                        12/72*
M          2195.      5.          COHEN     72 CNTR   S CHANNEL PBAR P 12/72*
M         . . . . . . . . .
M  AVG     2194.0     4.5     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

M        PEAKS FROM PRODUCTION EXPERIMENTS
M  N      (2195.0)   (15.0)       CHIKOVANI 66 MMSP  -  12.0 PI-P       12/72*
M  N     NOT SEEN BY BOWEN 72.
M          2207.      13.         ALLES-BOR 67 HBC    0 5.7 PBAR P      12/66
M  A       ALLES-BORELLI 67 SEE NEUTRAL MODE ONLY (PI+PI-PIO)
M          2190.0    10.0         CLAYTON   67 HBC  +- 2.5PBAR,A2+OMEGA 10/67
M          2207.0    22.0         CASO      70 HBC   - 11.2PI- P,NOTE C. 5/70
M  C       SEEN IN RHO- PI+ PI- (OMEGA AND ETA ANTISELECTED IN 4 PI SYSTEM)  5/70
M  D       2157.0    10.0         KRAMER    70 HBC  +  13.1 PI+ P,2PI   11/70
M  D       HAS IG=1+ FROM ABSENCE OF PI+PI+ PEAK. THUS JP=(ODD)-.        11/70
M         . . . . . . . . .
M     AVERAGE MEANINGLESS (SCALE FACTOR = 2.0)
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                 32  T WIDTH (MEV)

W        S CHANNEL NBAR N
W  B       (85.)                  ABRAMS    67 CNTR   S CHANNEL NBAR N  7/67
W  B        SEE NOTE B UNDER T(2200) MASS ABOVE.
W  K       BETWEEN 20 AND 80 MEV  KALBFLEIS 69 HBC    0 S-CHANNEL PBARP  7/69
W          95.       15.          COHEN     72 CNTR   S CHANNEL PBAR P 12/72*

W        PEAKS FROM PRODUCTION EXPERIMENTS
W  N      (13.0)  OR LESS         CHIKOVANI 66 MMSP  -  12.0 PI-P        8/66
W          62.       52.          ALLES-BOR 67 HBC    0 5.7 PBAR P      12/66
W         (130.0)                 CASO      70 HBC   - 11.2PI- P,NOTE C. 5/70
W  C       SEEN IN RHO- PI+ PI- (OMEGA AND ETA ANTISELECTED IN 4 PI SYSTEM)  5/70
W  D       68.0      22.0         KRAMER    70 HBC  +  13.1 PI+ P,2PI   11/70
W  D       HAS IG=1+ FROM ABSENCE OF PI+PI+ PEAK. THUS JP=(ODD)-.        11/70
W         . . . . . . . . .
W     AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)
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         32  SIGMA (MB) FOR FORMATION BY NUCLEON ANTINUCLEON

CS A       (5.5)                  ABRAMS    70 CNTR   S CHANNEL NBAR N  1/71
CS A     FOR I=1 NBAR N
CS         2.25      0.08         COHEN     72 CNTR   S CHANNEL PBAR P  1/73*
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REFERENCES FOR T


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CHIKOVAN 66 PL  22  233          CERN MISSING MASS SPECTROMETER GROUP (CERN)
FOCACCI  66 PRL  17  890         CERN MISSING MASS SPECTROMETER GROUP (CERN)
   ALSO 69 CASO
ABRAMS   67 PRL 18 1209          +COOL,GIACOMELLI,KYCIA,LEONTIC,LI,+    (BNL)
ALLES-BO 67 NC 50 A 776          ALLES-BORELLI,FRENCH,FRISK,+  (CERN+BONNIG=-
CLAYTON  67 HEIDBG.CONF.P.57     +MASON,MUIRHEAD,FILIPPAS+(LIVERPOOL+ATHENS)
COOPER   68 PRL 20 1059          +HYMAN,MANNER,MUSGRAVE,VOYVODIC        (ANL)

BAUBILLI 69 LUND PAPER 87        BAUBILLIER,DUBOC,HURIAUX,+        (IPN+LIVP)
BRICMAN  69 PL 29 B 451          +FERRO-LUZZI,BIZARD,+         (CERN+CAEN+SACL)
CASO     69 NC 62 A 755          +CONTE,BENZ,+    (GENO+DESY+HAMB+MILA+SACL)
KALBFLEI 69 PL 29 B  259         G.KALBFLEISCH,R.STRAND,V.VANDERBURG    (BNL)
MONTANET 69 LUND CONF.P.189      L.MONTANET, RAPPORTEUR                (CERN)

ABRAMS   70 PR D 1 1917          +COOL,GIACOMELLI,KYCIA,LEONTIC,LI,+    (BNL)
CASO     70 LNC 3 707            +CONTE,TOMASINI,CORDS+(GENO+HAMB+MILA+SACL)
   ALSO 69 CASO
KALBFLEI 70 PHILAD.CONF.P.409 G.KALBFLEISCH AND D.MILLER REVUES        (BNL)
KRAMER   70 PRL 25 396           +BARTON,GUTAY,LICHTMAN,MILLER,+    (PURDUE)

BACON    71 NP B 32 66           +BUTTERWORTH,MILLER,PHELAN,+     (RHEL+LIVP)
FIELDS   71 PRL 27 1749          +COOPER,RHINES,ALLISON            (ANL+OXF)
YOH      71 PRL 26 922           +BARISH,CAROLL,LOBKOVICZ+    (CIT+BNL+ROCH)

ALEXANDE 72 NP B 45 29           ALEXANDER,BAR-NIR,BEVARY,DAGAN,+      (TELA)
BERTANZA 72  CERN 72-10          L.BERTANZA REVIEW AT CHEXBRES 72      (PISA)
BOWEN    72  PREP.NUB 2167       +EARLES,FAISSLER,GARELICK,GETTNER,+   (NEAS)
BUGG     72 PR D 6 3047          +CONDO,HART,COHN,ENDORF,+  (TENN+ORNL+CINC)
CLAYTON  72 NP B 47 81           +MASON,MUIRHEAD,RIGOPOULOS,+     (LIVP+PATR)
COHEN    72 PHIL.CONF.PROC.      K.J.COHEN                          (RUTGERS)
DIEBOLD  72  BATAV.CONF.         R.DIEBOLD  RAPPORTEUR TALK              (ANL)
DONALD   72 PL 40 B 586          +GALLETLY,EDWARDS,DE BILLY,+     (LIVP+LPNP)
DONALD   72  BAT.CONF.PAP.263 +EDWARDS,GIBBINS,BRIAND,DUBOC,+ (LIVP+LPNP)
DONALD   72  BAT.CONF.PAP.265 INTERNAT.COLLABORATION               (LIVP+)
KIENZLE  72 PHIL.CONF.PROC207 W.KIENZLE                            (CERN)
MING MA  72 NP B 51 77           +EASTMAN,OH,PARKER,SMITH,SPRAFKA      (MSU)
WOHLMUT  72  BAT.CONF.PAP.275 +YEE,JOHNSON,PETERS,STENGER         (HAWAII)
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ρ(~2275) REGION →

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52  RHO (2275, JPG= +) I=1

NICHOLSON 69 SUGGEST IG=1+,JP=5- FROM  ANALYSIS OF
DIFFERENTIAL CROSS-SECTIONS FOR PBAR PI -- 2PI.
NOT SUPPORTED BY EHRLICH 72.
OMITTED FROM TABLE.
------ --------- --------- --------- --------- --------- --------- --------
                 52  RHO(2275) MASS (MEV)

M          2260.0    18.0         ANDERSON  69 MMS   -  16 PI- P,BACKW   8/69
M         (2290.)                 NICHOLSON 69 CNTR   0 .7-2.4 PB P,2PI  9/69
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                 52  RHO(2275) WIDTH (MEV)

W         (25.0)  OR LESS         ANDERSON  69 MMS   -  16 PI- P,BACKW   8/69
W  N      (165.)                  NICHOLSON 69 CNTR   0 .7-2.4 PB P,2PI  9/69
W  N       THE WIDTH INCLUDES RESOLUTION.
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REFERENCES FOR RHO(2275)


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ANDERSON 69 PRL 22 1390          +COLLINS,BLIEDEN+                (BNL+CARN)
NICHOLSO 69 PRL 23 603           NICHOLSON,BARISH,DELORME,+   (CIT+ROCH+BNL)
EHRLICH  72 PRL 28 1147          +ETKIN,GLODIS,HUGHES,KONDO,LU,MORI,+ (YALE)
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U(2360) REGION →

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33  U (2360,JPG=   ) I=1

THIS ENTRY CONTAINS THE BROAD BUMP OBSERVED
IN THE S CHANNEL NBAR N, AND VARIOUS OTHER PEAKS,
MOSTLY CONTROVERSIAL. OMITTED FROM TABLE.
FOR REVIEW SEE ASTBURY 72, DIEBOLD 72.
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                 33  U(2360)  MASS (MEV)

M        S CHANNEL NBAR N
M  R      (2370.0)   (10.0)       RING      69 HBC    0 S-CHANNEL PBARP 11/71
M  R       NOT CONFIRMED IN EXTENSION OF THE EXP..SEE CHAPMAN 71.       11/71
M  A       2350.      10.         ABRAMS    70 CNTR   S CHANNEL NBAR N  1/73*
M  A     FOR I=1 NBAR N
M  N      (2360.0)   (25.0)       OH        70 HDBC  -OPBAR(P,N),K*K2PI  1/73*
M  N       NO EVIDENCE FOR THIS BUMP SEEN IN THE PBAR P DATA OF CHAPMAN 71  1/73*
M  I      (2360.)     (5.)        COHEN     72 CNTR   S CHANNEL PBAR P  1/73*
M  I     ISOSPINS 0 AND 1 NOT SEPARATED

M        PEAKS FROM PRODUCTION EXPERIMENTS
M  M      (2382.0)   (24.0)       CHIKOVANI 66 MMS   -  12.0 PI-P       12/72*
M  M     NOT SEEN BY BOWEN 72                                          12/72*
M  C      (2324.0)   (20.0)       CLAYTON   67 HBC  +- 2.5PBAR,A2+OMEGA 11/69
M  C       MAY BE DIFFERENT OBJECT. VALUE QUOTED IN HEIDELBERG PROC. OF
M  C       2380 +- 10 IS MISTAKE... PRIV. COMM. FROM MUIRHEAD.
M          2370.      17.         ANDERSON  69 ASPK  - 16 PI- BKSCAT    11/69
M         (2420.0)   (25.0)       JOHNSON   70 HBC   -  12.0 PI- P       1/71
M       73(2374.)     (4.)        ATHERTON  71 HBC    0 5.7 PBAR P       2/73*
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                 33  U(2360)  WIDTH (MEV)

W        S CHANNEL NBAR N
W          (140.)                 ABRAMS    67 CNTR   S CHANNEL PBAR N  1/73*
W  R       (40.0)  OR LESS        RING      69 HBC    0 S-CHANNEL PBARP 11/71
W  R       NOT CONFIRMED IN EXTENSION OF THE EXP..SEE CHAPMAN 71.       11/71
W  N       (60.0)  OR LESS        OH        70 HDBC  -OPBAR(P,N),K*K2PI 11/71
W  N       NO EVIDENCE FOR THIS BUMP SEEN IN THE PBAR P DATA OF CHAPMAN 71 11/71
W  I      (163.)     (15.)        COHEN     72 CNTR   S CHANNEL PBAR P  1/73*
W  I     ISOSPINS 0 AND 1 NOT SEPARATED

W        PEAKS FROM PRODUCTION EXPERIMENTS
W  M       (30.0)  OR LESS        CHIKOVANI 66 MMS   -  12.0 PI-P        8/66
W  M     NOT SEEN BY BOWEN 72                                          12/72*
W          (57.)                  ANDERSON  69 ASPK  - 16 PI- BKSCAT    11/69
W          (80.0)  OR LESS        JOHNSON   70 HBC   -  12.0 P+- P       1/71
W       73 (24.)   OR LESS        ATHERTON  71 HBC    0 5.7 PBAR P       2/73*
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         33  SIGMA (MB) FOR FORMATION BY NUCLEON ANTINUCLEON

CS A       (3.2)                  ABRAMS    70 CNTR   S CHANNEL NBAR N  1/71
CS A     FOR I=1 NBAR N
CS I       (2.0)     (0.07)       COHEN     72 CNTR   S CHANNEL PBAR P  1/73*
CS I     ISOSPINS 0 AND 1 NOT SEPARATED
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REFERENCES FOR U(2360)


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CHIKOVAN 66 PL  22  233          CERN MISSING MASS SPECTROMETER GROUP (CERN)
FOCACCI  66 PRL  17  890         CERN MISSING MASS SPECTROMETER GROUP (CERN)

ABRAMS   67 PRL 18 1209          +COOL,GIACOMELLI,KYCIA,LEONTIC,LI,+    (BNL)
CLAYTON  67 HEIDBG.CONF.P.57     +MASON,MUIRHEAD,FILIPPAS+(LIVERPOOL+ATHENS)
   ALSO 71 PRIV.COMM.            W.MUIRHEAD                            (LIVP)

ANDERSON 69 PRL 22 1390          +BLESER,BIRNBAUM,EDELSTEIN,+    (BNL+CARN)
BRICMAN  69 PL 29 B 451          +FERRO-LUZZI,BIZARD,+         (CERN+CAEN+SACL)
CASO     69 LNC 3 707            +CONTE,BENZ,+    (GENO+DESY+HAMB+MILA+SACL)
RING1    69  MICH PREPRINT       +CHAPMAN,CHURCH,LYS,MURPHY,VANDERVELD(MICH)
RING     69                      JOINT PREPRINT COMBINES RING1 AND OH 70

ABRAMS   70 PR D 1 1917          +COOL,GIACOMELLI,KYCIA,LEONTIC,LI,+    (BNL)
JOHNSON  70  UH 511 77 70        +PETERS,STENGER,YEE                 (HAWAII)
LYS      70  PREPRINT            J.LYS                                 (MICH)
OH       70 PRL 24 1257          +PARKER,EASTMAN,SMITH,SPRAFKA,MA       (MSU)
SMITH    70  PREPRINT            G.A.SMITH                              (MSU)

ATHERTON 71  CERN PHYS.71-18     +CELNIKIER,CLAYTON,FRANEK,FRENCH,+    (CERN)
CHAPMAN  71 PR D4 1275           +GREEN,LYS,MURPHY,RING,+              (MICH)
FIELDS   71 PRL 27 1749          +COOPER,RHINES,ALLISON            (ANL+OXF)
YOH      71 PRL 26 922           +BARISH,CAROLL,LOBKOVICZ+    (CIT+BNL+ROCH)

ASTBURY  72  CERN 72-10          A.ASTBURY REVIEW AT CHEXBRES 72       (RHEL)
BOWEN    72  PREP.NUB 2167       +EARLES,FAISSLER,GARELICK,GETTNER,+   (NEAS)
COHEN    72 PHIL.CONF.PROC.      K.J.COHEN                          (RUTGERS)
DIEBOLD  72  BATAV.CONF.         R.DIEBOLD  RAPPORTEUR TALK              (ANL)
DONALD   72  BAT.CONF.PAP.265 INTERNAT.COLLABORATION               (LIVP+)
EASTMAN  72 NP B 51 29           +MING MA,OH,PARKER,SMITH,SPRAFKA       (MSU)
KIENZLE  72 PHIL.CONF.PROC207 W.KIENZLE                            (CERN)
MING MA  72 NP B 51 77           +EASTMAN,OH,PARKER,SMITH,SPRAFKA       (MSU)
WOHLMUT  72  BAT.CONF.PAP.275 +YEE,JOHNSON,PETERS,STENGER         (HAWAII)
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0 0 0 0 3 6 0 4 8 1 6

Data Card Listings

For notation, see key at front of Listings.

Mesons

$N\bar{N}_{I=0}(2375)$, X(2500–3600), $K^{\pm}$, K^0, $K^*(892)$

$N\bar{N}_{I=0}(2375)$ →

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41   N NBAR (2375,JPG=    ) I=0

          EVIDENCE FOR RESONANCE PRELIMINARY.
          OMITTED FROM TABLE.

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               41   N NBAR(2375) MASS

M           2375.      10.          ABRAMS    70 CNTR    S CHANNEL NBAR N  1/71
M    I     (2360.)    (5.)          COHEN     72 CNTR    S CHANNEL PBAR P  1/73*
M    I   ISOSPINS 0 AND 1 NOT SEPARATED

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               41   N NBAR(2375) WIDTH

W          (190.)                   ABRAMS    70 CNTR    S CHANNEL NBAR N  1/71
W    I     (163.)    (15.)          COHEN     72 CNTR    S CHANNEL PBAR P  1/73*
W    I   ISOSPINS 0 AND 1 NOT SEPARATED

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               41   N NBAR(2375) SIGMA (MB) FOR FORMATION BN

CS          (2.5)                   ABRAMS    70 CNTR                      1/71
CS   I      (2.0)    (0.07)         COHEN     72 CNTR    S CHANNEL PBAR P  1/73*
CS   I   ISOSPINS 0 AND 1 NOT SEPARATED

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                  REFERENCES FOR N NBAR (2375)

BRICMAN  69 PL 29 B 451        +FERRO-LUZZI,BIZARD,+       (CERN+CAEN+SACL)
ABRAMS   70 PR D 1 1917        +COOL,GIACOMELLI,KYCIA,LEONTIC,LI,+    (BNL)
COHEN    72 PHIL.CONF.PROC.    K.J.COHEN                          (RUTGERS)
EASTMAN  72 NP B 51 29         +MING MA,OH,PARKER,SMITH,SPRAFKA       (MSU)
MING MA  72 NP B 51 77         +EASTMAN,OH,PARKER,SMITH,SPRAFKA       (MSU)
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X(2500–3600) →

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46   X(2500-3600)

THIS ENTRY CONTAINS VARIOUS HIGH MASS NON-STRANGE
PEAKS. OMITTED FROM TABLE.
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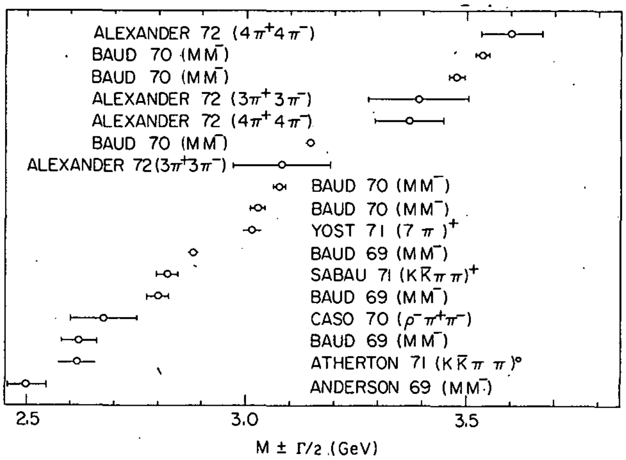
The high mass region is covered nearly continuously by evidence for peaks of various widths and decay modes (see figure). As a satisfactory grouping into particles is not yet possible, we list all the Y = 0 bumps with M > 2400 MeV together by increasing mass. Note that ANTIPOV 72 ($\pi^- p \to pMM^-$ at 25 and 40 GeV/c) see no narrow bumps.



Masses and widths of reported enhancements with Y = 0, M > 2400 MeV. (—O— indicates that upper limit only was reported for the width.)

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             46   X(2500-3600)   MASSES AND WIDTHS   (MEV)

M          2500.0     32.0          ANDERSON  69 MMS   -  16 PI- P,BACKW9  8/69
W          (87.0)                   ANDERSON  69 MMS   -  16 PI- P,BACKW9  8/69

M       66 2613.       7.           ATHERTON  71 HBC   0 5.7 PBAR P        2/73*
W       66 (90.)    OR LESS         ATHERTON  71 HBC   0 5.7 PBAR P        2/73*

M      550 2620.      20.           BAUD      69 MMS   -  8.-10. PI- P     9/69
W      550   85.      30.           BAUD      69 MMS   -  8.-10. PI- P     9/69

M          2676.0     27.0          CASO      70 HBC   - 11.2PI- P,NOTE C  5/70
W          (150.0)                  CASO      70 HBC   - 11.2PI- P,NOTE C  5/70
W    C     SEEN IN RHO- PI+ PI- (OMEGA AND ETA ANTISELECTED IN 4 PI SYSTEM)  5/70

M      640 2800.      20.           BAUD      69 MMS   -  8.-10. PI- P     9/69
W      640   46.      10.           BAUD      69 MMS   -  8.-10. PI- P     9/69

M  C    15 2820.      10.           SABAU     71 HBC   +  8. PI+ P         11/71
W  C    15   50.      10.           SABAU     71 HBC   +  8. PI+ P         11/71
W  C       SEEN IN (K KBAR PI PI)+ MASS DISTRIBUTION                       11/71

M      230 2880.      20.           BAUD      69 MMS   -  8.-10. PI- P     9/69
W      230 (15.)    OR LESS         BAUD      69 MMS   -  8.-10. PI- P     9/69

M  Y    43 3013.       5.           YOST      71 HBC   + 11.PI+ P,P(8PI)+ 11/71
W  Y    43 (40.)    OR LESS         YOST      71 HBC   + 11.PI+ P,P(8PI)   5/71
W  Y       4.3 S.D. EFFECT  . DECAY TO 7 PIONS                            11/71

M          3025.0     20.0          BAUD      70 MMS   - 10.5-13 PI- P     5/70
W          (25.0)   APPROX.         BAUD      70 MMS   - 10.5-13 PI- 7

M          3075.0     20.0          BAUD      70 MMS   - 10.5-13 PI- P     5/70
W          (25.0)   APPROX.         BAUD      70 MMS   - 10.5-13 PI- P     5/70

M  D       3080.      20.           ALEXANDER 72 HBC   0 6.94 PBAR P       1/73*
W  D        220.      70.           ALEXANDER 72 HBC   0 6.94 PBAR P       1/73*
   D    DECAYS TO 3PI+ 3PI-

M          3145.0     20.0          BAUD      70 MMS   - 10.5-15 PI- P     5/70
W          (10.0)   OR LESS         BAUD      70 MMS   - 10.5-15 PI- P     5/70

M  D       3370.      10.           ALEXANDER 72 HBC   0 6.94 PBAR P       1/73*
W  D        150.      40.           ALEXANDER 72 HBC   0 6.94 PBAR P       1/73*
   D    DECAYS TO 4PI+ 4PI-

M  D       3390.      20.           ALEXANDER 72 HBC   0 6.94 PBAR P       1/73*
W  D        220.     100.           ALEXANDER 72 HBC   0 6.94 PBAR P       1/73*
   D    DECAYS TO 3PI+ 3PI-

M          3475.0     20.0          BAUD      70 MMS   - 14-15.5 PI- P     5/70
W          (30.0)   APPROX.         BAUD      70 MMS   - 14-15.5 PI- P     5/70

M          3535.0     20.0          BAUD      70 MMS   - 14-15.5 PI- P     5/70
W          (30.0)   APPROX.         BAUD      70 MMS   - 14-15.5 PI- P     5/70

M  D       3600.      20.           ALEXANDER 72 HBC   0 6.94 PBAR P       1/73*
W  D        140.      20.           ALEXANDER 72 HBC   0 6.94 PBAR P       1/73*
   D    DECAYS TO 4PI+ 4PI-

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                  REFERENCES FOR X(2500-3600)

ANDERSON 69 PRL 22 1390         +COLLINS,+                        (BNL+CARN)
BAUD     69 PL  30B 129         CERN BOSON SPECTROMETER GROUP         (CERN)
ALEXANDE 70 PRL 25 63           +BAR-NIR,DAGAN,GIDAL,GRUNHAUS+   (TEL-AVIV)
BAUD     70 PL 31 B 549         CERN BOSON SPECTROMETER GROUP         (CERN)
CASO     70 LNC 3 707           +CONTE,TOMASINI,CORDS+(GENO+HAMB+MILA+SACL)
ATHERTON 71  CERN PHYS.71-18    +CELNIKIER,CLAYTON,FRANEK,FRENCH,+   (CERN)
SABAU    71 LNC 1 514           +URETSKY                          (BUCH+ANL)
YOST     71 PR D 3 642          +MORRIS,ALBRIGHT,BRUCKER,LANNUTTI     (FSU)
ALEXANDE 72 NP B 45 29          ALEXANDER,BAR-NIR,BEVARY,DAGAN,+     (TELA)
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$K^{\pm}$

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10   CHARGED K (494,JP=0-) I=1/2

SEE STABLE PARTICLE DATA CARD LISTINGS

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K^0

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11   NEUTRAL K (498,JP=0-) I=1/2

SEE STABLE PARTICLE DATA CARD LISTINGS

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$K^*(892)$

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18   K* (892,JP=1-) I=1/2

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               18   K*(892) MASS (MEV)

M  CHARGED ONLY. THIS IS WHAT APPEARS ON MESON TABLE
M            898.0      5.0         CHADWICK  63 HBC  +   1.5 K+P
M       3870 891.0      1.0         WOJCICKI  64 HBC  -   1.7 K-P
M            889.5      2.5         ADELMAN   65 HBC  -   1.5 K-P            6/66
M            895.0      3.0         GELSEMA   65 HBC  -   1.5 K-P
M            895.       3.          BOMSE     67 HBC  +  2.3 K+P             7/67
M            891.       2.          DE BAERE  67 HBC  +  3.5 K+P (KO PI+)    7/67
M            892.5      2.5         DE BAERE  67 HBC  +  3.5 K+P (K+ PIO)    7/67
M            898.       4.          SALLSTROM 67 HBC  +  3. K+ P (KO PI+)    7/67
M            883.       5.          SALLSTROM 67 HBC  +  3. K+ P (K+ PIO)    7/67
M            890.       3.          BARLOW    67 HBC  +-  1.2 PBAR P         2/72
M            889.       3.          BARLOW    67 HBC  +-  1.2 PBAR P        11/66
M            896.0      5.0         CONFORTO  67 HBC  +-  0. PBAR P          9/67
M            893.       4.          ADERHOLZ  68 HBC  -   10 K- P            6/68
M            891.       4.          FICENEC1  68 HBC  -   1.3 K-P (K-PIO)    9/67
M            887.       3.          FICENEC1  68 HBC  -   1.3 K-P (KOPI-)    9/67
M            890.0      5.0         FICENEC2  68 HBC  -   2.7 K- P(K-PIO)    2/69
M            892.0      3.0         FICENEC2  68 HBC  -   2.7 K- P(KOPI-)    2/69
M            896.0      4.0         SCHWEINGR 68 HBC  -   4.1 K-P            9/67
M            892.0      2.0         SCHWEINGR 68 HBC  -   5.5 K-P            9/67
M            884.0      5.0         KANG      68 HBC  -   4.6 K- P           7/69
M            891.0      2.0         CRENNELL  69 DBC  -   3.9 K-N (KOPI-)    7/69
M            892.0      3.0         ERWIN     69 HBC  +   3.5 K+ P           9/69
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Mesons

Data Card Listings

For notation, see key at front of Listings.

$K^*(892)$

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M    2886 (894.)     (1.)             FRIEDMAN  69 HBC  -  2.1  K-P (3BDY)  2/72
M     728 (892.)     (2.)             FRIEDMAN  69 HBC  -  2.45 K-P (3BDY)  2/72
M    3229 (892.)     (1.)             FRIEDMAN  69 HBC  -  2.6  K-P (3BDY)  2/72
M    1027 (892.)     (1.)             FRIEDMAN  69 HBC  -  2.7  K-P (3BDY)  2/72
M          895.       2.              LIND      69 HBC  +  9. K+ P          9/69
M    4404  892.2      1.5             AGUILAR1  71 HBC  -  3.9,4.6 K- P    11/71
M          . . . . . . . . . .
M   AVG    891.71     0.50   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

M  NEUTRAL ONLY. BUT WE DONT USE THIS FOR MASS DIFF. - SEE TYPED NOTE
M      70  897.0     10.0             COLLEY    62 HBC    0 2.0 PI-P
M     200  892.0      2.0             KRAEMER   63 HBC    0 2.3 K+P
M     150 (885.0)                     SMITH     63 HBC    0 2.3 PI-P
M          899.       4.              BARLOW    67 HBC    0 1.2 PBAR P     11/66
M          897.       4.              BARLOW    67 HBC    0 1.2 PBAR P     11/66
M          889.0      5.0             CONFORTO  67 HBC    0 0. PBAR P       9/67
M          894.7      1.3             DAUBER    67 HBC    0  2.0 K- P      12/66
M          892.0      4.0             GEORGE    67 HBC    0 5.0 K+ P       11/67
M          893.       3.              DE WIT    68 DBC    0 3. K- D         9/69
M  F       895.       4.              FICENEC1  68 HBC    0 1.3 K-P (K-PI+) 11/69
M  F       901.       4.              FICENEC2  68 HBC    0 2.7 K-P (K-PI+) 11/69
M  F FICENEC ERROR RAISED     SEE TYPED NOTE
M          896.0      4.0             SCHWEINGR 68 HBC    0 4.1 K+P         9/67
M          903.0      4.0             SCHWEINGR 68 HBC    0 5.5 K+P         9/67
M          899.0      5.0             KANG      68 HBC    0 4.6 K- P        7/69
M   10700  893.7      2.0             DAVIS     69 HBC    0 12. K+ P        9/69
M  D 2000  890.0      1.25            DE BAERE  69 HBC    0 5.0 K+ P        9/69
M  D          ERRORS ENLARGED BY US TO   GAMMA/SQRT(N). SEE TYPED NOTE.
M    4000  895.0      1.0             HABER     70 DBC    0 3. K-N          5/70
M    2934  897.9      0.8             AGUILAR1  71 HBC    0 3.9,4.6 K- P   11/71
M    5362  898.0      0.5             AGUILAR1  71 HBC    0 3.9,4.6 K- P   11/71
M  D 1700  898.4      1.3             BUCHNER   72 DBC  0 4.6 K+ N,K+ PI-P 12/72*
M          . . . . . . . . . .
M   AVG    896.57     0.65   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 2.0)
                     (SEE IDEOGRAM BELOW )
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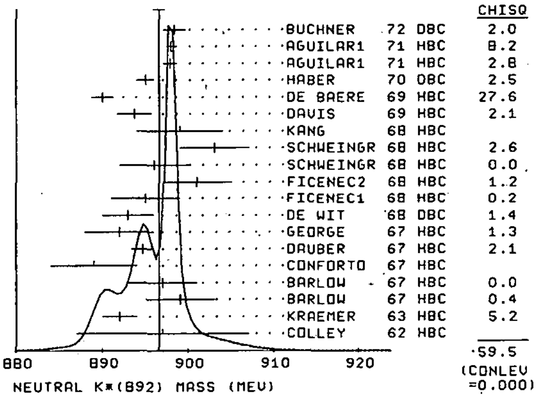
WEIGHTED AVERAGE = 896.57 ± 0.65
ERROR SCALED BY 2.0



Note on $K^*(892)$ Masses and Mass Difference

1) All mass values listed above come from physical region fits of Breit-Wigner functions. However, a recent $K\pi$ phase shift analysis (BINGHAM 72) indicates that part of the $K^*(892)$ peak may be due to a large S wave (see note "S-wave $K\pi$ interactions"). Because the S-wave phase shift is ambiguous ("up" and "down") in the $K^*(892)$ region, BINGHAM 72 find two solutions for the P wave:

"up" solution $m \approx 900$ MeV, $\Gamma \approx 48$ MeV

"down" solution $m \approx 895$ MeV, $\Gamma > 48$ MeV.

2) Impossibly small errors are reported by some experiments. We use simple "realistic" tests for the minimum errors on the determination of mass and width from a sample of N events:

$$\delta_{min}(m) = \frac{\Gamma}{\sqrt{N}}, \quad \delta_{min}(\Gamma) = 4\frac{\Gamma}{\sqrt{N}} .$$

(For detailed discussion see the April 1971 edition of this note.) We have increased some unrealistic errors and scaled up some errors that are inconsistent.

3) There are two more difficulties in measuring a mass difference $m(K^{*0}) - m(K^{*\pm})$ of ~ 7 MeV when the half-width $\Gamma/2$ of the K^* is 25 MeV:

a) The two charges of K^* have different topologies; this introduces differences in the measuring and fitting of the events, which can also produce mass shifts.

b) Interferences between the resonant amplitude and background can in general shift the peak in the mass spectrum by some fraction of $\Gamma/2$.

Some reactions (symmetric under reflection of I_z) are immune to this difficulty. Thus compare the mass of K^{*0} produced in

$$\pi^- p \rightarrow \Lambda \pi^- K^+$$

with the mass of K^{*+} in the I_z-reflected reaction

$$\pi^+ n \rightarrow \Lambda \pi^+ K^0.$$

The final-state amplitudes of each will contain not only the $|K^*\rangle$ with I-spin 1/2, but also an interfering I = 3/2 P-wave, which we can call $|K^*_{3/2}\rangle$. But I_z symmetry forces $\langle \pi^- p | \Lambda K^{*0} \rangle$ to equal $\langle \pi^+ n | \Lambda K^{*+} \rangle$; and similarly for the two $K^*_{3/2}$ amplitudes, so that the shifting of the K^* peak is the same in both reactions. Nobody has published a mass difference exploiting this fact.

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                     18  K*(0) - K*(+-) MASS DIFF. (MEV)

D     330   6.3      6.0              BARASH    67 HBC      0 PBAR P         8/67
D    1400   6.5      5.0              FICENEC1  68 HBC       1.3 K- P        2/69
D    1600   9.5      5.0              FICENEC2  68 HBC       2.7 K- P        2/69
D    7338   5.7      1.7              AGUILAR1  71 HBC    -0 3.9,4.6 K- P   11/71
D           . . . . . . . . . .
D   AVG     6.1      1.5       AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
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                     18  K*(892) WIDTH (MEV)

W  CHARGED ONLY. THIS IS WHAT APPEARS ON MESON TABLE
W           46.0     8.0             CHADWICK  63 HBC  +  1.5 K+P
W    3870   46.0     3.0             WOJCICKI  64 HBC  -  1.7 K-P
W           51.0     3.0             ADELMAN   65 HBC  -  1.5 K-P              6/66
W           47.0     4.0             FERRO-LUZ 65 HBC  +  3.0 K+P
W           50.0    15.0             GELSEMA   65 HBC  -  1.5 K-P
W           50.      5.              BOMSE     67 HBC  + 2.3 K+P               7/67
W           53.      8.              DE BAERE  67 HBC  + 3.5 K+P (K+ PI0)      7/67
W           68.     10.              SALLSTROM 67 HBC  + 3. K+ P (K0 PI+)      7/67
W           47.     10.              SALLSTROM 67 HBC  + 3. K+ P (K+ PI0)      7/67
W           44.      7.              BARLOW    67 HBC  +-  1.2 PBAR P         11/66
W           43.      9.              BARLOW    67 HBC  +- 1.2 PBAR P          11/66
W           53.      7.              BARLOW    67 HBC  +-  1.2 PBAR P         11/66
W           58.      7.              ADERHOLZ  68 HBC  -  10 K- P              6/68
W           58.     16.              FICENEC1  68 HBC  -  1.3 K-P (K-PI0)      9/67
W           44.     13.              FICENEC1  68 HBC  -  1.3 K-P (K0PI-)      9/67
W           41.0     8.0             SCHWEINGR 68 HBC  -  4.1 K-P              9/67
W           47.0     4.0             SCHWEINGR 68 HBC  -  5.5 K-P              9/67
W           57.0    13.0             FICENEC2  68 HBC  -  2.7 K- P(K-PI0)      2/69
W           48.0     9.0             FICENEC2  68 HBC  -  2.7 K- P(K0PI-)      2/69
W           52.0     8.0             KANG      68 HBC  -  4.6 K- P             7/69
W          (27.0)   (8.0)    (6.0)   ERWIN     69 HBC  +  3.5 K+ P             9/69
W          (53.)    (3.)             FRIEDMAN  69 HBC  -  2.1  K-P (3BDY)      2/72
W          (49.)    (4.)             FRIEDMAN  69 HBC  -  2.45 K-P (3BDY)      2/72
W          (46.)    (2.)             FRIEDMAN  69 HBC  -  2.6  K-P (3BDY)      2/72
W          (49.)    (3.)             FRIEDMAN  69 HBC  -  2.7  K-P (3BDY)      2/72
W           50.      7.              LIND      69 HBC  +  9. K+ P              5/70
W    4404   54.3     2.6      2.3    AGUILAR1  71 HBC  -  3.9,4.6 K- P        11/71
W           . . . . . . . . . .
W   AVG     50.1     1.1       AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
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0 0 0 0 3 6 0 4 8 1 7

Data Card Listings

For notation, see key at front of Listings.

Mesons
K*(892), κ

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W  NEUTRAL ONLY.
W       70   60.0     10.0          COLLEY    62 HBC    0 2.0 PI-P
W      200   50.0      5.0          KRAEMER   63 HBC    0 2.3 K+P
W            53.      13.           BARLOW    67 HBC    0 1.2 PBAR P       11/66
W            34.       8.           BARLOW    67 HBC    0 1.2 PBAR P       11/66
W            44.       4.           DAUBER    67 HBC    0  2.0 K- P        12/66
W            58.       8.           DE WIT    68 DBC    0 3. K- D           9/69
W            52.      12.           FICENEC1  68 HBC    0 1.3 K-P (K-PI+)   9/67
W            50.0      8.0          FICENEC2  68 HBC    0 2.7 K- P(K-PI+)   2/69
W            48.0      8.0          KANG      68 HBC    0 4.6 K- P          7/69
W            51.0     11.0          SCHWEINGR 68 HBC    0 5.5 K-P           9/67
W            53.0     11.0          SCHWEINGR 68 HBC    0 4.1 K-P           9/67
W    10700   53.2      1.6          DAVIS     69 HBC    0 12. K+ P          9/69
W  D  2000   58.0      5.0          DE BAERE  69 HBC    0 5.0 K+ P          9/69
W  D          ERRORS ENLARGED BY US TO 4*GAMMA/SQRT(N). SEE TYPED NOTE.
W     4000   54.0      3.0          HABER     70 DBC    0 3. K-N            5/70
W     2934   55.8      4.2     3.4  AGUILAR1  71 HBC    0 3.9,4.6 K- P     11/71
W     5362   48.5      2.2          AGUILAR1  71 HBC    0 3.9,4.6 K- P     11/71
W  D  1700   51.4      5.0          BUCHNER   72 DBC   0 4.6 K+ N,K+ PI-P 12/72*
W
W   AVG      51.7      1.0     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.1)

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                 18  K*(892) PARTIAL DECAY MODES

                                                         DECAY MASSES
P1      K*(892) INTO K PI                               493+ 139
P2      K*(892) INTO K PI PI                            493+ 139+ 139
P3      K*(892)+ INTO K+ GAMMA                          493+   0

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                 18  K*(892) BRANCHING RATIOS

R1      K*(892) INTO (K PI PI)/(K PI)                   (P2)/(P1)
R1        0   (0.002)OR LESS           WOJCICKI2 64 HBC   -  1.7 K-P

R2      K*(892)+ INTO (K+ GAMMA)/TOTAL  (UNITS 10**-3)   (P3)
R2             (1.6)  OR LESS  CL=.95   BEMPORAD  72 CNTR +  10.-16. K+ A,COH  1/73*

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REFERENCES FOR K*(892)


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ALSTON   61 PRL 6 300          ALSTON,ALVAREZ,EBERHARD,GOOD,GRAZIANO+(LRL)
ALEXANDE 62 PRL 8 447          ALEXANDER,KALBFLEISCH,MILLER,G SMITH  (LRL)
COLLEY   62 CERN CONF 315      D COLLEY,N GELFAND +     (COLUMBIA+RUTGERS)

CHADWICK 63 PL 6 309           CHADWICK,CRENNELL,DAVIES,BETTINI+(OXF+PADO)
GOLDHABE 63 ATHENS CONF 92     SULAMITH GOLDHABER                    (LRL)
KRAEMER  63 ATHENS CONF 130    R KRAEMER L MADANSKY +      (JOHNS HOPKINS)
SMITH    63 PRL 10 138         SMITH,SCHWARTZ,MILLER,KALBFLEISCH,HUF+(LRL)

WOJCICKI 64 PR 135 B 484       STANLEY G WOJCICKI                    (LRL)

ADELMAN  65 ATHENS 527         STUART LEE ADELMAN              (CAVENDISH)
FERRO-LU 65 NC 36 1101         FERRO-LUZZI,GEORGE,HENRI,JONGEJANS   (CERN)
FERRO-LU 65 NC 39 417          FERRO-LUZZI,GEORGE,GOLDSCHMIDT-CLER+ (CERN)
GELSEMA  65 THESIS             E.S.GELSEMA (SEE ALSO PL 10 341)(AMSTERDAM)
WANGLER  65 PR 137 B 414       WANGLER,ERWIN,WALKER            (WISCONSIN)

BARASH   67 PR  156  1399      BARASH,KIRSCH,MILLER,TAN         (COLUMBIA)
BARLOW   67 NC  50 A  701      +MONTANET,D'ANOLAU+   (CERN+CDEF+IRAD+LIVP)
BOMSE    67 PR 158 1298        +BORENSTEIN+COLE+GILLESPIE+ (JOHN HOPKINS)
CONFORTO 67 NP 83 469          +MARECHAL,MONTANET+CERN+CDEF+IPN+LIVERPOOL
DAUBER   67 PR 153 1403        +SCHLEIN,SLATER,TICHO                (UCLA)
DE BAERE 67 NC 51 A 401        +GOLDSCHMIDT-CLERMONT,HENRI+    (BRUX+CERN)
FRENCH   67 NC 42A 442         +KINSON+MCDONALD+RIDDIFORD+     (CERN+BIRM)
GEORGE   67 NC 49A 9           +GOLDSCHMIDT-CLERMONT+HENRI+    (CERN+BRUX)
SALLSTRO 67 NC 49A 348         SALLSTROM+OTTER+EKSPONG         (STOCKHOLM)

ADERHOLZ 68 NP B 5  567        +DEUTSCHMANN+  (AACH+BERL+CERN+LOIC+VIENNA)
DE WIT   68  THESIS            S. DE WIT                       (AMSTERDAM)
FICENEC1 68 PR 169 1034        +HULSIZER+SWANSON+TROWER              (ILL)
FICENEC2 68 PR 175 1725        FICENEC, GORDON, TROWER          (ILLINOIS)
KANG     68 PR 176 1587        Y.W.KANG                             (IOWA)
SCHWEING 68 PR 166 1317        SCHWEINGRUBER,DERRICK,FIELDS+    (ANL+NWES)

CRENNELL 69 PRL 22  487        +KARSHON,LAI,ONEALL,SCARR             (BNL)
DAVIS    69 PRL 23 1071        +DERENZO,FLATTE,ALSTON,LYNCH,SOLMITZ  (LRL)
DE BAERE 69 NC 61 A 397        +GOLDSCHMIDT-CLERMONT,HENRI,+   (BELG+CERN)
ERWIN    69 NP B 9 364         +WALKER,GOSHAW,WEINBERG    (WISC+PRIN+VAND)
FRIEDMAN 69  UCRL-18860        J.FRIEDMAN,PH.D. THESIS               (LRL)
JUHALA   69 PR 184  1461       +LEACOCK,RHODE,KOPELMAN,LIBBY,+ (ISU+COLO)
LIND     69 NP B 14 1          +ALEXANDER,FIRESTONE,FU,GOLDHABER     (LRL) JP

ATHERTON 70 NP B 16 416        +FRANEK,FRENCH,FRISK,BEDNAR+    (CERN+PRAG)
DE BAERE 70  CERN PHYS 70 41   +DEBAISIEUX,DE WOLF,DUFOUR,+    (BELG+CERN)
HABER    70 NP B 17 289        +SHAPIRA,ALEXANDER+   (REHO+SACL+BGNA+EPOL)

AGUILAR  71 PRL 26 466         +BARNES,BASSANO,EISNER,KINSON,SAMIOS  (BNL)
AGUILAR1 71 PR D 4 2583        +EISNER,KINSON                        (BNL)
BARNHAM  71 NP B 28 171        +COLLEY,JOBES,GRIFFITHS,HUGHES,+(BIRM+GLAS)
BUCHNER  71 NP B 29 381        +DEHM,GOEBEL,GOLDSCHMIDT,+ (MPIM+CERN+BELG)
CORDS    71 PR D 4 1974        +CARMONY,ERWIN,MEIERE,+     (PURD+UCD+IUPU)
MERCER   71 NP B32 381         +ANTICH,CALLAHAN,CHIEN,COX,+ (JOHN HOPKINS)
YUTA     71 PRL 26 1502        +DERRICK,ENGELMANN,MUSGRAVE       (ANL+EFI)

ABRAMOVI 72 NP B 39 189        ABRAMOVICH,CHALOUPKA,CHUNG,HILPERT,+ (CERN)
BINGHAM  72 NP B 41 1          +          (INTERNATIONAL K+ COLLABORATION)
BEMPORAD 72 NP B 51 1          +BEUSCH,FREUDENREICH,+     (CERN+ETHZ+LOIC)
BRUNET   72 NP B 37 114        +DANYSZ,GOLDSACK,+     (CDEF+SACL+LOIC+LOWC)
BUCHNER  72 NP B 45 333        +DEHM,CHARRIERE,CORNET,+   (MPIM+CERN+BRUX)
CHARRIER 72 NP B 51 317        CHARRIERE,DRIJARD,DE BAERE,+    (CERN+BELG)
CRENNELL 72 PR D 6 1220        +GORDON,KWAN-WU LAI,SCARR             (BNL)
DEUTSCHM 72 NP B 36 373        DEUTSCHMANN,+          (ABCLV COLLABORATION)
ENGELMAN 72 PR D 5 2162        ENGELMANN,MUSGRAVE,FORMAN,+       (ANL+EFI)
ROUGE    72 NP B 46 29         +VIDEAU,VOLTE,DE BRION,+        (EPOL+SACL)
TIECKE   72 NP B 39 596        +GRIJNS,HEINEN,DE GROOT,+       (NIJM+ZEEM)

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κ

19 K PI S WAVE, CALLED KAPPA(750-1700 MEV)

S-wave Kπ Interactions in the Region 750-1700 MeV

Kπ interactions in the $I(J^P) = 1/2(0^+)$ wave can be described by the elastic phase shift δ_0^1 from the Kπ threshold (~630 MeV) up to at least 1100 MeV (BINGHAM 72). The first inelastic S-wave thresholds are Kπππ and Kη, neither of which is known to be important below 1400 MeV. Apart from the inelastic thresholds, the S-wave ππ and Kπ interactions are reminiscent of each other. Thus, the remarks in the ππ section about the meaningfulness of resonance parameters apply.

There are two intrinsic ambiguities in the solutions plotted below:

1) Any phase shift can be shifted modulo 180°.
2) If one amplitude is dominant [e.g., the P wave near $K^*(892)$ or the D wave near $K^*(1420)$], then the observed S-P or S-D interference can be explained by two ambiguous S-wave solutions, known as "up" and "down". Readers unfamiliar with the origin of the ambiguity can find a graphical explanation in our 1972 edition.

The combination of these two sorts of ambiguities leads to the multiple paths plotted in the figure. Simplicity favors the most slowly varying ("down") solutions, but where the authors give both, we plot both.

The figure displays the δ_0^1 solutions of four experimental groups:

1) BINGHAM 72 (an international K^+ collaboration), using data on $K^+p \rightarrow K\pi\Delta^{++}$ up to 12.7 GeV/c, find two solutions for δ_0^1, neither of which is <u>a priori</u> preferred:
   - "up", a resonant κ with m ~890 MeV, Γ ≤ 30 MeV (this requires δ_1^1 to be resonant near 900 MeV with ~48 MeV width). Note, however, the evidence of CHUNG 72 against a narrow-width S-wave state in the $K^*(892)$ region; in addition, the more recent partial-wave analysis of MATISON 72 (see 5, below) seems to rule out the "up" solution.
   - "down", a slowly rising δ_0^1 reaching ~70° at about 1100 MeV (requiring δ_1^1 to be resonant at about 895 MeV). Note that the up-down ambiguity is limited to the region 850-920 MeV. Above

Mesons

κ, $K_{A,I=3/2}(1175)$

Data Card Listings

For notation, see key at front of Listings.

920 MeV the "up" solution joins the "down" solution, since all phase shift values are determined only modulo 180°.

2) MERCER 71, using the first half of the data of BINGHAM 72, give phase shifts up to 1230 MeV, ignoring possible inelasticity.

3) YUTA 71, using 5.5 GeV/c $K^-p \to K\pi N$, agree with the solutions of BINGHAM 72, their "down" solution agreeing also with MERCER 71, ignoring possible inelasticity up to 1250 MeV.

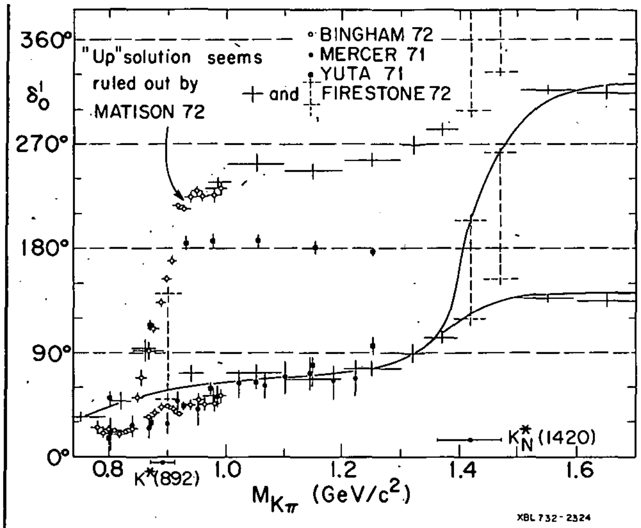
4) FIRESTONE 71 and 72, using 12 GeV/c $K^+n \to K^+\pi^-p$, have continued $K\pi$ partial wave analysis up to 1700 MeV. They find that δ_0^1 crosses 90° just below the $K^*(1420, 2^+)$, and, indeed, near 1420 MeV, shows the "up-down" ambiguity mentioned above. Their unique solutions are plotted as solid crosses, their ambiguous ones as pairs of dashed crosses joined by dashed vertical lines.

5) MATISON 72 has performed a recent analysis of 12 GeV/c $K^+p \to K^+\pi^-\Delta^{++}$ (the same reaction as studied by the International K^+ Collaboration, and with comparable statistics, but all at 12 GeV/c). Matison's analysis was similar to that of the Collaboration, except that she added two important constraints to impose internal consistency:

i) The P wave in the K^* region was determined by a Breit-Wigner fit to the Y_2^0 moment. (This yielded m_{K^*} = 896 MeV, Γ_{K^*} = 47 MeV.)

ii) $\sigma_{K\pi}$(tot) was included in the overall fit. She was then able to resolve the ambiguity in favor of the "down" solution.

Meanwhile several groups have attempted to clarify the situation around 1370 MeV. CORDS 72, FRATI 72, and ROUGE 72 give some support to the resonant S-wave interpretation of FIRESTONE 71. The other groups (AGUILAR 72, BUCHNER 72, CRENNELL 72, ENGELMANN 72) agree that the S wave is important but not necessarily resonant. In analogy with the $\pi\pi$ case, where a possible ϵ pole is located several hundred MeV below the observed $\pi^0\pi^0$ peak and quite far from the real axis, the 1370 bump could also be caused by a quite distant κ pole.



S-wave $K\pi$ phase shift. The "up-down" ambiguity now seems resolved by MATISON 72, who performs a partial-wave analysis of $K\pi$ moments extrapolated to the pion pole. In addition, CHUNG 72 imposes positivity on physical region $K\pi$ moments, and finds a narrow resonance most unlikely.

REFERENCES FOR KAPPA

TRIPPE 68 PL 28 B 203 +CHIEN,MALAMUD,MELLEMA,SCHLEIN,+ (UCLA)

CRENNELL 69 PRL 22 487 +KARSHON,LAI,O.NEALL,SCARR (BNL)
DODD 69 PR 177 1994 +JOLDERSMA,PALMER,SAMIOS (BNL)
GOLDBERG 69 PL 30 B 434 SABRE COLLABOR. (SACL+AMST+BGNA+REHO+EPOL)
SCHLEIN 69 ARGONNE CONF. 446 P.SCHLEIN (UCLA)

FIRESTON 71 PRL 26 1460 A.FIRESTONE,G.GOLDHABER,D.LISSAUER (LRL)
MERCER 71 NP B32 381 +ANTICH,CALLAHAN,CHIEN,COX,+ (JOHN HOPKINS)
YUTA 71 PRL 26 1502 +DERRICK,ENGELMANN,MUSGRAVE (ANL+EFI)

AGUILAR 72 PR D 6 11 AGUILAR-BENITEZ,CHUNG,EISNER (BNL)
BINGHAM 72 NP B 41 1 + (INTERNATIONAL K+ COLLABORATION)
BUCHNER 72 NP B 45 333 +DEHM,CHARRIERE,CORNET,+ (MPIM+CERN+BRUX)
CHUNG 72 PRL 29 1570 +EISNER,AGUILAR-BENITEZ (BNL)
CORDS 72 COO-1428-308 +CARMONY,LANDER,MEIERE,+ (PURD+UCD+IUPU)
CRENNELL 72 PR D 6 1220 +GORDON,KWAN-WU LAI,SCARR (BNL)
DIEBOLD 72 BATAV.CONF. R.DIEBOLD RAPPORTEUR TALK (ANL)
ENGELMAN 72 PR D 5 2162 ENGELMANN,MUSGRAVE,FORMAN,+ (ANL+EFI)
FIRESTON 72 PR D 5 2188 +GOLDHABER, LISSAUER, TRILLING (LBL)PWA
FRATI 72 PR D 6 2361 +HALPERN,HARGIS,SNAPE,CARNAHAN,+(PENN+CINC)
ROUGE 72 NP B 46 29 +VIDEAU,VOLTE,DE BRION,+ (EPOL+SACL)
MATISON 72 LBL 1537 (THESIS) REVISED VERSION WILL GO TO PHYS.REV. LBL

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$K_{A,I=3/2}(1175)$ →

24 KA 3/2 (1175,JP=) I = 3/2

EVIDENCE NOT COMPELLING. OMITTED FROM TABLE. FOR A DISCUSSION SEE ROSENFELD 68 AND GIACOMELLI 70 WHO CONCLUDES THAT IF THIS STATE HAS WIDTH NOT LARGER THAN 100 MEV, THEN ITS PRODUCTION CROSS SECTION IS 1 OR 2 ORDERS OF MAGNITUDE SMALLER THAN THAT OF NON-EXOTIC K*S.

REFERENCES FOR KA3/2(1175)

WANGLER 64 PL 9 71 T P WANGLER,A R ERWIN,W D WALKER(WISCONSIN)
MILLER 65 PL 15 74 MILLER,KOVACS,MCILWAIN,PALFREY + (PURDUE)
ROSENFEL 68 PHILA.CONF.P.455 A.H.ROSENFELD (LRL)
DODD 69 PR 177 1991 +JOLDERSMA, PALMER, SAMIOS (BNL)
CHO 70 PL 32 B 409 +DERRICK,JOHNSON,MUSGRAVE,+ (ANL+NWES+KANS)
GIACOMEL 70 PL 33 B 373 G.GIACOMELLI + (BGNA+SACL+ZEEM+REHO+EPOL)

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Data Card Listings

For notation, see key at front of Listings.

$K_{A,I=3/2}(1265)$ →

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25  KA 3/2 (1265,JP=  ) I = 3/2

EVIDENCE NOT COMPELLING. OMITTED FROM TABLE.
FOR A DISCUSSION SEE ROSENFELD 68.

REFERENCES FOR KA3/2(1265)

FRENCH    67 NC 52A 442          +KINSON+MCDONALD+RIDDIFORD+      (CERN+BIRM)
ROSENFEL  68 PHILA.CONF.P.455    A.H.ROSENFELD                          (LRL)
CHO       70 PL 32 B 409         +DERRICK,JOHNSON,MUSGRAVE,+ (ANL+NWES+KANS)

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Q REGION, $K\pi\pi(1240-1400)$

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28  Q REGION I=1/2
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The main effect in the Q region is a broad bump in the $K\pi\pi$ spectrum between 1200 and 1400 MeV, i.e. not far above $K^*(892)\pi$ threshold, produced by K beams without charge exchange. In particular, it has been observed in coherent K^+d intereactions (FIRESTONE 72) and in coherent interactions on heavy nuclei (BINGHAM 73). The dominant J^P assignment throughout the whole region is 1^+ and $I = \frac{1}{2}$. In addition, evidence for narrower states in the Q region has been reported from non-diffractive reactions (π^-p, $\bar{p}p$).

The following points are relevant to the rather complex situation in the Q region:

- The broad Q peak does not have a simple Breit-Wigner shape. It can be fitted at all energies by a superposition of two Breit-Wigner amplitudes [FIRESTONE 70, BARNHAM 71, BOWLER 71].
- The Q bump was observed with a similar shape in the backward direction by FIRESTONE1 72.
- In addition to the dominant modes $K^*\pi$ and $K\rho$, there is some evidence for a $K\pi\pi$ mode, with the $\pi\pi$ system in an S wave. [ALEXANDER 69, BARNHAM 71, DAVIS 72].
- Analyses of the interference between the $K^*\pi$ and $K\rho$ modes show the relative magnitude and relative phase of the two amplitudes varying with $K\pi\pi$ mass. This is suggestive of the presence of two $J^P = 1^+$ resonances coming possibly from a mixing between the strange members of the $J^{PC} = 1^{++}$ ("A_1") and 1^{+-}(B) nonets [GOLDHABER 67, BARNHAM 71, BOWLER 71, GARFINKEL 71, FIRESTONE 72]. The $K\pi\pi$ mass spectra and the relative magnitudes of the $K^*\pi$ and $K\rho$ amplitudes may be understood from the mixing hypothesis; the relative phase variation has not been explained yet [BOWLER 72].

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                  28  Q  REGION MASS  (MEV)

M   PRODUCED BY BEAMS OTHER THAN K MESONS
M        1242.0      9.0     10.0   ASTIER     69 HBC    0 PBAR P         . 9/69
M   A  THIS IS THE C MESON.
M      45(1300.)                    CRENNELL   67 HBC    0 6 PI- P,LK2PI    7/67
M      40(1300.)                    CRENNELL   72 HBC    0 4.5PI-P,LK2PI   12/72*

M   PRODUCED BY K BEAMS
M      12(1320.0)   (25.0)          ALMEIDA   65 HBC  +   3-5 K+  P        12/72*
M   C    (1230.0)   (15.0)          BASSOMPIE 67 HBC  +   5. K+ P          11/67
M   C  35(1280.0)   (10.0)          BASSOMPIE 67 HBC  +   5. K+ P          11/67
M   C    (1320.0)   (15.0)          BASSOMPIE 67 HBC  +   5. K+ P          11/67
M   C  SPLIT THE Q REGION INTO 3 BUMPS
M        (1270.)    APPROX.         DE BAERE  67 HBC  +   3.5 K+ P          7/67
M         1335.0      6.0           BARTSCH   68 HBC      10. K-P,K NPI   . 9/69
M        (1300.)    APPROX.         BARBARO   69 HBC  +   12.K+ P (K 2PI)   9/69
M      45 1301.0     10.0           BISHOP    69 HBC  +   3.5 K+P(K* PI)    9/69
M      21 1300.0     10.0           ERWIN     69 HBC    0 3.5 K+P(K* PI)    9/69
M         1281.       7.            FRIEDMAN  69 HBC  --  2.6,2.7 K- P      9/69
M         1300.0     10.0           ABRAMS    70 HBC  +   2.5-3.2 K+ P     11/70
M         1260.      20.            FARBER    70 HBC  +   12.7 K+ P       . 6/70
M        (1325.0)                   DENEGRI   71 DBC  - 12.6 K-D,K 2PI D   5/71
M          . . . . . . . . . .
M   AVERAGE MEANINGLESS (SCALE FACTOR = 2.9)

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                  28  Q LOW (QA)  MASS  (MEV)

ML F   FROM EXPERIMENTS SPLITTING Q REGION INTO TWO PEAKS
ML
ML       (1280.)                    SHEN      66 HBC  + 0 4.6 K+P,5 BODY  12/72*
ML        1260.0     10.0           ALEXANDER 69 HBC      9.0 K+ P        12/72*
ML        1240.0      5.0           BARNHAM   70 HBC  +  10.0 K+P,K 2PI   12/72*
ML        1243.       8.            GARFINKEL 71 DBC  +  9. K+ D          12/72*
ML        1228.      14.            ANDERSON  72 DBC  -  7.3 K- D         12/72*
ML       (1260.)                    DAVIS     72 HBC  +  12. K+ P         12/72*
ML        1234.      12.            FIRESTONE 72 DBC  +  12. K+ D          2/73*
ML         . . . . . . . . . .
ML  AVERAGE MEANINGLESS (SCALE FACTOR = 1.1)

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                  28  Q HIGH (QB)  MASS  (MEV)

MH F   FROM EXPERIMENTS SPLITTING Q REGION INTO TWO PEAKS
MH
MH     70 1320.0     10.0           SHEN      66 HBC  +   4.6 K+  P       12/72*
MH        1380.0     20.0           ALEXANDER 69 HBC      9.0 K+ P        12/72*
MH        1420.0      5.0           BARNHAM   70 HBC  +  10.0 K+P,K 2PI   12/72*
MH        1344.       8.            GARFINKEL 71 DBC  +  9. K+ D          12/72*
MH        1414.      15.            ANDERSON  72 DBC  -  7.3 K- D         12/72*
MH       (1420.)                    DAVIS     72 HBC  +  12. K+ P         12/72*
MH        1368.      18.            FIRESTONE 72 DBC  +  12. K+ D          2/73*
MH         . . . . . . . . . .
MH  AVERAGE MEANINGLESS (SCALE FACTOR = 4.9)

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                  28  Q  REGION WIDTH  (MEV)

W   PRODUCED BY BEAMS OTHER THAN K MESONS
W          127.0      7.0     25.0  ASTIER    69 HBC    0 PBAR P         . 9/69
W      45  (60.)                    CRENNELL  67 HBC    0 6 PI- P          7/67
W      40  (60.)                    CRENNELL  72 HBC    0 4.5PI-P,LK2PI   12/72*

W   PRODUCED BY K BEAMS
W      12  (60.0)   (20.0)          ALMEIDA   65 HBC  +   3-5 K+P         12/72*
W   C      (60.0)   (20.0)          BASSOMPIE 67 HBC  +   5. K+ P         11/67
W   C  35  (80.0)   (20.0)          BASSOMPIE 67 HBC  +   5. K+ P         11/67
W   C      (60.0)   (20.0)          BASSOMPIE 67 HBC  +   5. K+ P         11/67
W   C  SPLIT THE Q REGION INTO 3 BUMPS
W         (200.)   APPROX.          DE BAERE  67 HBC  + 3.5 K+ P           7/67
W          196.0     16.0           BARTSCH   68 HBC    10. K- P,K NPI   . 9/69
W   B      250. APPROX.             BARBARO   69 HBC  +   12.K+ P (K 2PI)  9/69
W   B      NO BACKGROUND SUBTRACTION.
W      45   40.0     10.0           BISHOP    69 HBC  +   3.5 K+P(K* PI)   9/69
W      21   40.0     15.0           ERWIN     69 HBC    0 3.5 K+P(K* PI)   9/69
W           51.      22.            FRIEDMAN  69 HBC  -   2.6,2.7 K- P     9/69
W           80.0     20.0           ABRAMS    70 HBC  +   2.5-3.2 K+ P    11/70
W          180.      28.            FARBER    70 HBC  +   12.7 K+ P      . 6/70
W         (180.0)                   DENEGRI   71 DBC  - 12.6 K-D,K 2PI D   5/71
W          . . . . . . . . . .
W   AVERAGE MEANINGLESS (SCALE FACTOR = 4.2)

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                  28  Q LOW (QA)  WIDTH  (MEV)

WL F   FROM EXPERIMENTS SPLITTING Q REGION INTO TWO PEAKS
WL
WL         100.0     20.0           SHEN      66 HBC  + 0 4.6 K+P,5 BODY  12/72*
WL          40.0     10.0           ALEXANDER 69 HBC      9.0 K+ P        12/72*
WL         110.0     15.0           BARNHAM   70 HBC  +  10.0 K+P,K 2PI   12/72*
WL          70.      26.       18.  GARFINKEL 71 DBC  +  9. K+ D          12/72*
WL         111.      33.            ANDERSON  72 DBC  -  7.3 K- D         12/72*
WL        (120.)                    DAVIS     72 HBC  +  12. K+ P         12/72*
WL         188.      21.            FIRESTONE 72 DBC  +  12. K+ D          2/73*
WL          . . . . . . . . . .
WL  AVERAGE MEANINGLESS (SCALE FACTOR = 3.1)

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                  28  Q HIGH (QB)  WIDTH  (MEV)

WH F   FROM EXPERIMENTS SPLITTING Q REGION INTO TWO PEAKS
WH
WH     70   80.0     20.0           SHEN      66 HBC  +   4.6 K+P         12/72*
WH         120.0     20.0           ALEXANDER 69 HBC      9.0 K+ P        12/72*
WH         120.0     15.0           BARNHAM   70 HBC  +  10.0 K+P,K 2PI   12/72*
WH         (60.)   OR LESS          GARFINKEL 71 DBC  +  9. K+ D          12/72*
WH          89.      24.            ANDERSON  72 DBC  -  7.3 K- D         12/72*
WH         (80.)                    DAVIS     72 HBC  +  12. K+ P         12/72*
WH         241.      30.            FIRESTONE 72 DBC  +  12. K+ D          2/73*
WH          . . . . . . . . . .
WH  AVERAGE MEANINGLESS (SCALE FACTOR = 2.3)

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                  28  Q REGION PARTIAL DECAY MODES

                                                      DECAY MASSES
P1     Q REGION INTO K*(892) PI                      891+ 139
P2     Q REGION INTO K RHO                           497+ 770
P3     Q REGION INTO K PI                            497+ 139
P4     Q REGION INTO K ETA                           497+ 548
P5     Q REGION INTO K OMEGA                         497+ 783
P6     Q REGION INTO K PI PI                         497+ 139+ 139

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Mesons
Q, $K_N(1420)$


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                     28  Q REGION BRANCHING RATIOS

     PRODUCED BY BEAMS OTHER THAN K MESONS
R1      Q REGION INTO (K RHO)/TOTAL (UNITS OF 10**-2)       (P2)
R1          75.0      10.0            ARMENTERO 64 HBC       0.0 PBAR P       6/66
R1        DOMINANT                    CRENNELL  72 HBC     0 4.5PI-P,LK2PI   12/72*

R2      Q REGION INTO (K* PI)/TOTAL (UNITS OF 10**-2)       (P1)
R2          25.0      10.0            ARMENTERO 64 HBC       0.0 PBAR P       6/66

R3      Q REGION INTO (K+ PI-) / (K+0 PIO+ PI-)
R3          (0.2)  OR LESS  CL=.90    CRENNELL  67 HBC     0 6.0 PI-P         7/67

R4      Q REGION INTO (KO PI+ PI- PIO) / (K+0 PIO+ PI-)
R4          (0.1)  OR LESS  CL=.90    CRENNELL  67 HBC     0 6.0 PI-P         7/67

     PRODUCED BY K BEAMS
R10     Q REGION INTO (K PI) / (K*(892) PI)                  (P3)/(P1)
R10         (0.8)  OR LESS            SHEN      66 HBC       4.6 K+P, 5 BODY 11/67
R10         Q REGION      INTO K*(892) PI AND K RHO (OVERLAPPING BANDS)(P1+P
R10     70   (1.0)                    SHEN      66 HBC   +   4.6 K+P          8/66

R11     Q REGION INTO (K OMEGA)/(K*(892) PI)                 (P5)/(P1)
R11         (0.1)  OR LESS            SHEN      66 HBC   +   4.6 K+P         10/66

R12     Q REGION INTO (K PI) / (K*(892) PI)                  (P3)/(P1)
R12         (0.30) OR LESS            SHEN      66 HBC   +   4.6 K+P         10/66

R13     Q REGION INTO K*(892) PI AND K RHO (OVERLAPPING BANDS)
R13                                                          (P1+P2)
R13     200   (1.0)                   BERLINGHI 67 HBC   +  12.7 K+ P         7/67

R14     Q REGION INTO (K PI) / TOTAL                         (P3)
R14         (0.02) OR LESS            BERLINGHI 67 HBC   +  12.7 K+ P        11/67
R14         (0.02) OR LESS  CL=.95    BARTSCH   68 HBC   -  10.0 K- P

R15     Q REGION INTO (K ETA) / TOTAL                        (P4)
R15         (0.02) OR LESS            BERLINGHI 67 HBC   +  12.7 K+ P        11/67

R16     Q REGION INTO (K OMEGA) / TOTAL                      (P5)
R16         (0.02) OR LESS            BERLINGHI 67 HBC   +  12.7 K+ P        11/67
R16     12   0.01      0.005          BARTSCH   68 HBC   -  10.0 K- P         9/68

R17     Q REGION INTO (K RHO) / (K*(892) PI)                 (P2)/(P1)
R17          0.91      0.25           BERLINGHI 67 HBC   +  12.7 K+ P        11/67
R17     701  0.4       0.1            BARTSCH   68 HBC   -  10.0 K- P         9/68
R17
R17 AVG      0.47      0.18    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.9)

R18     Q REGION INTO (K PI) / (K*(892) PI)                  (P3)/(P1)
R18         (0.21) OR LESS            DE BAERE  67 HBC   +   3.5 K+ P        11/66

R19     Q REGION INTO (K PI PI) / TOTAL                      (P6)
R19     201  0.22      0.08           BARTSCH   68 HBC   -  10.0 K- P         9/68
R19  S       POSSIBLY SEEN            ALEXANDER 69 HBC       9.0 K+ P         2/73*
R19  S       POSSIBLY SEEN            DAVIS     72 HBC   +  12. K+ P          1/73*
R19  S   WITH THE (PI PI) SYSTEM IN S-WAVE                                    1/73*
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REFERENCES FOR Q REGION


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        PRODUCED BY BEAMS OTHER THAN K MESONS

ARMENTER 64 DUBNA CONF 1 577    ARMENTEROS,EDWARDS,D-ANDLAU +   (CERN+CDEF)
  ALSO   64 DUBNA CONF 1 617    R ARMENTEROS (RAPPORTEUR)
  ALSO   66 PR  145  1095       BARASH,KIRSCH,MILLER,TAN           (COLUMBIA)
CRENNELL 67 PRL 19  44          +KALBFLEISCH,LAI,SCARR,SCHUMANN       (BNL)I
ASTIER   69 NP B 10 65          +MARECHAL,MONTANET,+  (CDEF+CERN+IPNP+LIVP)IJP
BETTINI  69 NC 62 A 1038        +CRESTI,LIMENTANI,BERTAUZA,BIGI+(PADO+PISA)I

        PRODUCED BY K BEAMS

ALMEIDA  65 PL 16 184           ALMEIDA,ATHERTON,BYER,DORNAN,FORSON+ (CAVE)

SHEN     66 PRL  17  726        +BUTTERWORTH,FU,GOLDHABERS,TRILLING   (LRL)
  ALSO   66  (PRIVATE COMMUN)GERSON GOLDHABER                         (LRL)

BASSOMPI 67 PL 26B 30           BASSOMPIERRE,GOLDSCHMIDT+  (CERN+BRUX+BIRM)IJP
BERLINGH 67 PRL 18 1087         BERLINGHIERI+FARBER+FERBEL+FORMAN  (ROCH)IJP
DE BAERE 67 NC 49A 374          +DEBAISIEUX+FAST+FILIPPAS+      (CERN+BRUX)
  ALSO PRIVATE COMMUNICATION BY B. JONGEJANS
GOLDHABE 67 PRL 19 976          G.GOLDHABER                           (LBL)

BARTSCH  68 NP B8 9             +COCCONI,+          (AACH+BERL+CERN+LOIC+VIEN)
BOMSE    68 PRL 20 1519         +BORENSTEIN,CALLAHAN,COLE,COX,+  (JOHNHOPK)  I+
DENEGRI  68 PRL 20 1194         +CALLAHAN+ETTLINGER+GILLESPIE+   (JOHNHOPK)  I+
  ALSO   70 ANTICH

ALEXANDE 69 NP B 13 503         G.ALEXANDER,FIRESTONE,GOLDHABER,+     (LRL)
ANDREWS  69 PRL 22 731          +LACH,LUDLAM,SANDWEISS,BERGER,+  (YALE+LRL)
BARBARO  69 PRL 22 1207         BARBARO-GALTIERI,DAVIS,FLATTE,+       (LRL)
BISHOP   69 NP B 9 403          +GOSHAW,ERWIN,WALKER                 (WISC)
CHIEN    69 PL 29B 433          +MALAMUD,MELLEMA,RUDNICK,SCHLEIN+    (UCLA)
CHUNG    69 PR 182 1443         +EISNER+BALI+LUERS                    (BNL)
COLLEY   69 NC A 59 519         +EASTWOOD,+  (BIRM+GLAS+LOIC+MPIM+OXF+RHEL)
ERWIN    69 NP B 9 364          +WALKER,GOSHAW,WEINBERG       (WISC+PRIN+VAND)
FRIEDMAN 69  UCRL-18860         J.FRIEDMAN,PH.D. THESIS               (LRL)
WERNER   69 PR 188 2023         +AMMAR,DAVIS,KROPAC,YARGER,CHO,+ (NWES+ANL) I+

ABRAMS   70 PR D 1 2433         +EISENSTEIN,KIM,MARSHALL,O-HALLORAN,+ (ILL)
ANTICH   70 NP B 20 201         +CARSON,CHIEN,COX,DENEGRI,ETTLINGER,+ (JHU)  I+
BOWLER   70 PL 31 B 318         M.G.BOWLER                          (OXFORD)
FARBER   70 PR D 1 78           +FERBEL,SLATTERY,YUTA                 (ROCH)  I+
FIRESTON 70 PHILAD.CONF.P.229   A. FIRESTONE REVIEW                   (LRL)

BARNHAM  71 NP B25 49           +COLLEY,GRIFFITHS,ALPER, +  (BIRM+GLAS+OXF)
BOWLER   71 BOLOGNA CONF.PROC   M.G.BOWLER  INTRODUCTORY TALK       (OXFORD)
DENEGRI  71 NP B 28 13          +ANTICH,CALLAHAN,CARSON,CHIEN,COX,+  (JHU)  I+
FORMAN   71 PR D 3 2610         +GELFAND,LEARY,MOSER,SEIDL,WOLFSON    (EFI)
GARFINKE 71 PRL 26 1505         GARFINKEL,HOLLAND,CARMONY,LANDER+(PURD+UCD)  I+
SLATTERY 71  UR-875-332(PREP)   P.SLATTERY,A REVIEW OF STRANGE MESONS(ROCH)

ANDERSON 72 PR D 6 1823         +FRANKLIN,GODDEN,KOPELMAN,LIBBY,TAN  (COLO)
BINGHAM  72 NP B 48 589         +EISENSTEIN,GRARD,HERQUET,+     (CERN+BRUX)
BRANDENB 72 NP B 45 397         BRANDENBURG,BRODY,JOHNSON,LEITH,LOOS+(SLAC)
BRANDENB 72 PRL 28 932          BRANDENBURG,JOHNSON,LEITH,LOOS,LUSTE+(SLAC)
CRENNELL 72 PR D 6 1220         +GORDON,KWAN-WU LAI,SCARR             (BNL)
DAVIS    72 PR D 5 2688         +ALSTON,BARBARO,FLATTE,FRIEDMAN,LYNCH+(LBL)
FIRESTON172 NP B 47 348         A.FIRESTONE                           (CIT)
FIRESTON 72 PR D 5 505          FIRESTONE,GOLDHABER,LISSAUER,TRILLING (LBL)
FRATI    72 PR D 6 2361         +HALPERN,HARGIS,SNAPE,CARNAHAN,+(PENN+CINC)
HAATUFT  72 NP B 48 78          +ARNOLD,HAGUENAUER,+   (BERG+STRB+EPOL+MADR)
BINGHAM  73 NP B (TO APPEAR)    +FARWELL,+          (LBL,ORSAY,BNL,SACLAY,MILAN)
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$K_N(1420)$

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22  KN (1420,JP=2+) I=1/2

    JP = 3- IS UNLIKELY BUT NOT YET COMPLETELY RULED OUT.

                       22  KN(1420) MASS (MEV)

M   FOR DIFFICULTIES IN MEASURING MASS DIFFERENCE, SEE TYPED NOTE UNDER K*

M   CHARGED ONLY, WITH FINAL STATE K PI
M            1440.      24.0    40.   DE BAERE  67 HBC  +  3.5 K+P (K+ PIO) 10/66
M            1423.      21.           ADERHOLZ  68 HBC  -  10 K- P (K PI)    6/68
M            1401.0     20.0          SCHWEINGR 68 HBC  -  4.1 K- P (K PI)   2/72
M            1427.0      9.0          SCHWEINGR 68 HBC  -  5.5 K- P (K PI)   9/67
M            1425.0     15.0          BISHOP    69 HBC  +  3.5 K+ P          9/69
M            1416.0     10.0          CRENNELL  69 DBC  -  3.9 K-N (KOPI-)   7/69
M            1414.      11.           LIND      69 HBC  +  9. K+ P(KO PI+)   9/69
M            1430.      10.           ABRAMS    70 HBC  +  2.5-3.2 K+P,K2PI 11/70
M       1400 1420.0      3.1          AGUILAR1  71 HBC  -  3.9,4.6 K- P     11/71
M        200 1425.       6.           BARNHAM   71 HBC  +  K+ P,KO PI+ P     1/72
M
M   AVG      1421.3      2.3      AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

M   CHARGED ONLY, WITH OTHER FINAL STATES
M            1400.0     20.0          BADIER    65 HBC  -  3.  K- P (K*PI) 10/66
M         20 1440.0     20.0          DUBAL     68 MMS  -  11.5 K- P         6/68
M   B    240 1396.       6.           BASSOMPIE 69 HBC  +  5 K+P (K 2PI)   11/69
M           (1411.)     (7.)          FRIEDMAN  69 HBC  -  2.7 K-P (K 2PI)  2/72
M
M   AVG      1399.7      8.2      AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.5)

M   CHARGED AND NEUTRAL
M            1404.0     15.0          FOCARDI   65 HBC  -0 3.  K- P (K PI) 10/66
M            1390.0     30.0          SHEN      66 HBC  +0 4.6 K+ P (K PI) 10/66
M            1430.0     10.0          SHEN      66 HBC  +0 4.6 K+ P (K*PI) 10/66
M            1423.0      7.0          BASSANO   67 HBC  -0 4.6, 5.0 K- P   10/67
M            1420.0     10.0          GOLDHABER 67 HBC       9.0 K+ P(K 2PI) 10/67
M
M   AVG      1421.2      4.7      AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

M   NEUTRAL ONLY
M            1446.0      7.9          DAHL      67 HBC   0 4.PI- P (KPI)   10/66
M            1425.0     15.0          KANG      68 HBC   0 4.6 K- P         7/69
M            1405.0     18.0          SCHWEINGR 68 HBC   0 4.1 K- P (K PI)  9/67
M            1397.0     19.0          SCHWEINGR 68 HBC   0 5.5 K- P (K PI)  9/67
M   B    420 1422.       5.           BASSOMPIE 69 HBC   0 5 K+P (K PI)    11/69
M   B BASSOMP. ERRORS ENLARGED BY US TO  GAMMA/SQRT(N). SEE K* TYPED NOTE. 11/69
M       2200 1421.1      2.6          DAVIS     69 HBC   0 12. K+ P(K+PI-)  9/69
M       1800 1419.1      3.7          AGUILAR1  71 HBC   0 3.9,4.6 K- P    11/71
M        600 1416.       6.           CORDS     71 DBC   0 9. K+ N,K+ PI- P  2/72
M       1100 1427.       3.           BUCHNER   72 DBC   0 4.6 K+ N,K+ PI-P 12/72*
M
M   AVG      1422.8      2.5      AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.6)
                                  (SEE IDEOGRAM BELOW )
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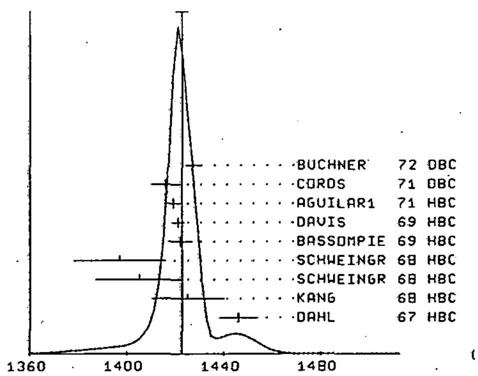
WEIGHTED AVERAGE = 1422.8 ± 2.5
ERROR SCALED BY 1.6



NEUTRAL KN(1420) MASS (MEV)

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                       22  KN(1420) WIDTH (MEV)

W   CHARGED ONLY, WITH FINAL STATE K PI
W             175.      57.           ADERHOLZ  68 HBC  -  10 K- P (K PI)    6/68
W             110.0     25.0          BISHOP    69 HBC  +  3.5 K+ P          9/69
W              96.      18.           LIND      69 HBC  +  9. K+ P           5/70
W              80.0     20.0          ABRAMS    70 HBC  +  2.5-3.2 K+P,K2PI 11/70
W       1400   94.7     15.1   12.5   AGUILAR1  71 HBC  -  3.9,4.6 K- P     11/71
W        200  115.      20.           BARNHAM   71 HBC  +  K+ P,KO PI+ P     1/72
W
W   AVG        99.1      8.1      AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

W   CHARGED ONLY, WITH OTHER FINAL STATES
W             105.0     30.0          BADIER    65 HBC  -  3.0 K-P           6/66
W   B    240  110.      25.           BASSOMPIE 69 HBC  +  5 K+P (K 2PI)   11/69
W             (43.)     (13.)         FRIEDMAN  69 HBC  -  2.7 K-P (K 2PI)  2/72
W
W   AVG       108.0     19.2      AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
```

0 0 0 0 3 6 0 4 3 1 9

Data Card Listings

For notation, see key at front of Listings.

Mesons

$K_N(1420)$, $K_N(1660)$

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W   CHARGED AND NEUTRAL
W            92.0     14.0              FOCARDI   65 HBC  -0 3.0 K- P (K PI)
W            75.0     25.0              SHEN      66 HBC  + 04.6 K+ P          8/66
W            65.0     20.0              BASSANO   67 HBC  -0 4.6, 5.0 K- P   10/67
W            80.0     20.0              GOLDHABER 67 HBC     9.0 K+ P(K 2PI) 10/67
W           107.0     20.0              SCHWEINGR 68 HBC  -0 4.1+5.5 K-P      9/67
W                 . . . . . . . . . .
W   AVG      85.9      8.4      AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

W   NEUTRAL ONLY
W            61.0     24.0              DAHL      67 HBC   0 3.8-4.2 PI- P    9/66
W           116.0     17.0              KANG      68 HBC   0 4.6 K- P         7/69
W  B   420  110.      21.               BASSOMPIE 69 HBC   0 5 K+P (K PI)    11/69
W  B           ERRORS ENLARGED BY US TO 4*GAMMA/SQRT(N). SEE K* TYPED NOTE.
W     2200  101.      10.               DAVIS     69 HBC   0 12. K+ P (K PI)  9/69
W     1800  116.6     10.3      15.5    AGUILAR1  71 HBC   0 3.9,4.6 K- P    11/71
W      600  144.      22.               CORDS     71 DBC  0 9. K+ N,K+ PI- P  2/72
W  B  1100  109.      12.               BUCHNER   72 DBC  0 4.6 K+ N,K+ PI-P 12/72*
W                 . . . . . . . . . .
W   AVG     108.4      6.3      AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.1)

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                    22  KN(1420) PARTIAL DECAY MODES

                                                           DECAY MASSES
P1      KN(1420) INTO K PI                               493+ 139
P2      KN(1420) INTO K*(892) PI                         891+ 139
P3      KN(1420) INTO K RHO                              493+ 770
P4      KN(1420) INTO K OMEGA                            493+ 783
P5      KN(1420) INTO K ETA                              493+ 548

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FITTED PARTIAL DECAY MODE BRANCHING FRACTIONS

The matrix below is derived from the error matrix for the fitted partial decay mode branching fractions, P_i, as follows: The diagonal elements are $P_i \pm \delta P_i$, where $\delta P_i = \sqrt{(\delta P_i \delta P_i)}$, while the off-diagonal elements are the normalized correlation coefficients $\langle \delta P_i \delta P_j \rangle / (\delta P_i \cdot \delta P_j)$. For the definitions of the individual P_i, see the listings above; only those P_i appearing in the matrix are assumed in the fit to be nonzero and are thus constrained to add to 1.

```
        P 1         P 2         P 3         P 4         P 5
 P 1 .5495+-.0274
 P 2   -.2293   .2945+-.0247
 P 3   -.3950     -.3925   .0923+-.0241
 P 4   -.2443     -.2458     -.1182  .0440+-.0166
 P 5   -.4097     -.2442     -.0787     -.0502  .0197+-.0200


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                     22  KN(1420) BRANCHING RATIOS

R1      KN(1420) INTO (K PI)/TOTAL                        (P1)
R1  R       (0.37)   (0.19)          BADIER    65 HBC      3.0 K-P          6/66
R1  R       (0.39)   (0.11)          BASSANO   67 HBC  -  4.6, 5.0 K- P   10/67
R1  R        WE CANNOT USE THIS STATISTICALLY REDUNDANT RATIO. AUTHORS
R1  R        OBTAIN IT MERELY BY SUBTRACTING FROM UNITY THEIR
R1  R        MEASUREMENTS OF OTHER RATIOS.
R1             . . . . . . . . . .
R1  FIT       0.550    0.027   FROM FIT

R2      KN(1420) INTO (K*(892) PI) / TOTAL                (P2)
R2  Q        (.41)   (0.14)          BADIER    65 HBC      3.0 K-P          6/66
R2  Q       (0.47)   (0.10)          BASSANO   67 HBC  -  4.6, 5.0 K- P   10/67
R2             . . . . . . . . . .
R2  FIT       0.295    0.025   FROM FIT

R3      KN(1420) INTO (K RHO)/TOTAL                       (P3)
R3  Q       (0.14)   (0.05)          BADIER    65 HBC      3.0 K-P          6/66
R3  Q       (0.14)   (0.10)          BASSANO   67 HBC   0 4.6, 5.0 K- P   10/67
R3             . . . . . . . . . .
R3  FIT       0.092    0.024   FROM FIT

R4      KN(1420) INTO (K OMEGA)/TOTAL                     (P4)
R4            0.07     0.04          BADIER    65 HBC      3.0 K-P          6/66
R4             . . . . . . . . . .
R4  FIT       0.044    0.017   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R5      KN(1420) INTO (K ETA)/TOTAL                       (P5)
R5            0.02     0.02          BADIER    65 HBC      3.0 K-P          6/66
R5          (0.025)OR LESS           BASSOMPIE 69 HBC      5.0 K+ P         9/68
R5             . . . . . . . . . .
R5  FIT       0.020    0.020   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R6      KN(1420) INTO (K*(892) PI) / (K PI)               (P2)/(P1)
R6       6    0.33     0.33          CHUNG     65 HBC  + 0  3.9-4.2 PI- P   8/66
R6            0.65     0.20          SHEN      66 HBC    0  N* PRODUCED    10/66
R6  Q       (0.63)   (0.20)          SHEN      66 HBC  +    NO N* PRODUCED 10/66
R6            0.52     0.12          SCHWEINGR 68 HBC   0 4.1+5.5 K- P    10/67
R6  B        (0.9)    (0.2)          BASSOMPIE 69 HBC  + 0 5 K+P            1/73*
R6  B   SUPERSEDED BY CHARRIERE 72
R6  Q   84  (0.93)   (0.11)          BISHOP    69 HBC      3.5 K+ P         9/69
R6            0.47     0.08          AGUILAR1  71 HBC      3.9,4.6 K- P    11/71
R6            0.78     0.15          CHARRIERE 72 HBC   0 5. K+ P,K P 3PI   1/73*
R6             . . . . . . . . . .
R6  AVG       0.537    0.058    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R6  FIT       0.536    0.057   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R7      KN(1420) INTO (K OMEGA) / K PI                    (P4)/(P1)
R7          (0.08) OR LESS           SHEN      66 HBC      4.6 K+P          8/66
R7          (0.2)  OR LESS           BASSOMPIE 69 HBC  +   5 K+ P           9/69
R7            0.13     0.07          BASSOMPIE 69 HBC   0 5 K+ P            9/69
R7            0.05     0.04          AGUILAR1  71 HBC      3.9-4.6 K- P    11/71
R7             . . . . . . . . . .
R7  AVG       0.070    0.035    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R7  FIT       0.080    0.031   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R8      KN(1420) INTO (K RHO) / (K PI)                    (P3)/(P1)
R8          (0.09) OR LESS           CHUNG     65 HBC  + 0  3.9-4.2 PI- P   8/66
R8            0.26     0.16          SCHWEINGR 68 HBC   0 4.1+5.5 K- P    10/67
R8          (0.2)  OR LESS           BASSOMPIE 69 HBC  +   5 K+ P           9/69
R8          (0.3)  OR LESS           BASSOMPIE 69 HBC   0 5 K+ P            9/69
R8  Q   15  (0.11)   (0.06)          BISHOP    69 HBC      3.5 K+ P         9/69
R8            0.16     0.05          AGUILAR1  71 HBC      3.9,4.6 K- P    11/71
R8             . . . . . . . . . .
R8  AVG       0.169    0.048    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R8  FIT       0.168    0.048   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R9      KN(1420) INTO (K RHO) / (K*(892) PI)                  (P3)/(P2)
R9          (0.39) OR LESS            BASSOMPIE 67 HBC  +   5. K+ P          9/67
R9          (0.40) OR LESS  CL=.90    FIELD     67 HBC  - 3.8 K- P           6/67
R9             . . . . . . . . . .
R9  FIT       0.313    0.095   FROM FIT

R10     KN(1420) INTO (K OMEGA) / (K*(892) PI)                (P4)/(P2)
R10 Q       (0.10)   (0.04)           FIELD     67 HBC  - 3.8 K- P           6/67
R10            . . . . . . . . . .
R10 FIT       0.149    0.061   FROM FIT

R11     KN(1420) INTO (K ETA) / (K*(892) PI)                  (P5)/(P2)
R11 Q       (0.07)   (0.04)           FIELD     67 HBC  - 3.8 K- P           6/67
R11            . . . . . . . . . .
R11 FIT       0.067    0.069   FROM FIT

R12     KN(1420) INTO (K ETA) / (K PI)                        (P5)/(P1)
R12         (0.02) OR LESS            BISHOP    69 HBC     3.5 K+ P          9/69
R12         (0.04) OR LESS  CL=.95    AGUILAR1  71 HBC     3.9-4.6 K- P     11/71
R12            . . . . . . . . . .
R12 FIT       0.036    0.037   FROM FIT

R   Q  FOLLOWING SUGGESTION BY AGUILAR 70, WE DO NOT MAKE USE OF MEASURE-
R   Q   MENTS WHERE THE (K PI PI) BACKGROUND SUBTRACTION IS DIFFICULT DUE
R   Q   TO THE NEARBY Q REGION.


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                        REFERENCES FOR KN(1420)
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BADIER    65 PL 19 612          BADIER,DEMOULIN,GOLDBERG+(EPOL+SACL+ZEEMAN)
CHUNG     65 PRL  15  325       +DAHL,HARDY,HESS,JACOBS,KIRZ,MILLER    (LRL)
FOCARDI   65 PL 16 351          FOCARDI,MINGUZZI RANZI,SERRA+(BOLOGNA+SACL)

SHEN      66 PRL  17  726       +BUTTERWORTH,FU,GOLDHABERS,TRILLING    (LRL)
    ALSO 66  (PRIVATE COMMUN)GERSON GOLDHABER                          (LRL)

BASSANO   67 PRL  19  968       +GOLDBERG,GOZ,BARNES,LEITNER+(BNL+SYRACUSE)
BASSOMPI 67 PL 26B 30           BASSOMPIERRE,GOLDSCHMIDT+  (CERN+BRUX+BIRM)IJP
CRENNELL 67 PRL 19  44          +KALBFLEISCH,LAI,SCARR,SCHUMANN        (BNL)
DAHL      67 PR 163 1377        +HARDY+HESS+KIRZ+MILLER                (LRL)
    ALSO 65 PRL 14 401          HARDY,CHUNG,DAHL,HESS,KIRZ,MILLER      (LRL)
DE BAERE 67 NC 51 A 401         +GOLDSCHMIDT-CLERMONT,HENRI+     (BRUX+CERN)
FIELD     67 PL 24B 638         +HENDRICKS+PICCIONI+YAGER          (LAJOLLA)
GOLDHABE 67 PRL 19  972         G.GOLDHABER,FIRESTONE,SHEN             (LRL)

ADERHOLZ 68 NP B 5  567         +DEUTSCHMANN+  (AACH+BERL+CERN+LOIC+VIENNA)
    ALSO 66 PL 22 357           BARTSCH,DEUTSCHMANN,MORRISON+    (ABCL(IC)V)
ANTICH    68 PRL 21 1842       +CALLAHAN,CARSON,COX,DENEGRI,+         (JHU)
DUBAL     68 THESIS  1456       L.DUBAL                             (GENEVE)
KANG      68 PR 176 1587        Y.W.KANG                              (IOWA)
SCHWEING 68 PR 166 1317         SCHWEINGRUBER,DERRICK,FIELDS+    (ANL+NWES)
   ALSO  67  THESIS             F.L.SCHWEINGRUBER   (NORTHWESTERN,EVANSTON)

BASSOMPI 69 NP  B13 189         BASSOMPIERE,GOLDSCHMIDT-CLERN.+ (CERN+BRUX) JP
    ALSO 69 DE BAERE
    ALSO 70 DE BAERE
BISHOP    69 NP B 9 403         +GOSHAW,ERWIN,WALKER                  (WISC)
CRENNELL 69 PRL 22 ,487         +KARSHON,LAI,ONEALL,SCARR              (BNL)
DAVIS     69 PRL 23 1071        +DERENZO,FLATTE,ALSTON,LYNCH,SOLMITZ  (LRL)
DE BAERE 69 NC 61 A 397         +GOLDSCHMIDT-CLERMONT,HENRI,+    (BELG+CERN)
    ALSO 70 DE BAERE
FRIEDMAN 69  UCRL-18860         J.FRIEDMAN,PH.D. THESIS                (LRL)
LIND ,    69 NP B 14 1          +ALEXANDER,FIRESTONE,FU,GOLDHABER      (LRL) JP

ABRAMS    70 PR D 1 2433        +EISENSTEIN,KIM,MARSHALL,O'HALLORAN,+ (ILL)
AGUILAR   70 PRL 25 1362        AGUILAR-BENITEZ,BASSANO,EISNER,+ (BNL+PURD)
BIRMINGH 70  KIEV CONF.         ASTIER RAPPORTEURS TALK     (BIRM+GLAS+OXF)
DE BAERE 70  CERN PHYS 70 41    +DEBAISIEUX,DE WOLF,DUFOUR,+     (BELG+CERN)

AGUILAR1 71 PR D 4 2583         +EISNER,KINSON                         (BNL)
BARNHAM   71 NP B 28 171        +COLLEY,JOBES,GRIFFITHS,HUGHES,+(BIRM+GLAS)
CORDS     71 PR D 4 1974        +CARMONY,ERWIN,MEIERE,+       (PURD+UCD+IUPU)
SLATTERY 71  UR-875-332(PREP) P.SLATTERY,A REVIEW OF STRANGE MESONS(ROCH)

BUCHNER   72 NP B 45 333        +DEHM,CHARRIERE,CORNET,+   (MPIM+CERN+BRUX)
CHARRIER 72 NP B 51 317         CHARRIERE,ORIJARD,DE BAERE,+     (CERN+BELG)
CRENNELL 72 PR D 6 1220         +GORDON,KWAN-WU LAI,SCARR              (BNL)
DEUTSCHM 72 NP B 36 373         DEUTSCHMANN,+            (ABCLV COLLABORATION)
ENGELMAN 72 PR D 5 2162         ENGELMANN,MUSGRAVE,FORMAN,+        (ANL+EFI)
FRATI     72 PR D 6 2361        +HALPERN,HARGIS,SNAPE,CARNAHAN,+(PENN+CINC)
ROUGE     72 NP B 46 29         +VIDEAU,VOLTE,DE BRION,+         (EPOL+SACL)
TIECKE    72 NP B 39 596        +GRIJNS,HEINEN,DE GROOT,+        (NIJM+ZEEM)
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$K_N(1660)$

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27   KN (1660, JP=  ) I = 1/2

                 EVIDENCE NOT COMPELLING, OMITTED FROM TABLE

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                      27  KN(1660) MASS (MEV)

M          (1660.0)                      CARMONY   67 HBC  -  3.8 K-P,OMEGA K 11/67
M           1660.0     10.0              JOBES     67 HBC  +   5. K+ P         11/67
M    J     CLAIMED BY JOBES IN (K PI), (K*(892) PI), AND (KN(1420) PI)
M    J     MODES. K PI BUMP INTERFERES MOSTLY WITH DELTA(1236).
M          (1660.)                       CHARRIERE 72 HBC   0 5. K+ P,K P 3PI   1/73*

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                      27  KN(1660) WIDTH (MEV)

W             60.0     20.0              JOBES     67 HBC  +   5. K+ P         11/67
W            (60.)                       CHARRIERE 72 HBC   0 5. K+ P,K P 3PI   1/73*

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                      27  KN(1660) PARTIAL DECAY MODES

                                                           DECAY.MASSES
P1      KN(1660) INTO K PI                               493+ 139
P2      KN(1660) INTO K PI PI                            493+ 139+ 139
P3      KN(1660) INTO K*(892) PI                         891+ 139
P4      KN(1660) INTO KN(1420) PI                       1421+ 139

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Mesons

$K_N(1660)$, $K_N(1760)$, L(1770), $K_N(1850)$, $K^*(2200)$

Data Card Listings

For notation, see key at front of Listings.

REFERENCES FOR KN(1660)

CARMONY 67 PRL 18 615 — O.CARMONY,T.HENDRICKS,L.LANDER (LA JOLLA)
JOBES 67 PL 26B 49 — +BASSOMPIERRE,DE BAERE + (BIRM+CERN+BRUX)
CHARRIER 72 NP B 51 317 — CHARRIERE,DRIJARD,DE BAERE,+ (CERN+BELG)

$K_N(1760)$

60 KN (1760,JP=)

NEEDS FURTHER CONFIRMATION.OMITTED FROM THE TABLE.
FAVORED JP IS 3- , I=1/2 .

60 KN(1760) MASS (MEV)

M C 76(1753.) (12.) CARMONY 71 DBC 0 9. K+ N 11/71

60 KN(1760) WIDTH (MEV)

W C 76 (60.) (20.) CARMONY 71 DBC 0 9. K+ N 11/71
W C DISAGREEMENT BETWEEN THE FIT AND DATA ON BOTH SIDES OF THE SIGNAL 11/71

60 KN(1760) PARTIAL DECAY MODES

		DECAY MASSES
P1	KN(1760) INTO K PI	493+ 139
P2	KN(1760) INTO K*(892) PI	891+ 139
P3	KN(1760) INTO K RHO	493+ 770
P4	KN(1760) INTO KN(1420) PI	1421+ 139
P5	KN(1760) INTO K PI PI	493+ 139+ 139

60 KN(1760) BRANCHING RATIOS

R1 KN(1760) INTO (K PI)/(K*(892) PI + K RHO) (P1)/(P2+P3)
R1 E (0.40) (0.10) CARMONY 71 DBC 0 9. K+ N 11/71

R2 KN(1760) INTO (K*(892) PI)/(K PI PI) (P2)/(P5)
R2 E (0.40) (0.15) CARMONY 71 DBC 0 9. K+ N 11/71

R3 KN(1760) INTO (K RHO)/(K PI PI) (P3)/(P5)
R3 E (0.60) (0.25) CARMONY 71 DBC 0 9. K+ N 11/71

R4 KN(1760) INTO (K*(892) PI + K RHO)/(K PI PI) (P2+P3)/(P5)
R4 E (1.) (0.12) CARMONY 71 DBC 0 9. K+ N 11/71

R5 KN(1760) INTO (KN(1420) PI)/(K PI PI) (P4)/(P5)
R5 E (0.06) OR LESS CARMONY 71 DBC 0 9. K+ N 11/71
R5 E DIFFICULT BACKGROUND SUBTRACTION . ERRORS STATISTICAL ONLY . 11/71

REFERENCES FOR KN(1760)

CARMONY 71 PRL 27 1160 — +CORDS,CLOPP,ERWIN,MEIERE,+ (PURD+UCD+IUPU)

L(1770)

23 L (1770, JP=) I = 1/2

FOR REVIEWS SEE HUGHES 71,SLATTERY 71 .

23 L MASS (MEV)

M 20(1780.) BERLINGHI 67 HBC + 12.7 K+P 7/67
M (1760.0) (15.0) JOBES 67 HBC + 5. K+ P 1/73*
M B (1785.0) (12.0) BARTSCH 68 HBC 10.0 K- P 11/71
M B INCLUDED IN BARTSCH 70 11/71
M 1745.0 20.0 AGUILAR 70 HBC - 4.6 K- P 6/70
M 1780.0 15.0 BARTSCH 70 HBC - 10.1 K- P 1/71
M (1760.0) (15.0) LUDLAM 70 HBC - 12.6 K- P 1/73*
M X 1765.0 40.0 COLLEY 71 HBC + 10.K+P,K 2PI 1/73*
M X SYSTEMATIC ERRORS ADDED CORRESP. TO SPREAD OF DIFFERENT FITS.
M (1740.0) DENEGRI 71 DBC - 12.6 K-D,K 2PI D 5/71
M 1767. 6. BLIEDEN 72 MMS - 11.-16. K- P 12/72*
M P 306 1730. 20. FIRESTONE 72 DBC + 12. K+ D 1/73*
M P PRODUCED IN CONJUNCTION WITH D*
M . . . .
M AVG 1764.6 6.7 AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.3)

23 L WIDTH (MEV)

W 20 (80.) BERLINGHI 67 HBC + 12.7 K+P 7/67
W (60.0) (20.0) JOBES 67 HBC + 5. K+ P 1/73*
W B (127.0) (43.0) BARTSCH 68 HBC 10.0 K- P 11/71
W B INCLUDED IN BARTSCH 70 11/71
W 100.0 50.0 AGUILAR 70 HBC - 4.6 K- P 6/70
W 138.0 40.0 BARTSCH 70 HBC - 10.1 K- P 1/71
W (50.0) (40.0) (20.0) LUDLAM 70 HBC - 12.6 K- P 1/73*
W X 90. 70. COLLEY 71 HBC + 10.K+P,K 2PI 1/73*
W X SYSTEMATIC ERRORS ADDED CORRESP. TO SPREAD OF DIFFERENT FITS.
W (130.0) DENEGRI 71 DBC - 12.6 K-D,K 2PI D 5/71
W 100. 26. BLIEDEN 72 MMS - 11.-16. K- P 12/72*
W P 306 210. 30. FIRESTONE 72 DBC + 12. K+ D 12/72*
W P PRODUCED IN CONJUNCTION WITH D*
W . . . .
W AVG 137.7 24.2 AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.5)

23 L PARTIAL DECAY MODES

		DECAY MASSES
P1	L INTO K PI PI	497+ 134+ 134
P2	L INTO KN(1420) PI	134+1421
P3	L INTO K PI PI PI	497+ 134+ 134+ 134
P4	L INTO K*(892) PI	891+ 134
P5	L INTO K*(892) RHO	891+ 770
P6	L INTO K*(892) OMEGA	891+ 783
P7	L INTO K*(892) PI PI	891+ 134+ 134

23 L BRANCHING RATIOS

R1 L INTO (KN(1420) PI) / (K PI PI) (P2)/(P1)
R1 LARGE DENEGRI 68 DBC - 12.6 K- D 1/71
R1 (1.0) BARBARO 69 HBC + 12.0 K+ P 1/71
R1 0.2 0.2 AGUILAR 70 HBC - 4.6 K- P 1/71
R1 LESS THAN 1.0 BARTSCH 70 HBC - 10.1 K- P 1/71
R1 LESS THAN 1.0 COLLEY 71 HBC 10. K+ P 11/71
R1 P CONSISTENT WITH 1. FIRESTONE 72 DBC + 12. K+ D 12/72*
R1 P PRODUCED IN CONJUNCTION WITH D* 12/72*
R1 R LESS THAN 1.0 SEEMS TO BE ESTABLISHED.
R1 R FOR DISCUSSION OF THE EXPERIMENTAL EVIDENCE ON OTHER DECAY 11/71
R1 R MODES SEE HUGHES 71,SLATTERY 71 . 11/71

REFERENCES FOR L(1770)

BARTSCH 66 PL 22 357 — +DEUTSCHMANN,+ (AACH+BERL+CERN+LOIC+VIEN)
BERLINGH 67 PRL 18 1087 — BERLINGHIERI+FARBER+FERBEL+FORMAN+ (ROCH)I
JOBES 67 PL 26B 49 — +BASSOMPIERRE,DE BAERE + (BIRM+CERN+BRUX)
DENEGRI 68 PRL 20 1194 — +CALLAHAN+ETTLINGER+GILLESPIE+ (JHU)
BARTSCH 68 NP B8 9 — +COCCONI,+ (AACH+BERL+CERN+LOIC+VIEN)

ANDREWS 69 PRL 22 731 — +LACH,LUDLAM,SANDWEISS,BERGER,+ (YALE+LRL)
BARBARO 69 PRL 22 1207 — BARBARO-GALTIERI,DAVIS,FLATTE,+ (LRL)
COLLEY 69 NC A 59 519 — +EASTWOOD,+ (BIRM+GLAS+LOIC+MPIM+OXF+RHEL)

AGUILAR 70 PRL 25 54 — AGUILAR-BENITEZ,BARNES,BASSANO,CHUNG,+(BNL)
BARTSCH 70 PL 33 B 186 — +DEUTSCHMANN,+ (AACH+BERL+CERN+LOIC+VIEN)
CHIEN 70 PHILA.CONF.P.275 — C.Y.CHIEN (JOHNS HOPKINS)
LUDLAM 70 PR D 2 1234 — +SANDWEISS,SLAUGHTER (YALE)

COLLEY 71 NP B 26 71 — +JOBES,KENYON,PATHAK,HUGHES,+ (BIRM+GLAS)
DENEGRI 71 NP B 28 13 — +ANTICH,CALLAHAN,CARSON,CHIEN,COX,+ (JHU) JP
HUGHES 71 BOLOGNA CONF.PROC — I.S.HUGHES,TALK AT BOLOGNA CONF. (GLASGOW)
SLATTERY 71 UR-875-332(PREP) — P.SLATTERY,A REVIEW OF STRANGE MESONS(ROCH)

ANDERSON 72 PR D 6 1823 — +FRANKLIN,GODDEN,KOPELMAN,LIBBY,TAN (COLO)
BLIEDEN 72 PL 39 B 668 — +FINOCCHIARO,BOWEN,EARLES,+ (STON+NEAS)
CHARRIER 72 NP B 51 317 — CHARRIERE,DRIJARD,DE BAERE,+ (CERN+BELG)
FIRESTON 72 PR D 5 505 — FIRESTONE,GOLDHABER,LISSAUER,TRILLING (LBL)

$K_N(1850)$

61 KN (1850,JP=)

STRUCTURE IS SEEN IN THE K PI SCATTERING ANGULAR DISTRIBUTION
AT MASSES NEAR 1850 MEV.THE MOST SIMPLE EXPLANATION INVOLVES
A RAPIDLY INCREASING F-WAVE AMPLITUDE,POSSIBLY INDICATING
PRESENCE OF A JP=3- RESONANCE.
NEEDS FURTHER CONFIRMATION. OMITTED FROM THE TABLE.

61 KN(1850) MASS (MEV)

M I (1850.) APPROX. FIRESTONE 71 DBC 0 12.K+ N,K+ PI-P 11/71

61 KN(1850) WIDTH (MEV)

W I (300.) APPROX. FIRESTONE 71 DBC 0 12.K+ N,K+ PI-P 11/71
W I APPARENT INTERFERENCE WITH OTHER AMPLITUDES PRECLUDES 11/71
W I PRECISE DETERMINATION . 11/71

REFERENCES FOR KN(1850)

FIRESTON 71 PL 36 B 513 — FIRESTONE,GOLDHABER,LISSAUER,TRILLING (LBL)

$K^*(2200)$

40 K* (2200,JP=)

ENHANCEMENT SEEN IN (ANTIHYPERON-NUCLEON) MASS
NEAR THRESHOLD.INTERPRETATION UNCERTAIN.
OMITTED FROM TABLE.

40 K*(2200) MASS (MEV)

M 20 2240. 20. LISSAUER 70 HBC 9. K+ P 11/71
M C (2200.) APPROX. SLATTERY 71 RVUE 8-13 K+ P 11/71
M C COMPILATION OF (ANTIHYP.-NUCLEON) MASS IN K+ P 8.-13. GEV/C 11/71

40 K*(2200) WIDTH (MEV)

W 20 80. 20. LISSAUER 70 HBC 9. K+ P 11/71
W C (200.) APPROX. SLATTERY 71 RVUE 8-13 K+ P 11/71
W C COMPILATION OF (ANTIHYP.-NUCLEON) MASS IN K+ P 8.-13. GEV/C 11/71

REFERENCES FOR K*(2200)

ALEXANDE 68 PRL 20 755 — ALEXANDER,FIRESTONE,GOLDHABER,SHEN (LRL)
LISSAUER 70 NP B 18 491 — +ALEXANDER,FIRESTONE,GOLDHABER (LBL)

CARMONY 71 PRL 27 1160 — +CORDS,CLOPP,ERWIN,MEIERE,+ (PURD+UCD+IND)
SLATTERY 71 UR-875-332(PREP) — P.SLATTERY,A REVIEW OF STRANGE MESONS(ROCH)

Data Card Listings

For notation, see key at front of Listings.

K*(2800)

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62  K* (2800,JP=  )
NEEDS FURTHER CONFIRMATION.OMITTED FROM THE TABLE.
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          62  K*(2800) MASS (MEV)

M    H  59(2800.)                   HUGHES    71 HBC  +  10.K+P,P MMS+    11/71
------ --------- --------- --------- --------- --------- --------- --------

          62  K*(2800) WIDTH (MEV)

W    H  59  (40.)   OR LESS         HUGHES    71 HBC  +  10.K+P,P MMS+    11/71
W    H     ONLY SEEN IN MISSING MASS DISTRIBUTION,NOT IN FITTED EVENTS.   11/71
W    H     PROBABLY DECAYS INTO (3 CHARGED + 2 OR MORE NEUTRAL) PARTICLES 11/71
****** ********* ********* ********* ********* ********* ********* ********

                    REFERENCES FOR K*(2800)
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HUGHES 71 PREPRINT +MC*CORMICK,PROCTER,TURNBULL (GLASGOW)

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Baryons

N's and Δ's

Note on Speed Plots

In the discussion which follows, we use the term "speed plot" to indicate a plot showing the variation with C. M. energy m of the derivative $|dT/dm|$ of a partial-wave amplitude T. (See section IV C of the main text.) In principle such plots are a very sensitive and useful means of searching for a resonance. A rapid increase in speed followed by a rapid decrease is certainly a good indication of the presence of a resonance. In practice these plots must be judiciously used because:

1) The values of dT/dm are sensitive to variations in T. It is difficult enough to determine T(m); finding its derivative is necessarily more difficult.

2) Once the speed plot tells us that a resonance is present, the determination of precise parameters from such a plot requires additional considerations:

a) the maximum of the speed is not necessarily at the resonance mass,

b) the width cannot simply be obtained by the relation $|dT/dm|_{m=M} = 2x/\Gamma$.

Consider for example the P_{33} partial-wave amplitude in π-N scattering. Since its elasticity (x) is one, we have

$$T(m) = \frac{\Gamma(m)/2}{M-m-i\Gamma(m)/2} \quad . \qquad (1)$$

If we let $\Gamma'(m) = d\Gamma/dm$, then we find that

$$\text{"Speed"} = \left|\frac{dT}{dm}\right| = \frac{2}{\Gamma}\,\frac{1+(M-m)\Gamma'/\Gamma}{1+4(M-m)^2/\Gamma^2} \quad . \qquad (2)$$

To estimate where Eq. (2) is maximum, we let $m = M + \delta$ and find that for small δ,

$$\frac{d}{dm}\left|\frac{dT}{dm}\right| = -\frac{16}{\Gamma^3}\left(\frac{\Gamma\Gamma'}{8} + \delta\right) + \mathcal{O}(\delta^2) . \qquad (3)$$

Since all reasonable parametrizations of Γ(m) agree that $\Gamma' \geqslant 0$, we may conclude that the "speed" will have its maximum value at an energy about $\Gamma\Gamma'/8$ less than the resonant value, m=M.

This effect is illustrated in Fig. 1, which is taken from UCRL-20030 πN.[1] For the P_{33} partial wave, the CERN experimental and CERN Kirsopp solutions indicate the instability of $|dT/dm|$ in the region of a resonance (the other solutions are "smooth" by the nature of the analysis). In addition, each of the plots, quite consistently, gives $2/\Gamma \approx 16$ GeV^{-1} at a resonant mass of ~1236 MeV. This corresponds to a width at resonance of ~125 MeV. The speed, however, peaks

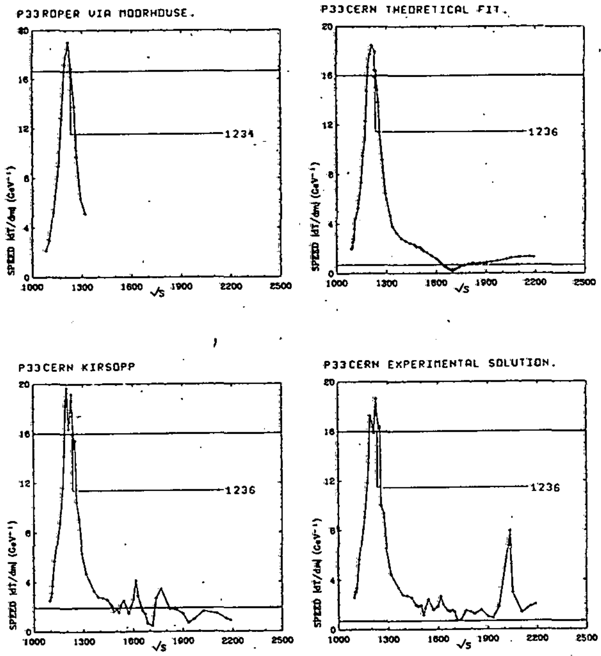

Fig 1. Speed plots as computed from four solutions compiled in Ref. 1. ($\sqrt{S}$ = m = c.m. energy in MeV)

some 10 to 15 MeV lower in mass and at a value of ~18.5 GeV^{-1}. Hence, were we to estimate the mass and width of the 33-resonance from the maximum speed, we would get M ≈ 1220 MeV and Γ = 108 MeV. For additional discussion on the mass and width of this resonance, see the mini-review at the beginning of the Δ(1236) listings.

Reference

1. D. Herndon, et al., "πN Partial-Wave Amplitudes, a Compilation," UCRL-20030 πN, Feb. 1970.

Note on N's and Δ's: Partial-Wave Analyses

There now exist complete partial-wave analyses performed by two groups after the beginning of 1970. The older analysis, AYED 70, is an update of the previous Saclay analyses. These are essentially energy-independent solutions selected on the basis of various energy "smoothness" criteria. A more recent analysis, ALMEHED 72, is a continuation of the "CERN group" program, which uses "smoothness" criteria supplemented by constraints from partial-wave dispersion relations. For a discussion of earlier partial-wave analyses see Refs. 1 and 2.

Data Card Listings

For notation, see key at front of Listings.

For the purposes of comparison, we show Argand plots of the solutions in Figs. 1 and 2. The arrowheads on the lines connecting points at discrete energies are 5 MeV long, and are spaced at 20 MeV intervals. The AYED 70 analysis extends in c.m. energy from 1400 to 2450 MeV; the ALMEHED 72 analysis, from 1100 to 2200 MeV. We have indicated the energies where AYED 70 and ALMEHED 72 claim resonances, and in the case of ALMEHED 72 we have also indicated the grade, A through D, assigned to each of their resonances by this group. In addition, we also show in Figs. 3 and 4 plots of δ and η versus c.m. energy ($\sqrt{s}$) for the same two solutions.

The Saclay group has presented preliminary results on a new πN phase-shift analysis in an unpublished report to the 1972 Batavia conference. This analysis includes recent data, and improves some of the methods of the earlier analysis. These improvements include checking the final results for smoothness in energy of invariant amplitudes at fixed t and the unmeasured charge exchange polarization Legendre coefficients, as well as a qualitative check of the final results for consistency with an unsubtracted forward dispersion relation for the B amplitude. The main differences between the resonance parameters extracted from this new analysis (AYED 72) and those of ALMEHED 72 are summarized below. None of the states listed below were reported by AYED 70 except the P_{11} with M = 1461, Γ = 164, and x = 0.56.

	ALMEHED 72			AYED 72		
Wave	M	Γ	x	M	Γ	x
S_{11}	2100	200	0.5	2195	280	0.173
P_{11}	1470	220	0.65	1427 1530	236 65	0.524 0.120
D_{13}				1730	130	0.1
D_{15}	2100	150	0.2	2055	170	0.09
F_{17}	2000	200	0.15	2048	183	0.058
G_{19}				2130	250	0.08
D_{35}	2200	600	0.25	1870	160	0.095

Of particular interest are the new results on the P_{11} and D_{13} partial waves. Previous partial-wave analyses have seen a single fairly elastic ($x \gtrsim 0.5$) $P_{11}(1470)$ resonance in the mass range 1440-1500 MeV, while many production experiments have observed a bump in the invariant mass distribution tending to be somewhat narrower and at somewhat lower mass than that obtained from partial-wave analysis. The Saclay group now claims two states. As for the D_{13}, the quark model predicts an inelastic resonance in the neighborhood of 1700 MeV, and the existence of such a state is now indicated by isobar model fits to $\pi N \rightarrow \pi\pi N$ (see the mini-review on this subject) and by AYED 72. The effect now claimed by AYED 72 to be the $D_{13}(1700)$ is visible in both the ALMEHED 72 and AYED 70 solutions (see Figs. 3 and 4) in the 1700 MeV region.

The remaining new results listed above are five high mass resonances, four of which were seen by ALMEHED 72, but none by the earlier Saclay analysis. In the case of the D_{35} it may well be that ALMEHED 72 and AYED 72 are reporting completely different effects.

Spread in Values of Resonance Parameters

Values of masses, widths, and branching ratios can be obtained only from phase-shift analyses. In production experiments, in fact, it is seldom clear which of the many states at similar masses is being observed. In addition to the two complete phase-shift analyses discussed above, we have other analyses, done by using somewhat incomplete data, by several different groups, but we are quite far from having reliable masses and widths derived therefrom.

There are essentially two problems in obtaining reliable resonance parameters. First there is often disagreement as to just what the values of the phase shifts (η's and δ's) are. This problem is obviously related to the quality and quantity of the data and to the procedures used to determine or choose the phase shifts. Secondly, even if smooth curves were available for the phase shifts, there would still be some ambiguity in deciding what the resonant parameters are. We might hope that some sort of energy-dependent fit to the smooth phase shifts would yield unique parameters. Unfortunately, however, a sufficiently clever combination of background and/or resonances could fit the phase shifts, satisfy elastic unitarity, and still yield the wrong parameters. (See the Comments on the Mass and Width of Δ(1236), below.)

We list the values of M, Γ and x quoted by the various authors with a comment on the method used to derive such parameters. We now discuss briefly the different methods used. AYED 70 analyze their

Baryons
N's and Δ's

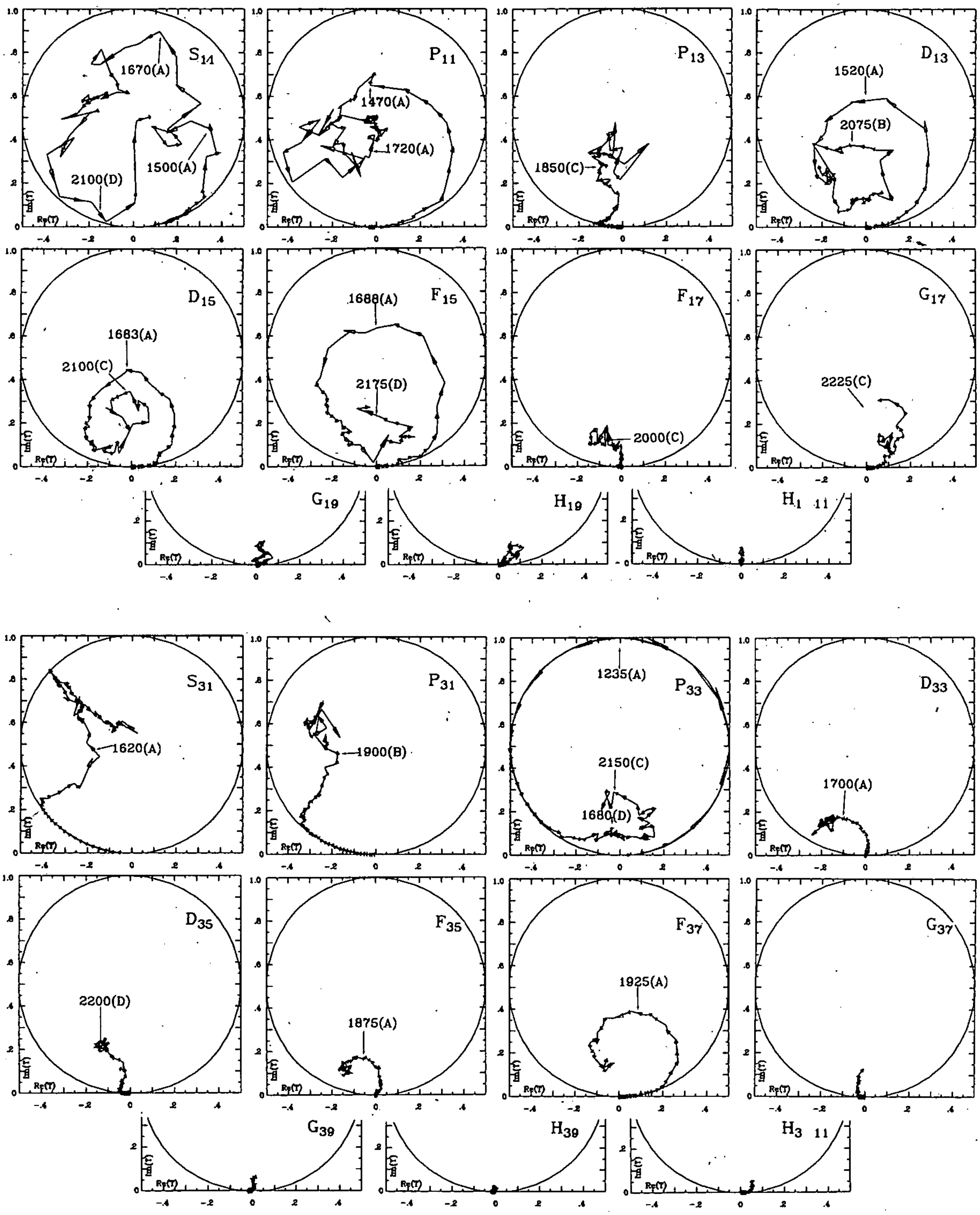

Fig. 1. πN Argand plots from the solution of ALMEHED 72. The bases of the arrowheads are 20 MeV apart; the end point is at ~2200 MeV. The numbers are the resonant masses claimed by ALMEHED 72, and the letters indicate their evaluation of the resonance.

Data Card Listings

For notation, see key at front of Listings.

Baryons

N's and Δ's

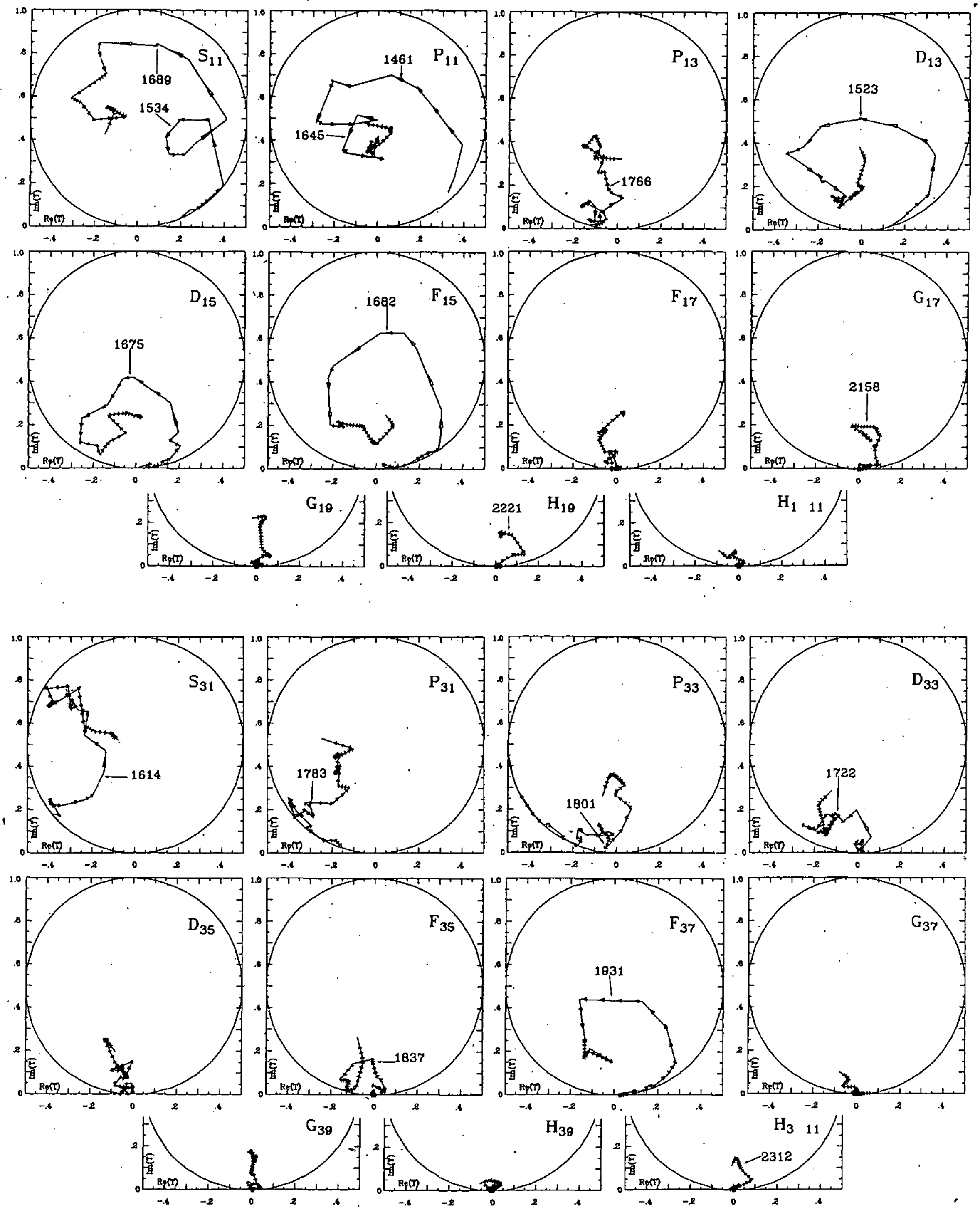

Fig. 2. πN Argand plots from the "minimum surface" solution of AYED 70 [Phys. Letters 31B, 598 (1970)]. To conserve space, we arbitrarily do not show the "minimum path" solution; it is not significantly different. The bases of the arrowheads are 20 MeV apart; the last point is at ~2400 MeV.

Baryons

N's and Δ's

Data Card Listings

For notation, see key at front of Listings.

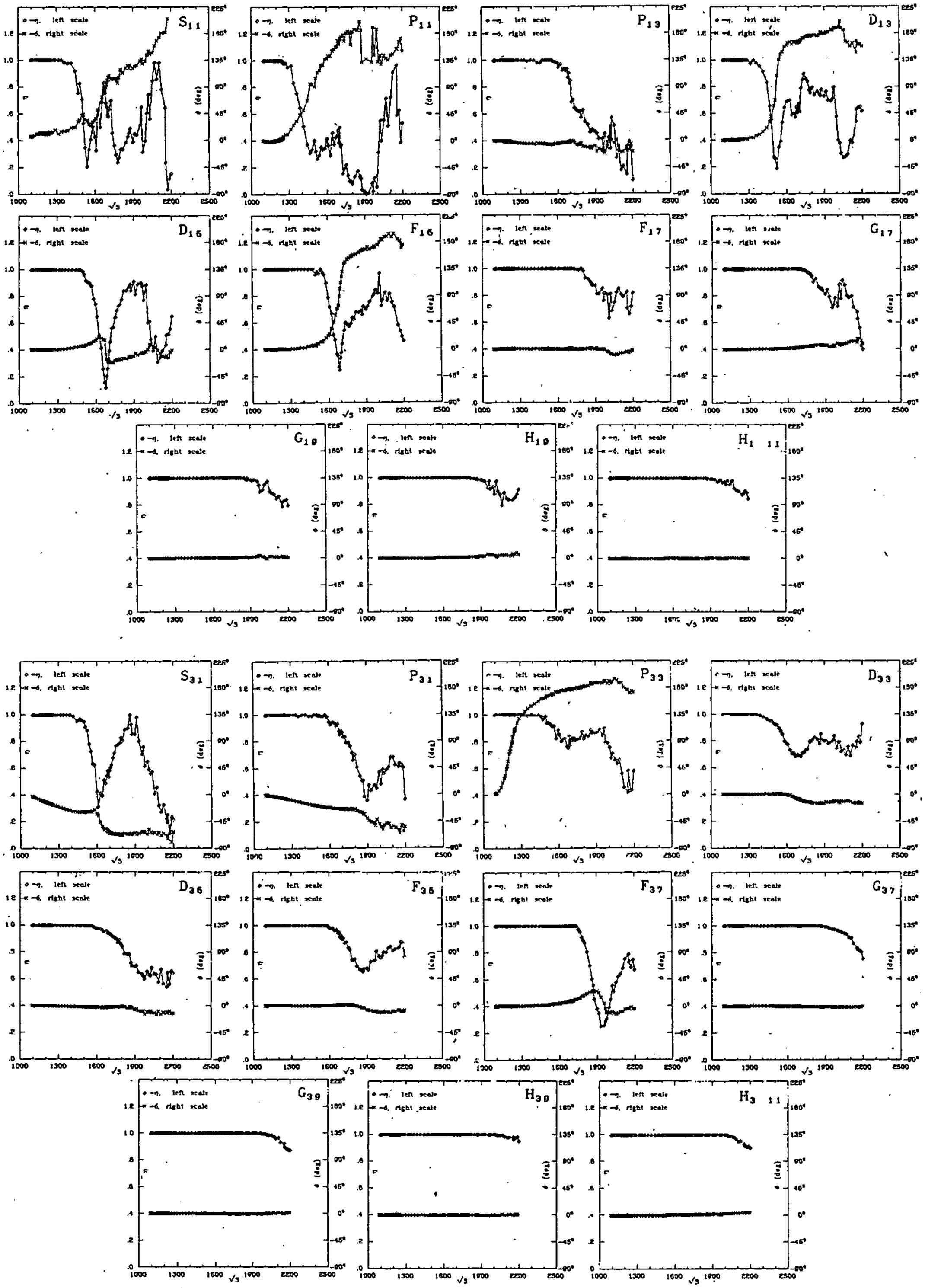

Fig. 3. δ and η versus c.m. energy (in MeV) from the πN partial-wave analysis solution of ALMEHED 72. × denotes δ (right-hand scale), ◇ denotes η (left-hand scale).

Data Card Listings

For notation, see key at front of Listings.

Baryons
N's and Δ's

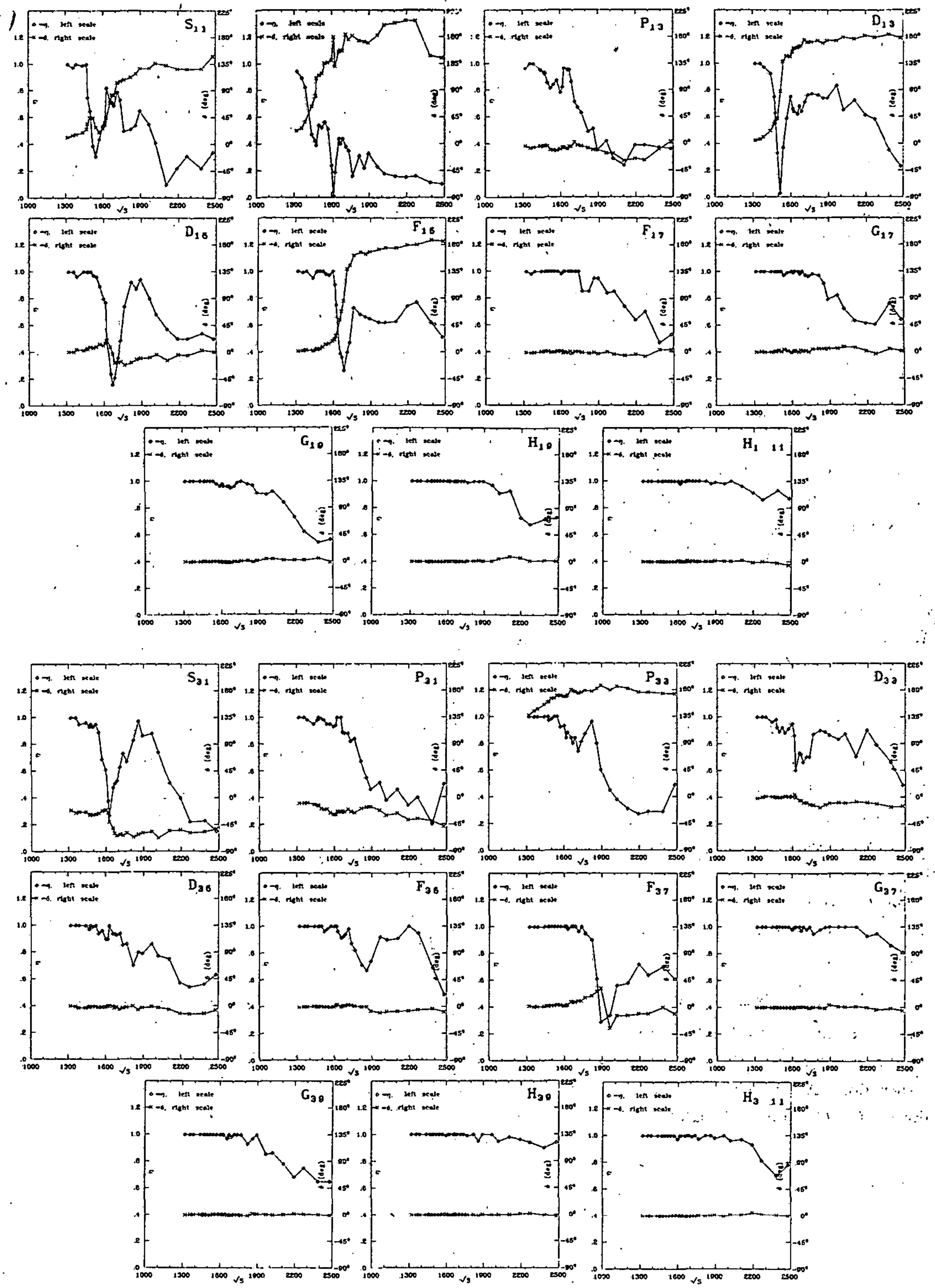

Fig. 4. δ and η versus c.m. energy (in MeV) from the πN partial-wave analysis "minimum surface" solution of AYED 70 [Phys. Letters 31B, 598(1970)]. × denotes δ (right-hand scale), ◇ denotes η (left-hand scale).

phase-shift results with an energy-dependent background and Breit-Wigner amplitudes. (This analysis appears only in the unpublished Kiev Conference report of AYED 70, not in their Physics Letter.) BAREYRE 68 uses two methods: 1) cross-section method — the energy where the total cross section is maximum; 2) speed method — the energy where the speed of variation of the amplitude in the Argand plot is maximum. CERN, as well as ALMEHED 72, quotes only one method, usually where the absorption is maximum. The Glasgow group (DAVIES 70) uses Breit-Wigner parametrization; their solutions A and B differ in the starting values of the minimization (CERN I solution was used for solution B). Only the parameters from solution A are included in the listings. For some states no parameters have been quoted by the authors.

At the beginning of the Data Card Listings for N's and Δ's, we present a table giving our evaluation of the N and Δ resonances based on information contained in the Listings. In the Table of Particle Properties, we do not quote values and errors for parameters, but only give ranges for masses and widths in order to emphasize that in some cases these parameters are quite poorly determined.

Availability of Partial-Wave Analyses and Data

All the solutions mentioned in this note, including AYED 70 and ALMEHED 72, are available on tape from the Particle Data Group. This tape is essentially an updated version of the one corresponding to the compilation of Ref. 2. In addition, the extensive input data used by ALMEHED 72 (courtesy of C. Lovelace) are also available on tape from the Particle Data Group.

References

1. Particle Data Group, Rev. Mod. Phys. 43, No. 2, Part II, S1 (1971).
2. D. J. Herndon, A. Barbaro-Galtieri, A. H. Rosenfeld, UCRL-20030 πN (Feb. 1970).

Note on N's and Δ's: Isobar Model Fits

In the figure below we show the inelastic Argand plots of Herndon 72.[1] These plots are the result of a partial-wave analysis, using the isobar model, of $\pi N \to \pi\pi N$ data in the c.m. energy range 1300-2000 MeV. The partial waves are labeled

$$LL'_{2I2J}(R),$$

where L is the incoming (πN) angular momentum, and L' is the outgoing angular momentum between the isobar R [ρ, ϵ (= ππ I=0, S wave), Δ] and the remaining hadron (π or N); as usual I and J are the isospin and total spin ($\vec{J} = \vec{L} + \vec{S} = \vec{L}' + \vec{S}'$) respectively. Also indicated on these Argand plots are the locations (in MeV) of known or suspected resonances from $\pi N \to \pi N$ partial-wave analyses.

Clear circular behavior is observed in many of these plots. Perhaps the most interesting among these are the $DP_{13}(\epsilon)$ and $DS_{13}(\Delta)$ partial waves. While all the D_{13} waves show evidence for the well-known N(1520), these two indicate some effect in the 1700-1800 MeV region—perhaps the long sought after $D_{13}(1700)$.

In order to estimate the inelastic coupling of the resonances indicated in these plots, we measured (with a ruler!) the diameters of "interpolated" circles. Recall that

$$A = \frac{\sqrt{xx'}}{\epsilon - i}, \quad \epsilon = \frac{2(M-E)}{\Gamma_{tot}}, \quad x = \frac{\Gamma_{el}}{\Gamma_{tot}}, \quad x' = \frac{\Gamma_{inel}}{\Gamma_{tot}};$$

thus, at resonance ($\epsilon = 0$) the circle diameter is $\sqrt{xx'}$. The amplitudes at resonance thus estimated are given in the following table. The spread in values represents our guess as to the range in resonance circles consistent with the data.

Reference

1. D. J. Herndon et al., LBL-1065 Rev. (1972), submitted to Phys. Rev.

0 0 0 0 3 6 0 4 8 2 4

Data Card Listings

For notation, see key at front of Listings.

Baryons
N's and Δ's

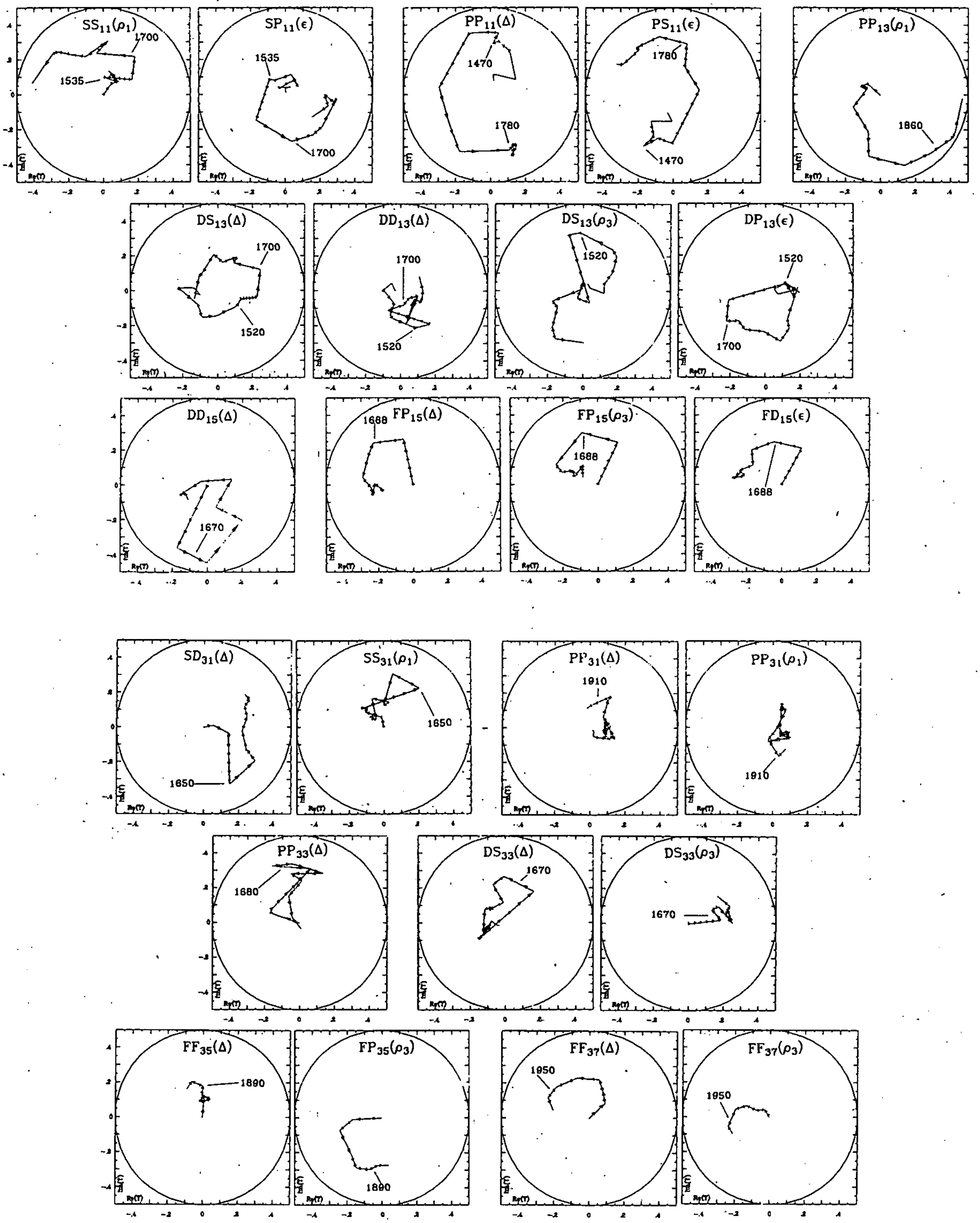

Fig. "Isobar" model Argand plots from Herndon 72. The bases of the arrowheads are 20 MeV apart. The solution covers the energy interval 1300-2000 MeV. See the mini-review text for partial-wave notation.

Baryons
N's and Δ's

Amplitude at resonance, $\sqrt{xx'}$, as estimated from Argand plots of Herndon 72.[1] A dash indicates coupling cannot exist or is essentially zero.

N's	x (PDG)	$\pi N \to \rho N$	$\pi N \to \epsilon N$	$\pi N \to \pi\Delta$	Δ's	x (PDG)	$\pi N \to \rho N$	$\pi N \to \pi\Delta$
$S_{11}(1535)$	.35	.07-.09	small	---	$S_{31}(1650)$	.28	.15-.21	.27-.30
$S_{11}(1700)$	.60	.20-.30	.39-.44	---	$P_{31}(1910)$	.25	.08-.20	.10-.20
$P_{11}(1470)$	.60	---	.18-.22	.35-.42	$P_{33}(1680)$[a]	~.10	---	.29-.45
$P_{11}(1780)$	.20	---	.48-.55	.43-.50	$D_{33}(1670)$	.15	small	.18-.21
$P_{13}(1860)$	.25	.43-.51	---	---	$F_{35}(1890)$	.17	.31-.35	small
$D_{13}(1520)$	.50	.31-.35	.05-.10	.28-.34[b] .11-.15[c]	$F_{37}(1950)$	.45	.19-.23	.25-.29
$D_{13}(1700)$	~.10	small	.29-.35	.09-.13[b] small[c]				
$D_{15}(1670)$	.40	---	---	.45-.49				
$F_{15}(1688)$	.60	.29-.31	.27-.28	.27-.28				

[a] Not in main Baryon Table. [b] DS_{13}. [c] DD_{13}.

Note on N's and Δ's: Photon Couplings

In this edition we start to quote results on the couplings of baryon resonances to the γN system. They can be studied in reactions like

$$\gamma N \to N^* \to \pi N,\ K\Lambda,\ K\Sigma,\ \pi\Delta, \ldots$$

A partial-wave analysis of these formation processes is the standard technique to determine the coupling strengths, $g(N^* N\gamma)$. Up to now almost all results are derived from analyses of pion-photoproduction. In the following we therefore outline the formulation of pion-photoproduction and define the conventions in which results will be quoted.

The process $\gamma N \to N^* \to \pi N$ for a specific intermediate resonance can be symbolically described as

$$\langle \pi N | H_\pi | N^* \rangle \langle N^* | H_\gamma | \gamma N \rangle . \quad (1)$$

The first term is measured in strong interactions, e. g. by partial-wave analysis of πN elastic scattering. A common feature of almost all analyses of pion-photoproduction is a strong reliance on the knowledge of resonance parameters from πN phase-shift analyses. Very few attempts are made to determine new πN resonance parameters, partly because of lack of precise enough data, partly because photoproduction is complicated by the fact that the photon has spin states ±1 and can react as an isoscalar or isovector. Consequently in general, several couplings for $N^* \to \gamma N$ (2 for Δ, 4 for N) have to be determined.

Isospin Decomposition

We ignore possible isotensor components and treat the electromagnetic current as having isoscalar and isovector components only, while the final πN-state has isospin 1/2 and 3/2 components. Therefore three independent isospin amplitudes describe the 4 reactions

$$\gamma p \to \pi^+ n,\ \pi^0 p$$
$$\gamma n \to \pi^- p,\ \pi^0 n.$$

They can be chosen as the isoscalar transition to final state I=1/2, isovector transition to final state I=1/2 and isovector transition to final state I=3/2.

Data Card Listings

For notation, see key at front of Listings.

Baryons
N's and Δ's

We define amplitudes A^{Δ}, A^{p}, and A^{n} such that they are naturally related to the excitation of the physical states Δ, N^{*+} and N^{*0}. Ignoring spin labels, a transition amplitude $A(\gamma N \to \pi N)$ is described by

$$A(\gamma p \to \pi N) = C_{\pi N}^{3/2} A^{\Delta} + C_{\pi N}^{1/2} A^{p},$$
$$A(\gamma n \to \pi N) = C_{\pi N}^{3/2} A^{\Delta} + C_{\pi N}^{1/2} A^{n}, \quad (2)$$

where $C_{\pi N}^{I}$ is the C-G coefficient for the coupling of isospin I to the specific πN state under consideration.

An alternative set of amplitudes A^{V3}, A^{V1}, and A^{S} is used by Walker[1] with the relations

$$A^{V3} = A^{\Delta},$$
$$A^{V1} = \frac{1}{2}(A^{n} - A^{p}), \quad (3)$$
$$A^{S} = \frac{1}{2}(A^{n} + A^{p}),$$

where A^{V3} refers to isovector transition to final state I=3/2, and A^{V1} and A^{S} refer to isovector and isoscalar transitions to final state I=1/2 respectively.

Partial Waves

The S-matrix element for pion-photoproduction $(\gamma N_1 \to \pi N_2)$ is written in the form

$$S_{fi} = i(2\pi)^5 \delta^4(P_f - P_i) W (k\omega E_1 E_2)^{-1/2} A \quad (4)$$

where P_f and P_i are the total 4-momenta in the final and initial state, k, ω, E_1, and E_2 denote the c.m. energies of photon, pion, initial and final nucleon, and W is the total c.m. energy.

For a partial-wave analysis it is convenient to decompose A into helicity amplitudes[2]. Choosing the x-z plane as the scattering plane, the z-axis along the photon direction, and θ as the c.m. scattering angle between photon and pion, we define helicity amplitudes $A_{\mu\lambda}(W,\theta)$ (ignoring isospin labels). Here μ and λ denote the total final and initial helicities, $\mu = \lambda_\pi - \lambda_2$, $\lambda = \lambda_\gamma - \lambda_1$. Since $\lambda_\gamma = \pm 1$ and $\lambda_{1,2} = \pm 1/2$, we have a set of 8 helicity amplitudes. Because of parity conservation[2] only 4 are independent, which we choose by fixing $\lambda_\gamma = +1$. We thus consider $A_{\pm 1/2, 1/2}$ and $A_{\pm 1/2, 3/2}$. They are normalized such that the differential cross section is given by

$$\frac{d\sigma}{d\Omega} = \frac{1}{2} \frac{q}{k} \sum_{\lambda,\mu} |A_{\mu\lambda}|^2 .$$

Each of these is expanded in the usual way[2]

$$A_{\mu\lambda}(W,\theta) = \sum_j (2j+1) A_{\mu\lambda}^{j}(W)\, d_{\lambda\mu}^{j}(\theta) \quad (5)$$

into partial wave amplitudes $A_{\mu\lambda}^{j}(W)$ of total angular momentum j (but mixed parity) and the Wigner rotation functions.

We define amplitudes of definite parity by

$$C_\lambda^{\ell+}(W) = \frac{1}{\sqrt{2}}[A_{1/2\lambda}^{j}(W) + A_{-1/2\lambda}^{j}(W)]$$
$$C_\lambda^{(\ell+1)-}(W) = \frac{1}{\sqrt{2}}[A_{1/2\lambda}^{j}(W) - A_{-1/2\lambda}^{j}(W)] \quad (6)$$

where λ = 1/2, 3/2. The superscripts ℓ± refer in the usual notation to states with pion orbital angular momentum ℓ and total angular momentum j = ℓ ± 1/2.

Unitarity of the S-matrix imposes a phase condition on the C amplitudes known as Watson's theorem. It states that in the elastic region the phase of each $C_\lambda^{\ell\pm}$ is equal to the scattering phase of the corresponding πN-partial wave.

Since we are interested in intermediate resonances, we approximate the energy dependence of $C_\lambda^{\ell\pm}(W)$ by a Breit-Wigner form

$$C_\lambda^{\ell\pm}(W) = s\left\{\frac{\Gamma^\lambda(N^*\to\gamma N)\,\Gamma(N^*\to\pi N)}{k\cdot q}\right\}^{1/2} \frac{W}{W^2 - m_R^2 - iW\Gamma} \quad (7)$$

where s is the sign of the amplitude, m_R the resonance energy and k, q the c.m. momenta in the initial, final states. At resonance ($W = m_R$)

$$C_\lambda^{\ell\pm}(m_R) = s\left\{\frac{\Gamma_\gamma^\lambda \Gamma_\pi}{k\cdot q\cdot \Gamma^2}\right\}^{1/2} \quad (8)$$

A dominant feature in pion-photoproduction is the Born approximation which contains the nucleon pole in the s- and u-channel and the pion pole in the t-channel. It reproduces, e.g., the experimentally observed forward peak in charged pion-photoproduction. In partial-wave analyses the sign factor s is well determined relative to the Born terms.

Introducing helicity amplitudes $A_\lambda^{j^P}$ for the decay $N^*(j^P) \to (\gamma N)_\lambda$ (where j^P labels spin and parity of the N^*), we can calculate the radiative width Γ_γ^λ [3] at resonance energy $W = m_R$

$$\Gamma_\gamma^\lambda = \frac{k^2}{\pi} \frac{m_N}{m_R} \frac{1}{2j+1} |A_\lambda^{j^P}(m_R)|^2 \quad (9)$$

Baryons
N's and Δ's

where m_N is the nucleon mass. Introducing this expression into eq. (8) we find

$$C_\lambda^{\ell\pm}(m_R) = \left\{ \frac{1}{(2j+1)\pi} \frac{k}{q} \frac{m_N}{m_R} \frac{\Gamma_\pi}{\Gamma^2} \right\}^{1/2} A_\lambda^{j^P}(m_R). \tag{10}$$

We quote results of partial-wave analyses in terms of the amplitudes $A_\lambda^{j^P}$ in units of $\mathrm{GeV}^{-1/2}$.

The total radiative width Γ_γ and the contribution $\sigma_T^{j^P}$ of the partial waves $C_\lambda^{\ell\pm}$ to the total cross section are given by

$$\Gamma_\gamma = \sum_{\lambda=-3/2}^{3/2} \Gamma_\gamma^\lambda = \frac{k^2}{\pi} \frac{m_N}{m_R} \frac{2}{2j+1} \left\{ |A_{1/2}^{j^P}|^2 + |A_{3/2}^{j^P}|^2 \right\} \tag{11}$$

$$\sigma_T^{j^P} = (C_{\pi N}^I)^2 \, 2\frac{m_N}{m_R} \frac{\Gamma_\pi}{\Gamma^2} \left\{ |A_{1/2}^{j^P}|^2 + |A_{3/2}^{j^P}|^2 \right\} \tag{12}$$

Information in this Edition

The Baryon Table contains the branching fractions Γ_γ/Γ for 13 resonances.

Many partial-wave analyses have been performed over the last years using different methods and different data sets. R. Crawford[4] has averaged the results and tried to estimate the certainty of the parameters. His table is included in this mini-review.

The Data Card Listings contain the results of the analyses by Moorhouse and Oberlack[5] and Metcalf and Walker[6] which use the most recent data set

Photon couplings of baryon resonances as compiled by R. Crawford.[4]

State	W (GeV)	Γ (GeV)	x	λ	A_λ^p $(\mathrm{GeV})^{-\frac12}$	A_λ^n $(\mathrm{GeV})^{-\frac12}$	A_λ^{V1} $(\mathrm{GeV})^{-\frac12}$	A_λ^S $(\mathrm{GeV})^{-\frac12}$	References
P'_{11}	1.470	0.200	0.55	1/2	−.04[c]	~0	+.02	−.02	1, 5, 9, 10, 11, 12, 13
D'_{13}	1.520	0.120	0.50	1/2 3/2	−.03[b] +.17[a]	−.08[b] −.13[a]	−.03 −.15	−.06 +.02	1, 5, 9, 10, 11, 12, 13
S'_{11}	1.530	0.080	0.35	1/2	+.07[b]	−.07[b]	−.07	0	1, 5, 9, 10, 11, 12, 13
D'_{15}	1.670	0.145	0.45	1/2 3/2	+.01[d] +.02[c]	+.01[d] −.03[c]	0 −.03	+.01 −.01	1, 5, 10, 12
F'_{15}	1.690	0.125	0.60	1/2 3/2	−.01[c] +.12[b]	+.02[c] ~0	+.02 −.06	+.01 +.06	1, 5, 10, 12
S''_{11}	1.700	0.200	0.65	1/2	+.07[c]	−.07[c]	−.07	0	5
P''_{11}	1.750	0.300	0.25	1/2	+.03[d]	+.03[c]	0	+.03	5
					$A_\lambda^\Delta = A_\lambda^{V3}$ $(\mathrm{GeV})^{-\frac12}$				
P'_{33}	1.236	0.120	1.00	1/2 3/2	−.14[a] −.24[a]				1, 5, 7, 8, 10
S_{31}	1.650	0.160	0.25	1/2	+.09[c]				5
D_{33}	1.650	0.220	0.15	1/2 3/2	+.07[c] +.02[d]				5

[a] The uncertainty of the coupling is less than 20%.
[b] The uncertainty of the coupling is less than 50%.
[c] The sign of the coupling is probably established, but its size may be uncertain by up to 100%.
[d] The sign of the coupling is not clearly established.

Data Card Listings

For notation, see key at front of Listings.

Baryons

N's and Δ's, p, n, N(1470)

and cover a large energy region (up to the 4th resonance region).

Moorhouse and Oberlack quote their results in terms of the $A_\lambda^{j^P}$ introduced above. Metcalf and Walker follow the conventions of Walker.[1] Their amplitudes $A_{\ell\pm}$, $B_{\ell\pm}$ are related to the $A_\lambda^{j^P}$ by:

$$A_{\ell\pm}(m_R) = \mp\left\{\frac{1}{(2j+1)\pi}\,\frac{k}{q}\,\frac{m_N}{m_R}\,\frac{\Gamma_\pi}{\Gamma^2}\right\}^{1/2} C^I_{\pi N} A^{j^P}_{1/2}(m_R) \qquad (13)$$

$$B_{\ell\pm}(m_R) = \pm\left\{\frac{1}{(2j+1)\pi}\,\frac{k}{q}\,\frac{m_N}{m_R}\,\frac{\Gamma_\pi}{\Gamma^2}\right\}^{1/2} \times\left\{\frac{16}{(2j-1)(2j+3)}\right\}^{1/2} C^I_{\pi N} A^{j^P}_{3/2}(m_R) \qquad (14)$$

A more comprehensive collection of results and of the relationships between conventions used in different analyses will be included in the next edition.

(H. Oberlack, LBL)

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CODE EVENTS QUANTITY  ERROR+  ERROR-  REFERENCE YR TECN SIGN COMMENTS  DATE
      ABOVE                                                           PUNCHED
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STATUS OF N* RESONANCES
THOSE WITH AN OVERALL STATUS OF *** OR **** ARE INCLUDED IN THE MAIN BARYON TABLE. THE OTHERS AWAIT CONFIRMATION.

STATUS AS SEEN IN --

PARTICLE	LIJ	OVERALL STATUS	TOTAL* CR.S.	PI N	ETA N	K LAM	K SIG	PI DE	GAM N	OTHER CHANN.
N(940)	P11	****								
N*(1470)	P11	****		****				***	**	EPS N
N*(1520)	D13	****	****	****	*			***	***	RHO N
N*(1535)	S11	****		****	***				***	RHO N
N*(1670)	D15	****	***	****	*	*		***	*	
N*(1688)	F15	****	***	****	*	*		***	**	RHO N
N*(1700)	S11	****		****	*	***			**	EPS N
N*(1700)	D13	**		*		*		*		EPS N
N*(1780)	P11	***		***	*	**		***	*	EPS N
N*(1860)	P13	***		***	*	**			*	RHO N
N*(1990)	F17	**		**	*	*			*	
N*(2040)	D13	**		**	*	*			*	
N*(2100)	S11	*		*						
N*(2100)	D15	*		*						
N*(2175)	F15	*		*		*			*	
N*(2190)	G17	***	***	***		*			*	
N*(2220)	H19	***	***	***						
N*(2650)		***	***	*						
N*(3030)		***	***	*						
N*(3245)		*	*							
N*(3690)		*	*							
N*(3755)		*	*							
DE(1236)	P33	****	****	****	F				****	
DE(1650)	S31	****	**	****	O			**	**	RHO N
DE(1670)	D33	***	***	***	R			**	*	
DE(1690)	P33	*		*	B			**		
DE(1890)	F35	***	*	***	I				*	RHO N
DE(1910)	P31	***	*	***		D		*	*	RHO N
DE(1950)	F37	****	***	****		O	*	**	*	RHO N
DE(1960)	D35	*	*	*		E	*	*		
DE(2160)	P33	*		*		N				
DE(2420)	H311	***	***	***	F					
DE(2850)		***	***	**	O					
DE(3230)		***	***	*	R					

```
****  GOOD, CLEAR, AND UNMISTAKABLE.
 ***  GOOD, BUT IN NEED OF CLARIFICATION OR NOT ABSOLUTELY CERTAIN.
  **  NEEDS CONFIRMATION.
   *  WEAK.
   *  ATTRIBUTED TO THE STATE CLOSEST TO WHERE THE CROSS SECTION PEAKS.

****** ********* ********* ********* ********* ********* ********* ********
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p

16 PROTON (938, J=1/2) I=1/2

SEE STABLE PARTICLE DATA CARD LISTINGS

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****** ********* ********* ********* ********* ********* ********* ********
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n

17 NEUTRON (939, J=1/2) I=1/2

SEE STABLE PARTICLE DATA CARD LISTINGS

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****** ********* ********* ********* ********* ********* ********* ********
****** ********* ********* ********* ********* ********* ********* ********
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N(1470) 61 N*1/2(1470, JP=1/2+) I=1/2 **P'_{11}**

FOR DISCUSSION CONCERNING RESONANT PARAMETERS, SEE NOTE ABOVE

THE MASS AND WIDTH ARE BEST DETERMINED FROM PHASE-SHIFT ANALYSES. WE LIST PRODUCTION EXPERIMENTS SEPARATELY--SEE BELOW.
A PRELIMINARY ENERGY DEPENDENT ANALYSIS BY AYED 72 CLAIMS THERE ARE TWO P11 STATES IN THE 1500 MEV REGION. THE MOST SERIOUS DISAGREEMENT BETWEEN ALMEHED 72 AND AYED 72 IN FACT OCCURS IN THIS WAVE.
SEE THE N* MINI REVIEW.

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Baryons
N(1470)

Data Card Listings
For notation, see key at front of Listings.

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                    61  N*1/2(1470) MASS (MEV) .

M          (1370.0)                  BRANDSEN  65 RVUE    PHASE-SHIFT ANAL  9/66
M          (1380.0)                  ROPER     65 RVUE    PHASE-SHIFT ANAL  9/66
M    1     (1470.0)                  BAREYRE   68 RVUE    PHASE-SHIFT ANAL 11/67
M    1        WHERE CROSS SECTION IS GREATEST - EYEBALL FIT
M    3     (1466.0)                  DONNACHI  68 RVUE    PHASE-SHIFT ANAL  6/68
M    6     (1461.0)                  AYED      70 IPWA                      1/71
M    6    FROM ENER. DEP. FIT OF ARGAND DIAGRAM
M    4     (1462.0)                  DAVIES    70 RVUE    P-S ANAL   SOL A  8/69
M    7     (1470.)                   ALMEHED   72 IPWA                      2/72
------ --------- --------- --------- --------- --------- --------- --------

                    61  N*1/2(1470) WIDTH (MEV)

W    1      (255.0)                  BAREYRE   68 RVUE                     11/67
W    3      (211.0)                  DONNACHI  68 RVUE                      6/68
W    6      (164.0)                  AYED      70 IPWA                      1/71
W    4      (391.)                   DAVIES    70 RVUE    P-S ANAL   SOL A  8/69
W    7      (220.)                   ALMEHED   72 IPWA                      2/72
       SEE THE NOTES ACCOMPANYING THE MASSES QUOTED.
------ --------- --------- --------- --------- --------- --------- --------

                    61  N*1/2(1470) PARTIAL DECAY MODES

                                                           DECAY MASSES
P1        N*1/2(1470) INTO PI N                           139+ 938
P2        N*1/2(1470) INTO N EPSILON                      938+ 600
P3        N*1/2(1470) INTO N*3/2(1236) PI                1236+ 139
P4        N*1/2(1470) INTO N PI PI                        938+ 139+ 139
P5        N*1/2(1470) INTO GAMMA N                         0+ 938
P6        N*1/2(1470) INTO N RHO                          938+ 770
P7        N*1/2(1470) INTO GAM P, HELICITY=1/2             0+ 938
P8        N*1/2(1470) INTO GAM N, HELICITY=1/2             0+ 939
------ --------- --------- --------- --------- --------- --------- --------

                    61  N*1/2(1470) BRANCHING RATIOS

R1        N*1/2(1470) INTO (PI N)/TOTAL                      (P1)
R1   1          (0.68)               BAREYRE   68 RVUE                     11/67
R1   3          (0.658)              DONNACHI  68 RVUE                      6/68
R1   6          (0.564)              AYED      70 IPWA                      1/71
R1   4          (0.49)               DAVIES    70 RVUE    P-S ANAL   SOL A  8/69
R1   A          (0.67)    (0.18)     SAXON     70 HBC     AT 1400 MEV       6/70
R1   B          (0.58)    (0.09)     SAXON     70 HBC                       6/70
R1   A AND B CORRESPOND TO THE 2 BEST SOLUTIONS. ANALYSIS IS DONE ON THREE
R1   B BODY DECAYS, ASSUMING ONLY P1, P2 AND P3 DECAYS PRESENT.
R1   7          (0.65)               ALMEHED   72 IPWA                      2/72
       SEE THE NOTES ACCOMPANYING THE MASSES QUOTED.

R2        N*1/2(1470) INTO (N EPSILON)/TOTAL                 (P2)
R2             DOMINANT INELASTIC DECAY   THURNAUER 65 RVUE -              11/67
R2             DOMINANT INELASTIC DECAY   NAMYSLOWS 66 RVUE -              11/67
R2             DOMINANT INELASTIC DECAY   ROSENFELD 67 RVUE -              11/67
R2             DOMINANT INELASTIC DECAY   MORGAN    68 RVUE    ISOBAR MODEL  6/68
R2   D          (0.16)               DIEM      70 IPWA    3 BODY ANALYSIS   1/71
R2   D         ASSUMING  R1= 0.61
R2   A          (0.30)    (0.20)     SAXON     70 HBC                       6/70
R2   B          (0.20)    (0.12)     SAXON     70 HBC                       6/70
R2   A AND B CORRESPOND TO THE 2 BEST SOLUTIONS, SEE NOTE IN R1.

R3        N*1/2(1470) INTO (N*3/2(1236) PI)/TOTAL            (P3)
R3   D          (0.17)               DIEM      70 IPWA    3 BODY ANALYSIS   1/71
R3   D         ASSUMING  R1= 0.61
R3   A          (0.03)    (0.20)     SAXON     70 HBC                       6/70
R3   B          (0.22)    (0.12)     SAXON     70 HBC                       6/70
R3   A AND B CORRESPOND TO THE 2 BEST SOLUTIONS, SEE NOTE IN R1.
R3   R          (0.20)               MAKAROV   71 IPWA  0 PI- P TO PI PI N  3/72
R3   R    ASSUMES R1=0.6. MAXIMUM CM ENERGY ANALYZED WAS 1435 MEV.

R4        N*1/2(1470) INTO (GAMMA N)/(PI N)                  (P5)/(P1)
R4    F         STRONG INDICATICN    ROSSI     73 DBC   0 GAM N TO PI-P    2/73*
R4    F   DISAGREES WITH OTHER DATA                                        2/73*

R5        N*1/2(1470) INTO (N RHO )/TOTAL                    (P6)
R5   D          (0.07)               DIEM      70 IPWA    3 BODY ANALYSIS   1/71
R5   D         ASSUMING R1= 0.61

R6        N*1/2(1470) INTO (GAMMA N)/TOTAL                   (P5)
R6   E          (.0006)              MICKENS   71          THEORETICAL EST. 10/71
R6   E    TOTAL WIDTH TAKEN AS 250 MEV.
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                    61  N*1/2(1470) PHOTON DECAY AMPL(GEV**-1/2)

        FOR DEFINITION OF GAMMA-NUCLEON DECAY AMPLITUDES, SEE MINI-
       REVIEW PRECEDING THE BARYON LISTINGS.

A1        N*1/2(1470) INTO GAM P, HELICITY=1/2 (GEV**-1/2)
A1            -.055      .028        OBERLACK  72 DPWA    PI N PHOTO-PROD  2/73*
A1           (-.073)                 WALKER    73 DPWA    PI N PHOTO-PROD  2/73*

A2        N*1/2(1470) INTO GAM N, HELICITY=1/2 (GEV**-1/2)
A2            +.002      .025        OBERLACK  72 DPWA    PI N PHOTO-PROD  2/73*
A2           (+.058)                 WALKER    73 DPWA    PI N PHOTO-PROD  2/73*

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                        REFERENCES FOR N*1/2(1470)
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BRANDSEN 65 PR 139 B1566         +ODONNELL, MOORHOUSE          (DURHAM, RHEL)IJP
ROPER    65 PR 138 B190          LD ROPER,RM WRIGHT,BT FELD    (LRL-LVMR,MIT)IJP
THURNAUE 65 PRL 14 985           P G THURNAUER                          (ROCH)

NAMYSLOW 66 PR 157 1328          NAMYSLOWSKI,RAZMI,ROBERTS     (STAN,EDIN,LOIC)

ROSENFEL 67 IRVINE CONF          A H ROSENFELD, P SODING                 (LRL)

BAREYRE  68 PR 165 1731          P BAREYRE, C BRICMAN, G VILLET    (SACLAY)IJP
DONNACHI 68 PL 26B 161           A DONNACHIE, R G KIRSOPP, C LOVELACE (CERN)IJP
   ALSO  68 VIENNA 139           DONNACHIE  RAPPORTEUR.S TALK           (GLAS)
   ALSO  68 THESIS               R G KIRSOPP                            (EDIN)
MORGAN   68 PR 166 1731          D MORGAN                               (RHEL)

AYED     70 KIEV CONF            R AYED,P BAREYRE, G VILLET         (SACL)IJP
DAVIES   70 NP B21 359           A DAVIES                               (GLAS)
DIEM     70 KIEV CONF.           + SMADJA, CHAVANON, DELER, DOLBEAU+   (SACL)
SAXON    70 PR D2 1790           SAXON, MULVEY, CHINOWSKY           (OXF,LRL)

MAKAROV  71 SJNP 13 510          ,GASILOVA,NELYUBIN,++         (IOFFE INST)IJP
MICKENS  71 LNC  1  707          R E MICKENS                            (FISK)

ALMEHED  72 NP B40 157           +LOVELACE                     (LUND,RUTG)IJP
OBERLACK 72 PL 43B 44            H.OBERLACK,R.G.MOORHOUSE                (LBL)
ROSSI    73 NC 13A 59            +PIAZZA,SUSINNO,+     (ROMA,FRAS,NAPL,PAVIA)IJP
    ALSO 71 LNC 2 1183           CARBONARA,FIORE,+     (NAPL,FRAS,PAVIA,ROMA)IJP
WALKER   73 TO BE PUB.           R.L.WALKER,W.J.METCALF                  (CIT)

                                 PAPERS NOT REFERRED TO IN DATA CARDS.

BAREYRE  64 PL 8 137             +BRICMAN,VALLADAS,VILLET, +   (SACLAY,CAEN) IJ
BAREYRE  65 PL 18 342            +BRICMAN, STIRLING, VILLET        (SACLAY)IJP
DALITZ   65 PL 14 159            R H DALITZ, R G MOORHOUSE          (OXF,RHEL)
JOHNSON  67 UCRL-17683 THESIS C H JOHNSON                                (LRL)
DONNACHI 69 NP 108 433           A DONNACHIE, R KIRSOPP            (GLAS+EDIN)
AYED     70 PL 31B 598           +BAREYRE,VILLET                      (SACLAY)
BERARDO  70 PRL 24 419           +HADDOCK,NEFKENS,..,PARSONS+..     (UCLA+LRL)
AYED     72 BATAVIA CONF         R AYED,P BAREYRE, Y LEMOIGNE           (SACL)

     THE FOLLOWING ARE THEORETICAL PAPERS CONCERNING THE N*1/2(1470) --
RESNICK  66 PR 150 1292          L RESNICK                        (NIELS BOHR)
SCHWARZ  66 PR 152 1325          J H SCHWARZ                             (LRL)
BALL     67 PR 155 1725          JS BALL, GL SHAW, DY WONG     (UCLA,UCI,UCSD)
GOLDBERG 67 PR 154 1558          H GOLDBERG                          (CORNELL)
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N(1470) BUMPS

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          91  N*1/2(1470, JP=     ) I=1/2   PRODUCTION EXPERIMENTS

          IT IS NOT CLEAR THAT THE BUMP SEEN IN PRODUCTION EXPER-
          IMENTS AT LOW INVARIANT MASS CORRESPONDS TO THE P11
          RESONANT STATE.  DIFFRACTION SCATTERING SEEMS TO BE THE
          DOMINANT FEATURE IN THIS MASS REGION- SEE GELLERT 66,
          WALKER 68 AND CLEGG 68 FOR DISCUSSION OF THIS POINT.
       WE LIST VALUES OF MASSES AND WIDTHS FROM THESE EXPERIMENTS FOR
       THE READER'S CONVENIENCE- THE LIST MAY NOT BE COMPLETE.
       THE CNTR AND SPRK EXPERIMENTS SEE A BUMP IN THE MISSING MASS
       PLOT. THE HBC EXPERIMENTS SEE ENHANCEMENTS MAINLY IN THE
       P PI PI MASS PLOT. PRODUCTION OF THIS STATE IN GAMMA-P OR
       GAMMA-D IS VERY SMALL, SEE ALBERI 68.
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                  91  N*1/2(1470) MASS (MEV) (PROD.EXP.)

M           (1400.)   APPROX             COCCONI   64 CNTR +  PP 3.6-12 GEV/C
M           (1425.)   APPROX             ADELMAN   65 HBC  +  K-P 1.45 GEV/C     7/66
M           (1430.)   APPROX             ANKENBRAN 65 CNTR +  PP 7.1 GEV/C       7/66
M           (1400.)   APPROX             BELLETTIN 65 SPRK +  PP,D 10-26 GEV/C   7/66
M           (1405.)    (15.)             ANDERSON  66 SPRK +  PP, 6-30 GEV/C     7/66
M           (1410.)    (15.)             BLAIR     66 CNTR +  PP 2.8-7.9 GEV/C   7/66
M           (1400.)    (30.)             FOLEY     67 CNTR    PI+- P AND PP     11/67
M           (1450.)    (17.)             ALMEIDA   68 HBC  +  PP-P2PI ,10GEV/C  10/69
M           (1420.)   APPROX             BELL      68 HBC     PI+- P, 6 GEV/C    6/68
M           (1400.)   APPROX             LAMSA     68 HBC     PI-P , 8 GEV/C     6/68
M    S   175(1446.)    (11.)             SHAPIRA   68 DBC     INTO PPI,PN 7.0   10/69
M    S      (1390.)    (20.)             TAN       68 HBC     PP TO PIP, 6.1    10/69
M        120(1443.)    (15.)             RHODE     69 HBC     PP 22 GEV/C       10/69
M           (1410.)    (13.)             ANDERSON  70 MMS  -  PI- P TO PI- MMS   2/71
M           (1430.)    (20.)             BALLAM    71 HBC  +- PI+-P AT 16GEV     2/72
M           (1460.)                      BEKETOV   71 HBC  +  PI- P 4.45GEV/C    3/72
M           (1461.)    (10.)             BOESEBEC  71 RVUE    PP,PI-P,K-P PROD   3/72
M        120(1462.0)    (6.0)    120/80  MA        71 HBC  +  P P TO P N PI     10/71
M            1460. TO 1510.              MORSE     71 HBC  +0 PI-P,  7 GEV/C     3/72
M           (1510.0)   (20.0)            MORSE     71 HBC  +  PI-P, 25 GEV/C     3/72
M           (1425.)    (25.)             RUSHBROOKE71 HBC  +  PP TO P2PI 16GEV   2/72
M           (1411.0)   (10.0)            EDELSTEIN 72 MMS  +  PP 6 TO 30 GEV     1/73*
M         64(1410.0)   (33.0)            GAGE      72       0 PD  5.9GEV/C      12/72*
M           (1464.0)    (7.0)     45/45  KARSHON   72 DBC  +  PD--PD2PI 7 GEV   12/72*
M           (1440.)    (15.)             RONAT     72  HBC    PI+P TO 3PI P      2/73*
M    S   TAN 68, SHAPIRA 68, AND GAGE 72 ARE ONLY PRODUCTION EXPERIMENTS TO
M    S   SEE PPI DECAY.  HOWEVER THE EFFECT OF SHAPIRA 68, WITH MUCH IMPROVE
M    S   DATA, HAS ALMST DISAPPEARED (YEKUTIEL1 72).
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                  91  N*1/2(1470) WIDTH (MEV) (PROD. EXP.)

W            (100.)                      BELL      68 HBC     PI+- P AND PP      6/68
W    S   175 (198.)    (40.)             SHAPIRA   68 DBC                       10/69
W    S       (150.)    (60.)             TAN       68 HBC  +                    10/69
W        120 (100.)    (15.)             RHODE     69 HBC     PP 22 GEV/C       10/69
W            (210.)    (15.)             ANDERSON  70 MMS  -  PI- P TO PI- MMS   2/71
W            (150.)    (40.)             BALLAM    71 HBC  +- PI+-P AT 16GEV     2/72
W            (100.)                      BEKETOV   71 HBC  +  P PI+ PI- MASS     3/72
W             (60.)    (20.)             BOESEBEC  71 RVUE    PP,PI-P,K-P PROD   3/72
W    T   120  (54.0)   (12.0)    120/80  MA        71 HBC  +  P P TO P N PI     10/71
W    T    NARROW WIDTH SUGGESTS THIS IS NOT THE USUAL N*(1470).                 10/71
W              80. TO  120.              MORSE     71 HBC  +  PI-P,  7 GEV/C     3/72
W            (100.0)   (30.0)            MORSE     71 HBC  +  PI-P, 25 GEV/C     3/72
W            (125.)    (25.)             RUSHBROOKE71 HBC  +  PP TO P2PI 16GEV   2/72
W            (188.0)   (38.0)            EDELSTEIN 72 MMS  +  PP 6 TO 30 GEV     1/73*
W            (212.0)   (62.0)            GAGE      72 DBC   0 PD  5.9GEV/C      12/72*
W            (124.0)   (20.0)            KARSHON   72 DBC  +  PD--PD2PI 7 GEV   12/72*
W            (100.)    (30.)             RONAT     72  HBC    PI+P TO 3PI P      2/73*
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                  91  N*1/2(1470) PARTIAL DECAY MODES (PROD. EXP.)

                                                           DECAY MASSES
P1        N*1/2(1470) INTO PI N                           139+ 938
P2        N*1/2(1470) INTO N PIPI(J,I=0)                  938+ 139+ 139
P3        N*1/2(1470) INTO N*3/2(1236) PI                1236+ 139
P4        N*1/2(1470) INTO N PI PI                        938+ 139+ 139
P5        N*1/2(1470) INTO GAMMA N                         0+ 938
P6        N*1/2(1470) INTO N RHO                          938+ 770
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Data Card Listings
For notation, see key at front of Listings.

Baryons
N(1470), N(1520)

91 N*1/2(1470) BRANCHING RATIOS (PROD. EXP.)

R1 N*1/2(1470) INTO (PI N)/TOTAL (P1)
R1 (.66) TAN 68 HBC PP TO PIP, 6.1 10/69

R2 N*1/2(1470) INTO (N*3/2(1236) PI)/TOTAL (P3)
R2 PROBABLY SEEN JESPERSEN 68 HBC PP 22 BEV/C 11/68
R2 PROBABLY SEEN LAMSA 68 HBC PI-P 8 BEV/C 11/68

R3 N*1/2(1470) INTO (N PIPI(J,I=0))/TOTAL (P2)
R3 MAIN DECAY MODE MORSE 71 HBC + PI-P 7,25 GEV/C 3/72

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REFERENCES FOR N*1/2(1470) (PROD. EXP.)

COCCONI 64 PL 8 134 +LILLETHUN,SCANLON,STAHLBRANDT, + (CERN)
ADELMAN 65 PRL 14 1043 S L ADELMAN (CAMBRIDGE(CERN))
ANKENBRA 65 NC 35 1052 ANKENBRANDT,CLYDE,CORK,KEEFE,KERTH+ (LRL)
BELLETTI 65 PL 18 167 BELLETTINI,COCCONI,DIDDENS + (CERN)
ANDERSON 66 PRL 16 855 +BLESER,COLLINS,FUJII,+ (BNL,CARN)
BLAIR 66 PRL 17 789 +TAYLOR,CHAPMAN,+ (HARWELL,QUEENMARY,RHEL)

FOLEY 67 PRL 19 397 +JONES,LINDENBAUM,LOVE,OZAKI+ (BNL)
ALMEIDA 68 PR 174 1638 +RUSHBROOKE,SCHARENGUIVEL+ (CAVE,DESY)
BELL 68 PRL 20 164 +CRENNELL,HOUGH,KARSHON,LAI+ (BNL,CUNY)
JESPERSE 68 PRL 21 1368 JESPERSEN,KANG,KERNAN+ (IOWA STATE)
LAMSA 68 PR 166 1395 +CASON,BISWAS,DERADO,GROVES,+ (NOTRE DAME)
SHAPIRA 68 PRL 21 1835 +BENARY,EISENBERG,RONAT,YAFFE+ (REHO)
TAN 68 PL 28B 195 TAN,PERL,MARTIN,VHINOWSKU + (SLAC+LRL+UCI)
RHODE 69 PR 187 1844 RHODE, LEACOCK, KERNAN, JESPERSEN,+ (ISU)
ANDERSON 70 PRL 25 699 +BLESER, BLIEDEN, COLLINS++ (BNL,CARN)

BALLAM 71 PR D4 1946 +CHADWICK,GUIRAGOSSIAN,JOHNSON,++ (SLAC) I
BEKETOV 71 SJNP 13 605 ,ZOMBKOVSKII,KONOVALOV,KRUCHININ,++ (ITEP)IJ
BOESEBEC 71 NP B33 445 BOESEBECK,GRAESSLER,KRAUS,+++ (ABBCHLV) I
MA 71 PRL 26 333 +COLTON (MSU+LBL)I
MORSE 71 PR D4 133 +OH,WALKER,CARROLL,LYNCH + (WISC+TNTO)IJ
RUSHBROO 71 PR D4 3273 RUSHBROOKE,WILLIAMS+BAREFORD++ (CAVE,LOIC) IJ

EDELSTEI 72 PR D5 1073 EDELSTEIN,CARRIGAN,HIEN,MCMAHON,+(CARN+BNL)
GAGE 72 NP B46 21 W GAGE,E COLTON,W CHINOWSKI (LBL)
KARSHON 72 NP B37 371 +YEKUTIELI,YAFFE,SHAPIRA,RONAT,+ (REHO) I
RONAT 72 NP B38 20 40. +EISENBERG,LYONS,SHAPIRA,TOAFF+ (REHO)
YEKUTIEL 72 NP B40 77 YEKUTIELI,YAFFE,SHAPIRA,RONAT + (REHO)

PAPERS NOT REFERRED TO IN DATA CARDS

GELLERT 66 PRL 17 884 +SMITH,WOJCICKI,COLTON,SCHLEIN + (LRL,UCLA)
ALBERI 68 PR 176 1631 +APPEL,BUDNITZ,CHEN,DUNNING,GOITEIN+ (HARV)
CLEGG 68 PREPRINT A B CLEGG (LANC)
WALKER 68 PRL 20 133 +THOMPSON,ROBERTSON,OH,LEE,HARTUNG,+ (WISC)

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N(1520) 62 N*1/2(1520, JP=3/2-) I=1/2 **D'_{13}**

FOR DISCUSSION CONCERNING RESONANT PARAMETERS,SEE NOTE PRECEDING N*1/2(1470).

62 N*1/2(1520) MASS (MEV)

M (1530.0) BRANDSEN 65 RVUE PHASE-SHIFT ANAL 9/66
M (1536.0) ROPER 65 RVUE PHASE-SHIFT ANAL 9/66
M 1 (1510.0) BAREYRE 68 RVUE PHASE-SHIFT ANAL 11/67
M 1 WHERE CROSS SECTION IS GREATEST - EYEBALL FIT
M 3 (1541.0) DONNACHI 68 RVUE PHASE-SHIFT ANAL 6/68
M 6 (1523.0) AYED 70 IPWA 1/71
M 6 FROM ENER. DEP. FIT OF ARGAND DIAGRAM
M 4 (1512.0) DAVIES 70 RVUE P-S ANAL SOL A 8/69
M 7 (1520.) ALMEHED 72 IPWA 2/72

62 N*1/2(1520) WIDTH (MEV)

W 1 (125.0) BAREYRE 68 RVUE 11/67
W 3 (149.0) DONNACHI 68 RVUE 6/68
W 6 (131.0) AYED 70 IPWA 1/71
W 4 (106.0) DAVIES 70 RVUE P-S ANAL SOL A
W 7 (120.) ALMEHED 72 IPWA 2/72
SEE THE NOTES ACCOMPANYING THE MASSES QUOTED.

62 N*1/2(1520) PARTIAL DECAY MODES

DECAY MASSES
P1 N*1/2(1520) INTO PI N 139+ 938
P2 N*1/2(1520) INTO N*3/2(1236) PI 1236+ 139
P3 N*1/2(1520) INTO N PI PI 938+ 139+ 139
P4 N*1/2(1520)+ INTO NEUTRON PI+ 939+ 139
P5 N*1/2(1520)+ INTO PROTON PI+ PI- 938+ 139+ 139
P6 N*1/2(1520) INTO N ETA 939+ 548
P7 N*1/2(1520) INTO N EPSILON 938+ 600
P8 N*1/2(1520) INTO N RHO 938+ 770
P9 N*1/2(1520) INTO GAM P, HELICITY=1/2 0+ 938
P10 N*1/2(1520) INTO GAM P, HELICITY=3/2 0+ 938
P11 N*1/2(1520) INTO GAM N, HELICITY=1/2 0+ 939
P12 N*1/2(1520) INTO GAM N, HELICITY=3/2 0+ 939

62 N*1/2(1520) BRANCHING RATIOS

R1 N*1/2(1520) INTO (PI N)/TOTAL (P1)
R1 1 (0.54) BAREYRE 68 RVUE 11/67
R1 3 (0.509) DONNACHI 68 RVUE 6/68
R1 6 (0.593) AYED 70 IPWA 1/71
R1 4 (0.45) DAVIES 70 RVUE P-S ANAL SOL A 8/69
R1 7 (0.58) ALMEHED 72 IPWA 2/72
R1 SEE THE NOTES ACCOMPANYING THE MASSES QUOTED.
R1
R1 ALMOST THE ENTIRE INELASTICITY IS IN N PI PI (ONLY N ETA COULD COMPETE,
R1 AND IT DOESNT). THE N PI PI SEEMS TO BE MAINLY N*3/2(1236) PI, IN BOTH
R1 S AND D WAVES.

R2 N*1/2(1520) INTO (N*3/2(1236) PI)/TOTAL (P4)
R2 0.20 0.05 KIRZ 66 HBC 0 ASSUMING R1=0.72 9/66
R2 DOMINANT INEL DECAY OLSSON 66 RVUE PI P TO PI PI N 9/66
R2 D (0.40) DIEM 70 IPWA 3 BODY ANALYSIS 1/71
R2 D ASSUMING R1= 0.5

R3 N*1/2(1520) INTO (N*3/2(1236) PI)/(N PI PI) (P2)/(P3)
R3 LARGE THURNAUER 65 RVUE - 11/67
R3 LARGE NAMYSLOWS 66 RVUE - 11/67
R3 LARGE ROBERTS 67 RVUE - 11/67
R3 LARGE ROSENFELD 67 RVUE - 11/67
R3 LARGE MORGAN 68 RVUE ISOBAR MODEL 6/68

R4 N*1/2(1520) INTO (N EPSILON)/TOTAL (P7)
R4 PROBABLY PRESENT MORGAN 68 RVUE ISOBAR MODEL 6/68
R4 D (0.02) DIEM 70 IPWA 3 BODY ANALYSIS 1/71
R4 D ASSUMING R1= 0.5

R5 N*1/2(1520) INTO (N ETA)/TOTAL (P6)
R5 D (0.006) APPROX DAVIES 67 RVUE 11/67
R5 DAVIES 67 GIVES SEVERAL VALUES DEPENDING ON INPUT DATA. ALL ARE SMALL
R5 B (0.014) BOTKE 69 MPWA T POLE+ RESON. 10/69
R5 B (0.003) (0.001) DEANS 69 MPWA T POLE+ RESON. 5/70
R5 B (0.002)OR 0.004 CARRERAS 70 MPWA T POLE+ RESON. 5/70
R5 B PARAMETRIZATION USED COULD BE IN DANGER OF DOUBLE COUNTING

R6 N*1/2(1520) INTO (N RHO)/TOTAL (P8)
R6 D (0.07) DIEM 70 IPWA 3 BODY ANALYSIS 1/71
R6 D ASSUMING R1= 0.5

62 N*1/2(1520) PHOTON DECAY AMPL(GEV**-1/2)

FOR DEFINITION OF GAMMA-NUCLEON DECAY AMPLITUDES, SEE MINI-REVIEW PRECEDING THE BARYON LISTINGS.

A1 N*1/2(1520) INTO GAM P, HELICITY=1/2 (GEV**-1/2)
A1 -.026 .015 OBERLACK 72 DPWA PI N PHOTO-PROD 2/73*
A1 (-.007) WALKER 73 DPWA PI N PHOTO-PROD 2/73*

A2 N*1/2(1520) INTO GAM P, HELICITY=3/2 (GEV**-1/2)
A2 +.194 .031 OBERLACK 72 DPWA PI N PHOTO-PROD 2/73*
A2 (+.176) WALKER 73 DPWA PI N PHOTO-PROD 2/73*

A3 N*1/2(1520) INTO GAM N, HELICITY=1/2 (GEV**-1/2)
A3 -.085 .014 OBERLACK 72 DPWA PI N PHOTO-PROD 2/73*
A3 (-.043) WALKER 73 DPWA PI N PHOTO-PROD 2/73*

A4 N*1/2(1520) INTO GAM N, HELICITY=3/2 (GEV**-1/2)
A4 -.124 .013 OBERLACK 72 DPWA PI N PHOTO-PROD 2/73*
A4 (-.116) WALKER 73 DPWA PI N PHOTO-PROD 2/73*

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REFERENCES FOR N*1/2(1520)

SEE A PREVIOUS EDITION (RMP 37, 633, 1965) FOR EARLIER REFERENCES.

BRANDSEN 65 PR 139 B1566 +DONNELL, MOORHOUSE (DURHAM, RHEL)IJP
ROPER 65 PR 138 B190 LD ROPER,RM WRIGHT,BT FELD (LRL-LVMR,MIT)IJP
THURNAUE 65 PRL 14 985 P G THURNAUER (ROCH)

KIRZ 66 PRIVATE COMM J KIRZ (LRL)
NUMBER EXTRACTED FROM DATA DISCUSSED IN KIRZ 63. Z 63.
NAMYSLOW 66 PR 157 1328 NAMYSLOWSKI,RAZMI,ROBERTS (STAN,EDIN,LOIC)
OLSSON 66 PR 145 1309 M G OLSSON, G B YODH (WISC,UMD)

DAVIES 67 NC 52A 1112 A T DAVIES, R G MOORHOUSE (GLASGOW, RHEL)
ROBERTS 67 PREPRINT R G ROBERTS (DURHAM)
ROSENFEL 67 IRVINE CONF A H ROSENFELD, P SODING (LRL)

BAREYRE 68 PR 165 1731 P BAREYRE, C BRICMAN, G VILLET (SACLAY)IJP
DONNACHI 68 PL 26B 161 A DONNACHIE, R G KIRSOPP, C LOVELACE (CERN)IJP
ALSO 68 VIENNA 139 DONNACHIE RAPPORTEUR.S TALK (GLAS)
ALSO 68 THESIS R G KIRSOPP (EDIN)
MORGAN 68 PR 166 1731 D MORGAN (RHEL)

BOTKE 69 PR 180 1417 J C BOTKE (UCSB)
DEANS 69 PR 185 1797 S DEANS, J WOOTEN (UNIV S FLORIDA)

AYED 70 KIEV CONF R AYED,P BAREYRE, G VILLET (SACL)IJP
CARRERAS 70 NP B16 35 B CARRERAS, A DONNACHIE (DARE,MCHS)
DAVIES 70 NP B21 359 A DAVIES (GLAS)
DIEM 70 KIEV CONF. + SMADJA, CHAVANON, DELER, DOLBEAU+ (SACL)

ALMEHED 72 NP B40 157 +LOVELACE (LUND,RUTG)IJP
OBERLACK 72 PL 43B 44 H.OBERLACK,R.G.MOORHOUSE (LBL)
WALKER 73 TO BE PUB. R.L.WALKER,W.J.METCALF (CIT)

PAPERS NOT REFERRED TO IN DATA CARDS.

KIRZ 63 PR 130 2481 J KIRZ, J SCHWARTZ, R D TRIPP (LRL)
BAREYRE 65 PL 18 342 + BRICMAN, STIRLING, VILLET (SACLAY)IJP
CROUCH 65 DESY CONF II 21 + (BROWN,CEA,HARVARD,MIT,PADOVA,WEIZMANN)
DERADO 65 ATHENS CONF 244 +KENNEY,LAMSA, + (NOTRE DAME,KENTUCKY)
MERLO 66 P ROY SOC 289 489 J P MERLO, G VALLADAS (SACLAY)
THE ABOVE PAPERS DISCUSS INELASTIC CHANNELS NEAR THE REONANCE.
JOHNSON 67 UCRL-17683 THESIS C H JOHNSON (LRL)
DEANS 69 PRL 177 2623 S R DEANS (UNIV S FLORIDA)
DONNACHI 69 NP 10B 433 A DONNACHIE, R KIRSOPP (GLAS+EDIN)
AYED 70 PL 31B 598 +BAREYRE+VILLET (SACLAY)

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N(1535)

63 N*1/2(1535, JP=1/2-) I=1/2 S'_{11}

FOR DISCUSSION CONCERNING RESONANT PARAMETERS, SEE NOTE PRECEDING N*1/2(1470).

63 N*1/2(1535) MASS (MEV)

M		(1519.0)		HENDRY	65 RVUE	ETA N + S11 PI N	9/66
M		(1570.0)		MICHAEL	66 RVUE	FITS BAREYRE S11	7/66
M	N	(1557.0) OR 1565.0		UCHIYAMA-	66 RVUE	FITS N ETA DATA	9/66
M	N	FITTING GIVES TWO SOLUTIONS. PROBLEMS MATCHING PI P PHASE SHIFT					
M	1	(1535.0)		BAREYRE	68 RVUE	PHASE-SHIFT ANAL	11/67
M	1	WHERE CROSS SECTION IS GREATEST - EYEBALL FIT					
M	3	(1591.0)		DONNACHI	68 RVUE	PHASE-SHIFT ANAL	6/68
M		(1535.0)	(10.0)	DELCOURT	69 CNTR	PHOTOPRODUCT.	8/69
M	6	(1534.0)		AYED	70 IPWA		1/71
M	6	FROM ENER. DEP. FIT OF ARGAND DIAGRAM					
M	4	(1502.0)		DAVIES	70 RVUE	P-S ANAL SOL A	8/69
M	7	(1500.)		ALMEHED	72 IPWA		2/72

63 N*1/2(1535) WIDTH (MEV)

W		(130.0)		HENDRY	65 RVUE		9/66
W		(130.0)		MICHAEL	66 RVUE		7/66
W	N	(156.0) OR 144.0		UCHIYAMA-	66 RVUE	SEE NOTE ON MASS	9/66
W	1	(155.0)		BAREYRE	68 RVUE		11/67
W	3	(268.0)	APPROX	DONNACHI	68 RVUE		6/68
W		(120.0)		DELCOURT	69 CNTR	PHOTOPRODUCT.	8/69
W	6	(96.0)		AYED	70 IPWA		1/71
W	4	(36.0)		DAVIES	70 RVUE	P-S ANAL SOL A	8/69
W	7	(50.)		ALMEHED	72 IPWA		2/72

SEE THE NOTES ACCOMPANYING THE MASSES QUOTED.

63 N*1/2(1535) PARTIAL DECAY MODES

		DECAY MASSES
P1	N*1/2(1535) INTO PI N	139+ 938
P2	N*1/2(1535) INTO N ETA	939+ 548
P3	N*1/2(1535) INTO N PI PI	938+ 139+ 139
P4	N*1/2(1535) INTO N EPSILON	938+ 600
P5	N*1/2(1535) INTO N*3/2(1236) PI	1236+ 139
P6	N*1/2(1535) INTO N RHO	938+ 770
P7	N*1/2(1535) INTO N GAMMA	938+ 0
P8	N*1/2(1535) INTO GAM P, HELICITY=1/2	0+ 938
P9	N*1/2(1535) INTO GAM N, HELICITY=1/2	0+ 939

63 N*1/2(1535) BRANCHING RATIOS

R1		N*1/2(1535) INTO (PI N)/TOTAL				(P1)	
R1		(0.69)		HENDRY	65 RVUE		9/66
R1		(0.32)		MICHAEL	66 RVUE		9/66
R1	N	(0.71) OR 0.28		UCHIYAMA-	66 RVUE	SEE NOTE ON MASS	9/66
R1		(0.31) OR 0.43		DAVIES	67 RVUE	PIP TO N ETA,B,C	11/67
R1	3	(0.696)		DONNACHI	68 RVUE		6/68
R1		(0.33)		DELCOURT	69 CNTR		8/69
R1	6	(0.397)		AYED	70 IPWA		1/71
R1	4	(0.36)		DAVIES	70 RVUE	P-S ANAL SOL A	8/69
R1	7	(0.25)		ALMEHED	72 IPWA		2/72
R2		N*1/2(1535) INTO (N ETA)/TOTAL				(P2)	
R2		DOMINANT INEL DECAY		HENDRY	65 RVUE		9/66
R2		(0.68)		MICHAEL	66 RVUE		9/66
R2	N	(0.29) OR 0.71		UCHIYAMA-	66 RVUE	SEE NOTE ON MASS	9/66
R2		(0.69) OR 0.45		DAVIES	67 RVUE	PIP TO N ETA,B,C	11/67
R2	B	(0.4)	(0.1)	DEANS	69 MPWA	T POLE+ RESON.	5/70
R2		(0.66)		DELCOURT	69 MPWA		8/69
R2	B	(0.69) OR 0.696		CARRERAS	70 MPWA	T POLE+ RESON.	5/70
R2	B	PARAMETRIZATION USED COULD BE IN DANGER OF DOUBLE COUNTING					
R2		THE VALUES OF R2 LISTED ABOVE ARE INCOMPATIBLE WITH THE RESULTS					
R2		OF DIEM ET AL. (70)					
R3		N*1/2(1535) INTO (N*3/2(1236) PI)/TOTAL				(P5)	
R3	D	(0.07)		DIEM	70 IPWA	3 BODY ANALYSIS	1/71
R3	D	ASSUMING R1= 0.34					
R4		N*1/2(1535) INTO (N EPSILON)/TOTAL				(P4)	
R4	D	(0.26)		DIEM	70 IPWA	3 BODY ANALYSIS	1/71
R4	D	ASSUMING R1= 0.34					
R5		N*1/2(1535) INTO (N RHO)/TOTAL				(P6)	
R5	D	(0.20)		DIEM	70 IPWA	3 BODY ANALYSIS	1/71
R5	D	ASSUMING R1= 0.34					
R6		N*1/2(1535) INTO N GAMMA				(P7)	
R6		0.004	0.001	DEANS	72 MPWA	N ETA PHOTOPROD.	1/73*

63 N*1/2(1535) PHOTON DECAY AMPL(GEV**-1/2)

FOR DEFINITION OF GAMMA-NUCLEON DECAY AMPLITUDES, SEE MINI-REVIEW PRECEDING THE BARYON LISTINGS.

A1	N*1/2(1535) INTO GAM P, HELICITY=1/2 (GEV**-1/2)				
A1	+.053 .020	OBERLACK	72 DPWA	PI N PHOTO-PROD	2/73*
A1	(+.063)	WALKER	73 DPWA	PI N PHOTO-PROD	2/73*
A2	N*1/2(1535) INTO GAM N, HELICITY=1/2 (GEV**-1/2)				
A2	-.048 .021	OBERLACK	72 DPWA	PI N PHOTO-PROD	2/73*
A2	(-.050)	WALKER	73 DPWA	PI N PHOTO-PROD	2/73*

REFERENCES FOR N*1/2(1535)

HENDRY 65 PL 18 171 — A W HENDRY, R G MOORHOUSE (RHEL)
REVIEWS EARLY PHASE-SHEFT-ANALYSIS RESULTS AND PI- P TO ETA N EXPERIMENTS. WE TAKE NUMBERS FROM THE SOLUTION USING BRANDSEN 65.
MICHAEL 66 PL 21 93 — C MICHAEL (OXF)
UCHIYAMA 66 PR 149 1220 — F UCHIYAMA-CAMPBELL, R K LOGAN (ILL)IJP
DAVIES 67 NC 52A 1112 — A T DAVIES, R G MOORHOUSE (GLASGOW,RHEL)
BAREYRE 68 PR 165 1731 — P BAREYRE, C BRICMAN, G VILLET (SACLAY)IJP
DONNACHI 68 PL 26B 161 — A DONNACHIE, R G KIRSOPP, C LOVELACE (CERN)IJP
ALSO 68 VIENNA 139 — DONNACHIE RAPPORTEUR.S TALK (GLAS)
ALSO 68 THESIS — R G KIRSOPP (EDIN)
DEANS 69 PR 185 1797 — S DEANS, J WOOTEN (UNIV S FLORIDA)
DELCOURT 69 PL 29B 75 — DELCOURT,LEFRANCOIS,PEREZ-Y-JORBA,+ (ORSA)

AYED 70 KIEV CONF — R AYED,P BAREYRE, G VILLET (SACL)IJP
CARRERAS 70 NP 16B 35 — B CARRERAS, A DONNACHIE (DARE,MCHS)
DAVIES 70 NP B21 359 — A DAVIES (GLAS)
DIEM 70 KIEV CONF. — + SMADJA, CHAVANON, DELER, DOLBEAU+ (SACL)

ALMEHED 72 NP B40 157 — +LOVELACE (LUND,RUTG)IJP
DEANS 72 PN 3 217 — +JACOBS, LYONS, HICKS (U S FL TAMPA+CARN)
OBERLACK 72 PL 43B 44 — H.OBERLACK,R.G.MOORHOUSE (LBL)
WALKER 73 TO BE PUB. — R.L.WALKER,W.J.METCALF (CIT)

PAPERS NOT REFERRED TO IN DATA CARDS.

BAREYRE 65 PL 18 342 — + BRICMAN, STIRLING, VILLET (SACLAY)IJP
BRANDSEN 65 PR 139 B1566 — +ODONNELL, MOORHOUSE (DURHAM, RHEL)IJP
BASIS OF NUMBERS WE QUOTE FROM HENDRY 65.
JOHNSON 67 UCRL-17683 THESIS — C H JOHNSON (LRL)
LOVELACE 67 HEIDELBERG C. 79 — C LOVELACE (CERN)IJP
DONNACHI 69 NP 10B 433 — A DONNACHIE, R KIRSOPP (GLAS+EDIN)
AYED 70 PL 31B 598 — +BAREYRE+VILLET (SACLAY)

THE FOLLOWING ARTICLES DEAL WITH THE REACTIONS PI- P TO ETA N AND GAMMA P TO ETA P NEAR THRESHOLD. THE DATA AND THE THEORETICAL ARTICLES ARE USEFUL IN UNDERSTANDING THE BEHAVIOR OF THE S11 AMPLITUDE AS DETERMINED IN PI P PHASE-SHIFT ANALYSES. FURTHER REFERENCES MAY BE FOUND IN THEM.

MAINLY EXPERIMENTAL --
BULOS 64 PRL 13 486 — + (BROWN,BRANDEIS,HARVARD,MIT,PADOVA) I
BACCI 66 NC 45A 983 — +PENSO,SALVINI,MENCUCCINI,+ (ROMA,FRASCATI)IJP
JONES 66 PL 23 597 — +BINNIE,DUANE,HORSEY,MASON,+ (LOIC,RHEL)
RICHARDS 66 PRL 16 1221 — +CHIU,EANDI,HELMHOLZ,KENNEY,+ (LRL,HAWAII) IJ
PREPOST 67 PRL 18 82 — R PREPOST, D LUNDQUIST, D QUINN (STANFORD)
BLOOM 68 PRL 21 1100 — +HEUSCH, PRESCOTT, ROCHESTER (CIT)
BULOS 69 PR 187 1827 — +LANOU,BORDNER,BASTIEN+(BOST+HARV+MIT+PENN)
HEUSCH 70 PRL 25 1381 — +PRESCOTT,ROCHESTER,WINSTEIN (CIT)
MAINLY THEORETICAL --
BALL 66 PR 149 1191 — J S BALL (UCLA)
DOBSON 66 PR 146 1022 — P N DOBSON (HAWAII)
MINAMI 66 PR 147 1123 — S MINAMI (OSAKA)
DEANS 67 PR 161 1466 — S R DEANS, W G HOLLADAY (VANDERBILT)
LOGAN 67 PR 153 1634 — R K LOGAN, F UCHIYAMA-CAMPBELL (ILL)
MENCUCCI 67 NC 48A 579 — C MENCUCCINI, A REALE (FRASCATI)
MINAMI 67 PR 162 1619 — S MINAMI (OSAKA)
MOSS 67 PR 163 1785 — T A MOSS (LSU)
DEANS 68 PR 165 1886 — S R DEANS, W G HOLLADAY (VANDERBILT)
PAL 68 PR 167 1350 — B K PAL (NPL NEW DELHI)
BALL 69 PR 177 2257 — +GARG+SHAW (UCLA+UCI)
LEFIEVRE 70 NC 66A 349 — +LERUSTE (CDEF)

N(1520) BUMPS

8 N*1/2(1520, JP=) I=1/2 PRODUCTION EXPERIMENTS

THIS INFORMATION REFERS TO EITHER THE D13 OR THE S11 STATE SEEN AT THIS MASS
FOR SPIN-PARITY ANALYSIS OF THIS MASS REGION, SEE JOHNSTAD 72.

8 N*1/2(1520) MASS (MEV) (PROD. EXP.)

M		1507.0	6.0	A-BORELLI	67 HBC	0	PBAR P 5.7 GEV	10/71
M		1503.	6.	ANDERSON	70 MMS	-	PI- P TO PI- MMS	2/71
M		1500.0	10.0	AMALDI	71 CNTR		P P AT 24 GEV	10/71
M		1512.0	2.0	ELLIS	71 CNTR		MMS PP 3.7 GEV/C	10/71
M		1501.0	5.7	EDELSTEIN	72 MMS	+	PP 6 TO 30 GEV	1/73*
M		. . . . .	. . . . .					
M	AVG	1510.8	3.4	AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.8)				
M	1	(1500.)		OH	72 DBC	0	PI-N TO PI-PI-P	2/73*
M	1	DETERMINE J=3/2,D13 PROBABLE						2/73*

8 N*1/2(1520) WIDTH (MEV) (PROD. EXP.)

W		55.0	15.0	A-BORELLI	67 HBC	0	PBAR P 5.7 GEV	10/71
W		120.	10.	ANDERSON	70 MMS	-	PI- P TO PI- MMS	2/71
W		118.0	20.0	AMALDI	71 CNTR		P P AT 24 GEV	10/71
W		88.0	2.0	ELLIS	71 CNTR		MMS PP 3.7 GEV/C	10/71
W		140.0	43.0	EDELSTEIN	72 MMS	+	PP 6 TO 30 GEV	1/73*
W		. . . . .	. . . . .					
W	AVG	88.1	2.0	AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)				

8 N*1/2(1520) PARTIAL DECAY MODES (PROD. EXP.)

		DECAY MASSES
P1	N*1/2(1520) INTO PI N	139+ 938
P2	N*1/2(1520) INTO N*3/2(1236) PI	1236+ 139
P3	N*1/2(1520) INTO N PI PI	938+ 139+ 139
P4	N*1/2(1520)+ INTO NEUTRON PI+	939+ 139
P5	N*1/2(1520)+ INTO PROTON PI+ PI-	938+ 139+ 139
P6	N*1/2(1520) INTO N ETA	939+ 548
P7	N*1/2(1520) INTO N PIPI(J,I=0)	939+ 139+ 139
P8	N*1/2(1520) INTO N RHO	938+ 770

8 N*1/2(1520) BRANCHING RATIOS (PROD. EXP.)

R1	N*1/2(1520) INTO (N PI)/TOTAL					(P1)	
R1	N*(1520) INTO (N PI)/TOTAL PRODUCTION EXPERIMENTS						
R1	0.78	0.24		BASSOMPIE 67 HBC	+	K+P TO K* N*	11/68
R2	N*1/2(1520) INTO (NEUTRON PI+)/(P PI+ PI-)					(P4)/(P5)	
R2	0.77	0.45		ALEXANDER 67 HBC	+	PP 5.5 BEV/C	9/66
R3	N*1/2(1520) INTO (N PI)/(N PI PI)					(P1)/(P3)	
R3	1.25	0.44	0.71	A-BORELLI 67 HBC	0	PBAR P 5.7 BEV/C	9/66
R4	N*1/2(1520) INTO (N*3/2(1236) PI)/(N PI PI)					(P2)/(P3)	
R4	0.00	0.09		A-BORELLI 67 HBC			9/66

0 0 0 0 3 6 0 4 8 2 8

Data Card Listings

For notation, see key at front of Listings.

Baryons

N(1535), N(1670), N(1688)

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R5      N*1/2(1520) INTO (N PI PI)/TOTAL                  (P3)
R5          (0.08) OR LESS           BASSOMPIE 67 HBC   + K+P TO K* N*      11/68

R6      N*1/2(1520) INTO (N ETA)/TOTAL                    (P6)
R6          0.22      0.14           BASSOMPIE 67 HBC   + K+P TO K* N*      11/68

R7      N*1/2(1520) INTO (PI N)/(PI N*3/2(1236))          (P1)/(P2)
R7          (0.42) OR LESS           LEE       67 HBC     PI-P 3.6  GEV/C   11/67

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                        REFERENCES FOR N*1/2(1520) (PROD. EXP.)

A-BORELL 67 NC 47 232          ALLES-BORELLI,FRENCH,FRISK,MICHEJDA  (CERN)
ALEXANDE 67 PR 154 1284        ALEXANDER,BENARY,CZAPEK,+  (WEIZMANN(CERN))
BASSOMPI 67 PL 25B 440         BASSOMPIERRE, +             (CERN,BRUXELLES)
LEE      67 PR 159 1156        +MOEBS,ROE,SINCLAIR,VANDER VELDE     (MICH)

ANDERSON 70 PRL 25 699         +BLESER,BLIEDEN,COLLINS++        (BNL,CARN)
AMALDI   71 PL  34B 435        +BIANCASTELLI,BOSIO,+  (I SANITA ROMA+CERN)
ELLIS    71 PRL 27 442         +MAGLICH,NOREM,SANNES,SILVERMAN      (RUTG)

EDELSTEI 72 PR D5 1073         EDELSTEIN,CARRIGAN,HIEN,MCMAHON,+(CARN+BNL)
JOHNSTAD 72 NP B42 588         +MOLLERUD+...+JACOBSEN(BOHR,HELS,OSLO,STOH) IJP
OH       72 PL 42B 497         +FUNG,KERNAN,POE,SCHALK,SHEN        (UCR)IJP
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N(1670) 64 N*1/2(1670, JP=5/2-) I=1/2 **D'15**

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           FOR DISCUSSION CONCERNING RESONANT PARAMETERS,SEE NOTE
           PRECEDING N*1/2(1470).

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                   64 N*1/2(1670) MASS (MEV)

M          (1650.0)        APPROX      BRANDSEN  65 RVUE    PHASE-SHIFT ANAL  7/66
M    1     (1680.0)                    BAREYRE   68 RVUE    PHASE-SHIFT ANAL 11/67
M    1            WHERE CROSS SECTION IS GREATEST - EYEBALL FIT
M    3     (1678.0)                    DONNACHI  68 RVUE    PHASE-SHIFT ANAL  6/68
M          (1674.0)                    DUKE      68 CNTR    PI-P EL + POL     6/68
M    6     (1675.0)                    AYED      70 IPWA                      1/71
M    6   FROM ENER. DEP. FIT OF ARGAND DIAGRAM
M    4     (1669.0)                    DAVIES    70 RVUE    P-S ANAL  SOL A   8/69
M    7     (1683.)                     ALMEHED   72 IPWA                      2/72
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                   64 N*1/2(1670) WIDTH (MEV)

W    1     (135.0)                     BAREYRE   68 RVUE                     11/67
W    3     (173.0)                     DONNACHI  68 RVUE                      6/68
W    6     (143.0)                     AYED      70 IPWA                      1/71
W    4     (115.0)                     DAVIES    70 RVUE    SOL A AND B       8/69
W    7     (150.)                      ALMEHED   72 IPWA                      2/72
        SEE THE NOTES ACCOMPANYING THE MASSES QUOTED.
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                   64 N*1/2(1670) PARTIAL DECAY MODES

                                                            DECAY MASSES
P1      N*1/2(1670) INTO PI N                              139+ 938
P2      N*1/2(1670) INTO N ETA                             939+ 548
P3      N*1/2(1670) INTO LAMBDA K                         1115+ 497
P4      N*1/2(1670) INTO N*3/2(1236) PI                   1236+ 139
P5      N*1/2(1670) INTO N PI PI                           938+ 139+ 139
P6      N*1/2(1670) INTO GAM P, HELICITY=1/2                 0+ 938
P7      N*1/2(1670) INTO GAM P, HELICITY=3/2                 0+ 938
P8      N*1/2(1670) INTO GAM N, HELICITY=1/2                 0+ 939
P9      N*1/2(1670) INTO GAM N, HELICITY=3/2                 0+ 939
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                   64 N*1/2(1670) BRANCHING RATIOS

R1      N*1/2(1670) INTO (PI N)/TOTAL                     (P1)
R1   1      (0.41)                     BAREYRE   68 RVUE                     11/67
R1   3      (0.391)                    DONNACHI  68 RVUE                      6/68
R1   6      (0.392)                    AYED      70 IPWA                      1/71
R1   4      (0.50)                     DAVIES    70 RVUE    P-S ANAL  SOL A   8/69
R1   7      (0.45)                     ALMEHED   72 IPWA                      2/72
        SEE THE NOTES ACCOMPANYING THE MASSES QUOTED.

R2      N*1/2(1670) INTO (N ETA)/TOTAL                    (P2)
R2          (0.02) OR LESS             TRIPP     67 RVUE                      8/67
R2   B      (0.018)                    BOTKE     69 MPWA    T POLE + RESON.  10/69
R2   B      (0.006)  (0.004)           DEANS     69 MPWA    T POLE + RESON.   5/70
R2   B      (0.006)OR 0.012            CARRERAS  70 MPWA    T POLE + RESON.   5/70
R2   B    PARAMETRIZATION USED COULD BE IN DANGER OF DOUBLE COUNTING

R3      N*1/2(1670) INTO (LAMBDA K)/TOTAL                 (P3)
R3          (0.01) OR LESS             TRIPP     67 RVUE                      8/67
R3   B      (0.00) OR LESS             RUSH      68 MPWA    T POLE + RESON.   8/69
R3   B    PARAMETRIZATION USED COULD BE IN DANGER OF DOUBLE COUNTING
R3          (0.00) OR LESS  CL=.63     WAGNER    71 IPWA    PI-P TO K LAMB    1/71

R4      N*1/2(1670) INTO (N*3/2(1236) PI)/TOTAL           (P4)
R4 E 12600    0.63      0.1            BRODY     71 HBC     PI-P--2PI N,PWA   6/70
R4 E         ASSUMES ELASTIC BRANCHING RATIO 0.42+-0.04

   SEE NOTE PRECEDING THE N*1/2(1688) INELASTIC DECAY MODE MEASUREMENTS.

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                   64 N*1/2(1670) PHOTON DECAY AMPL(GEV**-1/2)

        FOR DEFINITION OF GAMMA-NUCLEON DECAY AMPLITUDES, SEE MINI-
      REVIEW PRECEDING THE BARYON LISTINGS.

A1      N*1/2(1670) INTO GAM P, HELICITY=1/2  (GEV**-1/2)
A1          +.011      .012            OBERLACK  72 DPWA    PI N PHOTO-PROD  2/73*
A1          (+.010)                    WALKER    73 DPWA    PI N PHOTO-PROD  2/73*

A2      N*1/2(1670) INTO GAM P, HELICITY=3/2  (GEV**-1/2)
A2          +.021      .020            OBERLACK  72 DPWA    PI N PHOTO-PROD  2/73*
A2          (+.039)                    WALKER    73 DPWA    PI N PHOTO-PROD  2/73*

A3      N*1/2(1670) INTO GAM N, HELICITY=1/2  (GEV**-1/2)
A3          +.010      .040            OBERLACK  72 DPWA    PI N PHOTO-PROD  2/73*
A3          (.00)                      WALKER    73 DPWA    PI N PHOTO-PROD  2/73*

A4      N*1/2(1670) INTO GAM N, HELICITY=3/2  (GEV**-1/2)
A4          -.035      .014            OBERLACK  72 DPWA    PI N PHOTO-PROD  2/73*
A4          (.00)                      WALKER    73 DPWA    PI N PHOTO-PROD  2/73*

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                        REFERENCES FOR N*1/2(1670)

BRANDSEN 65 PL 19 420          +DONNELLI, MOORHOUSE          (DURHAM, RHEL)IJP
TRIPP    67 NP B3 10           + LEITH, +          (LRL,SLAC,CERN,HEID,SACLAY)

BAREYRE  68 PR 165 1731        P BAREYRE, C BRICMAN, G VILLET     (SACLAY)IJP
DONNACHI 68 PL 26B 161         A DONNACHIE, R G KIRSOPP, C LOVELACE (CERN)IJP
   ALSO 68 VIENNA 139          DONNACHIE RAPPORTEUR.S TALK              (GLAS)
   ALSO 68 THESIS              R G KIRSOPP                              (EDIN)
DUKE     68 PR 166 1448        +JONES,KEMP,MURPHY,THRESHER, +   (RHEL,OXF)IJP
     INSIGHTFUL QUALITATIVE ARGUMENTS CONCERNING EXISTENCE AND IJP.
RUSH     68 PR 173 1776        J E RUSH                        (UNIV ALABAMA)

BOTKE    69 PR 180 1417        J C BOTKE                                (UCSB)
DEANS    69 PR 185 1797        S DEANS, J WOOTEN              (UNIV S FLORIDA)

AYED     70 KIEV CONF          R AYED,P BAREYRE, G VILLET          (SACL)IJP
CARRERAS 70 NP B16 35          B CARRERAS, A DONNACHIE           (DARE,MCHS)
DAVIES   70 NP B21 359         A DAVIES                                 (GLAS)

BRODY    71 PL 34B 665         +CASHMORE+..+HERNDON+..             (SLAC+LRL)
WAGNER   71 NP B25 411         F WAGNER, C LOVELACE                     (CERN)

ALMEHED  72 NP B40 157         +LOVELACE                         (LUND,RUTG)IJP
OBERLACK 72 PL 43B 44          H.OBERLACK,R.G.MOORHOUSE                  (LBL)
WALKER   73 TO BE PUB.         R.L.WALKER,W.J.METCALF                    (CIT)

                               PAPERS NOT REFERRED TO IN DATA CARDS.

BAREYRE  65 PL 18 342          + BRICMAN, STIRLING, VILLET        (SACLAY)IJP
DUKE     65 PRL 15 468         +JONES,KEMP,MURPHY,PRENTICE, +   (RHEL,OXF)IJP
JOHNSON  67 UCRL-17683 THESIS  C H JOHNSON                               (LRL)
DEANS    69 PRL 177 2623       S R DEANS                      (UNIV S FLORIDA)
DONNACHI 69 NP 10B 433         A DONNACHIE, R KIRSOPP              (GLAS+EDIN)
AYED     70 PL 31B 598         +BAREYRE+VILLET                        (SACLAY)

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N(1688) 65 N*1/2(1688, JP=5/2+) T=1/2 **F'15**

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           FOR DISCUSSION CONCERNING RESONANT PARAMETERS,SEE NOTE
           PRECEDING N*1/2(1470).

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                   65 N*1/2(1688) MASS (MEV)

M          (1680.0)                    BRANDSEN  65 RVUE    PHASE SHIFT ANAL  7/66
M    1     (1690.0)                    BAREYRE   68 RVUE    PHASE-SHIFT ANAL 11/67
M    1            WHERE CROSS SECTION IS GREATEST - EYEBALL FIT
M    3     (1687.0)                    DONNACHI  68 RVUE    PHASE-SHIFT ANAL  6/68
M          (1682.0)                    DUKE      68 CNTR    PI-P EL + POL     6/68
M    6     (1682.0)                    AYED      70 IPWA                      1/71
M    6   FROM ENER. DEP. FIT OF ARGAND DIAGRAM
M    4     (1685.0)                    DAVIES    70 RVUE    P-S ANAL  SOL A   8/69
M    7     (1688.)                     ALMEHED   72 IPWA                      2/72
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                   65 N*1/2(1688) WIDTH (MEV)

W    1     (110.0)                     BAREYRE   68 RVUE                     11/67
W    3     (177.0)                     DONNACHI  68 RVUE                      6/68
W    6     (109.0)                     AYED      70 IPWA                      1/71
W    4     (104.0)                     DAVIES    70 RVUE    P-S ANAL  SOL A   8/69
W    7     (140.)                      ALMEHED   72 IPWA                      2/72
        SEE THE NOTES ACCOMPANYING THE MASSES QUOTED.
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                   65 N*1/2(1688) PARTIAL DECAY MODES

                                                            DECAY MASSES
P1      N*1/2(1688) INTO PI N                              139+ 938
P2      N*1/2(1688) INTO N ETA                             939+ 548
P3      N*1/2(1688) INTO LAMBDA K                         1115+ 497
P4      N*1/2(1688) INTO N*3/2(1236) PI                   1236+ 139
P5      N*1/2(1688) INTO N PI PI                           938+ 139+ 139
P6      N*1/2(1688) INTO GAM P, HELICITY=1/2                 0+ 938
P7      N*1/2(1688) INTO GAM P, HELICITY=3/2                 0+ 938
P8      N*1/2(1688) INTO GAM N, HELICITY=1/2                 0+ 939
P9      N*1/2(1688) INTO GAM N, HELICITY=3/2                 0+ 939
P10     N*1/2(1688) INTO N EPSILON                         938+ 600
P11     N*1/2(1688) INTO N RHO                             938+ 770
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                   65 N*1/2(1688) BRANCHING RATIOS

R1      N*1/2(1688) INTO (PI N)/TOTAL                     (P1)
R1   1      (0.64)                     BAREYRE   68 RVUE                     11/67
R1   3      (0.560)                    DONNACHI  68 RVUE                      6/68
R1   6      (0.593)                    AYED      70 IPWA                      1/71
R1   4      (0.54)                     DAVIES    70 RVUE    SOL A AND B       8/69
R1   7      (0.65)                     ALMEHED   72 IPWA                      2/72
        SEE THE NOTES ACCOMPANYING THE MASSES QUOTED.

     MORE INFORMATION ON THE INELASTIC DECAY MODES OF THE 1690 MEV
     BUMP, AS SEEN IN PRODUCTION EXPERIMENTS, MAY BE FOUND BELOW

R2      N*1/2(1688) INTO (N ETA)/TOTAL                    (P2)
R2          (0.015)OR LESS             TRIPP     67 RVUE                      8/67
R2   B      (0.0004)                   BOTKE     69 MPWA    T POLE + RESON.  10/69
R2   B      (0.003)  (0.002)           DEANS     69 MPWA    T POLE + RESON.   5/70
R2   B      (0.0005)OR .001            CARRERAS  70 MPWA    T POLE + RESON.   5/70
R2   B    PARAMETRIZATION USED COULD BE IN DANGER OF DOUBLE COUNTING
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Baryons
N(1688), N(1700)

Data Card Listings
For notation, see key at front of Listings.

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R3       N*1/2(1688) INTO (N ETA)/(PI N)                    (P2)/(P1)
R3          (0.027)OR LESS         HEUSCH      66 RVUE +  PIO, ETA PHOTO      9/66

R4       N*1/2(1688) INTO (LAMBDA K)/TOTAL                  (P3)
R4          (0.00) OR LESS         TRIPP       67 RVUE                        8/67
R4  B       (0.001)OR LESS         RUSH        68 MPWA    T POLE + RESON.     5/70
R4  B    PARAMETRIZATION USED COULD BE IN DANGER OF DOUBLE COUNTING
R4          (0.001)OR LESS  CL=.63  WAGNER     71 IPWA    PI-P TO K LAMB      1/71

R5       N*1/2(1688) INTO (N*3/2(1236) PI)/TOTAL            (P4)
R5 E 12600  (0.13)   (0.04)  SOLN.A  BRODY     71  HBC    PI-P--2PI N/PWA     6/70
R5 E 12600  (0.39)   (0.10)  SOLN.B  BRODY     71  HBC    PI-P--2PI N/PWA     6/70
R5 E       ASSUMES ELASTIC BRANCHING RATIO 0.62+-0.06
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             65  N*1/2(1688) PHOTON DECAY AMPL(GEV**-1/2)

      FOR DEFINITION OF GAMMA-NUCLEON DECAY AMPLITUDES, SEE MINI-
    REVIEW PRECEDING THE BARYON LISTINGS.

A1       N*1/2(1688) INTO GAM P, HELICITY=1/2  (GEV**-1/2)
A1          -.008     .004         OBERLACK  72 DPWA    PI N PHOTO-PROD    2/73*
A1          (+.009)                WALKER    73 DPWA    PI N PHOTO-PROD    2/73*

A2       N*1/2(1688) INTO GAM P, HELICITY=3/2  (GEV**-1/2)
A2          +.100     .012         OBERLACK  72 DPWA    PI N PHOTO-PROD    2/73*
A2          (+.135)                WALKER    73 DPWA    PI N PHOTO-PROD    2/73*

A3       N*1/2(1688) INTO GAM N, HELICITY=1/2  (GEV**-1/2)
A3          +.017     .014         OBERLACK  72 DPWA    PI N PHOTO-PROD    2/73*
A3          (.00)                  WALKER    73 DPWA    PI N PHOTO-PROD    2/73*

A4       N*1/2(1688) INTO GAM N, HELICITY=3/2  (GEV**-1/2)
A4          -.005     .018         OBERLACK  72 DPWA    PI N PHOTO-PROD    2/73*
A4          (.00)                  WALKER    73 DPWA    PI N PHOTO-PROD    2/73*

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REFERENCES FOR N*1/2(1688)

SEE A PREVIOUS EDITION (RMP 37, 633, 1965) FOR EARLIER REFERENCES.


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BRANDSEN 65 PL 19 420          +ODONNELL, MOORHOUSE          (DURHAM, RHEL)IJP
HEUSCH   66 PRL 17 1019        C A HEUSCH, C Y PRESCOTT, R F DASHEN  (CIT)
TRIPP    67 NP B3 10           + LEITH, +       (LRL,SLAC,CERN,HEID,SACLAY)

BAREYRE  68 PR 165 1731        P BAREYRE, C BRICMAN, G VILLET      (SACLAY)IJP
DONNACHI 68 PL 26B 161         A DONNACHIE, R G KIRSOPP, C LOVELACE (CERN)IJP
    ALSO 68 VIENNA 139         DONNACHIE RAPPORTEUR.S TALK             (GLAS)
    ALSO 68 THESIS             R G KIRSOPP                             (EDIN)
DUKE     68 PR 166 1448        +JONES,KEMP,MURPHY,THRESHER, +   (RHEL,OXF)IJP
RUSH     68 PR 173 1776        J E RUSH                       (UNIV ALABAMA)

BOTKE    69 PR 180 1417        J C BOTKE                               (UCSB)
DEANS    69 PR 185 1797        S DEANS, J WOOTEN             (UNIV S FLORIDA)

AYED     70 KIEV CONF          R AYED,P BAREYRE, G VILLET           (SACL)IJP
CARRERAS 70 NP 16B 35          B CARRERAS, A DONNACHIE           (DARE,MCHS)
DAVIES   70 NP B21 359         A DAVIES                                (GLAS)

BRODY    71 PL 34B 253         +CASHMORE+..+HERNDON+..             (SLAC+LRL)
WAGNER   71 NP B25 411         F WAGNER, C LOVELACE                    (CERN)

ALMEHED  72 NP B40 157         +LOVELACE                        (LUND,RUTG)IJP
OBERLACK 72 PL 43B 44          H.OBERLACK,R.G.MOORHOUSE                 (LBL)
WALKER   73 TO BE PUB.         R.L.WALKER,W.J.METCALF                   (CIT)

                               PAPERS NOT REFERRED TO IN DATA CARDS.

CROUCH   65 DESY CONF II 21    +   (BROWN,CEA,HARVARD,MIT,PADOVA,WEIZMANN)
DERADO   65 ATHENS CONF 244    +KENNEY,LAMSA, +      (NOTRE DAME,KENTUCKY)
DUKE     65 PRL 15 468         +JONES,KEMP,MURPHY,PRENTICE, +   (RHEL,OXF)IJP
MERLO    66 P ROY SOC 289 489  J P MERLO, G VALLADAS                 (SACLAY)
ROBERTS  67 PREPRINT           R G ROBERTS                           (DURHAM)
BANNER   68 PR 166 1347        +DETOEUF,FAYOUX,HAMEL, +         (SACLAY,CAEN)
    THE ABOVE PAPERS DISCUSS INELASTIC CHANNELS NEAR THE BUMP.
BAREYRE  65 PL 18 342          + BRICMAN, STIRLING, VILLET         (SACLAY)IJP
DEANS    69 PRL 177 2623       S R DEANS                     (UNIV S FLORIDA)
DONNACHI 69 NP 10B 433         A DONNACHIE, R KIRSOPP             (GLAS+EDIN)
AYED     70 PL 31B 598         +BAREYRE+VILLET                       (SACLAY)
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N(1700)

66 N*1/2(1700, JP=1/2-) I=1/2 S''_{11}

FOR DISCUSSION CONCERNING RESONANT PARAMETERS,SEE NOTE PRECEDING N*1/2(1470).

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             66  N*1/2(1700) MASS (MEV)

M           (1695.0)                   BRANDSEN  65 RVUE   PHASE-SHIFT ANAL  9/66
M           (1700.0)                   MICHAEL   66 RVUE   FITS BAREYRE S11  7/66
M    1      (1710.0)                   BAREYRE   68 RVUE   PHASE-SHIFT ANAL 11/67
M    1             WHERE CROSS SECTION IS GREATEST - EYEBALL FIT
M    3      (1710.0)                   DONNACHI  68 RVUE   PHASE-SHIFT ANAL  8/68
M           (1705.0)    (10.0)         ORITO     69 RVUE   K LAMBDA PS ANAL  8/69
M    6      (1689.0)                   AYED      70 IPWA                     1/71
M    6    FROM ENER. DEP. FIT OF ARGAND DIAGRAM
M    4      (1766.0)                   DAVIES    70 RVUE   P-S ANAL  SOL A   8/69
M           (1678.0)                   SCHORSCH  70 DPWA   K LAM PHOTOPRO.  10/71
M    A      (1685.0)                   WAGNER    71 IPWA   PI-P TO K LAMB    1/71
M    A   THERE ARE 3 SIMILAR SOLUTIONS
M    7      (1670.)                    ALMEHED   72 IPWA                     2/72
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             66  N*1/2(1700) WIDTH (MEV)

W           (240.0)                    MICHAEL   66 RVUE                      7/66
W    1      (260.0)                    BAREYRE   68 RVUE                     11/67
W    3      (300.0)                    DONNACHI  68 RVUE                      8/69
W           (104.0)    (15.0)          ORITO     69 RVUE                      8/69
W    6      (166.0)                    AYED      70 IPWA                      1/71
W    4      (404.0)                    DAVIES    70 RVUE   P-S ANAL   SOL A   8/69
W    4   SOL B GIVES 121 MEV                                                  2/73*
W           (99.0)                     SCHORSCH  70 DPWA   K LAM PHOTOPRO.   10/71
W    A      (110.0)OR(140.0)           WAGNER    71 IPWA   PI-P TO K LAMB     1/71
W    7      (120.)                     ALMEHED   72 IPWA                      2/72
     SEE THE NOTES ACCOMPANYING THE MASSES QUOTED.
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             66  N*1/2(1700) PARTIAL DECAY MODES

                                                              DECAY MASSES
P1       N*1/2(1700) INTO PI N                                139+ 938
P2       N*1/2(1700) INTO N ETA                               939+ 548
P3       N*1/2(1700) INTO LAMBDA K                           1115+ 497
P4       N*1/2(1700) INTO N GAMMA                             938+   0
P5       N*1/2(1700) INTO GAM P, HELICITY=1/2                   0+ 938
P6       N*1/2(1700) INTO GAM N, HELICITY=1/2                   0+ 939
P7       N*1/2(1700) INTO N PI PI                             938+ 139+ 139
P8       N*1/2(1700) INTO N EPSILON                           938+ 600
P9       N*1/2(1700) INTO N RHO                               938+ 770
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             66  N*1/2(1700) BRANCHING RATIOS

R1       N*1/2(1700) INTO (PI N)/TOTAL                         (P1)
R1          (1.0)        APPROX        MICHAEL   66 RVUE                      7/66
R1  3       (0.79)                     DONNACHI  68 RVUE                      8/69
R1  6       (0.642)                    AYED      70 IPWA                      1/71
R1  4       (0.56)                     DAVIES    70 RVUE   P-S ANAL   SOL A   8/69
R1  7       (0.5)                      ALMEHED   72 IPWA                      2/72

R2       N*1/2(1700) INTO (LAMBDA K)*(PI N)/TOTAL**2          (P3*P1)
R2          0.039     0.019            ORITO     69 RVUE                      8/69
R2  A       (0.043)OR 0.054            WAGNER    71 IPWA   PI-P TO K LAMB     1/71

R3       N*1/2(1700) INTO (LAMBDA K)/TOTAL                     (P3)
R3  B       (0.028)     APPROX.        RUSH      68 MPWA    T POLE + RESON.   8/69
R3  B    PARAMETRIZATION USED COULD BE IN DANGER OF DOUBLE COUNTING

R4       N*1/2(1700) INTO (N ETA)/TOTAL                        (P2)
R4  B       (0.013)                    BOTKE     69 MPWA    T POLE + RESON.  10/69
R4  B       (0.03)    (0.02)           DEANS     69 MPWA    T POLE + RESON.   8/69
R4  C       (0.19) OR 0.27             CARRERAS  70 MPWA    T POLE + RESON.   5/70
R4  B    PARAMETRIZATION USED COULD BE IN DANGER OF DOUBLE COUNTING
R4  C    CARRERAS 70 USES REGGE POLES + RESONANCES. VALUES SUSPICIOUSLY LARG

R5       N*1/2(1700) FROM N GAMMA TO LAMBDA K                  SQRT(P3*P4)
R5          (0.002)OR LESS             ORITO2    69 CNTR    K LAM PHOTOPRO   10/71
R5          (0.0072)                   SCHORSCH  70 DPWA    K LAM PHOTOPRO.  10/71
R5          (0.006)                    DEANS     72 MPWA                      1/73*
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             66  N*1/2(1700) PHOTON DECAY AMPL(GEV**-1/2)

      FOR DEFINITION OF GAMMA-NUCLEON DECAY AMPLITUDES, SEE MINI-
    REVIEW PRECEDING THE BARYON LISTINGS.

A1       N*1/2(1700) INTO GAM P, HELICITY=1/2 (GEV**-1/2)
A1          +.066     .042             OBERLACK  72 DPWA    PI N PHOTO-PROD   2/73*
A1          (+.011)                    WALKER    73 DPWA    PI N PHOTO-PROD   2/73*

A2       N*1/2(1700) INTO GAM N, HELICITY=1/2 (GEV**-1/2)
A2          -.072     .066             OBERLACK  72 DPWA    PI N PHOTO-PROD   2/73*
A2          (-.015)                    WALKER    73 DPWA    PI N PHOTO-PROD   2/73*

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REFERENCES FOR N*1/2(1700)


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BRANDSEN 65 PL 19 420          +ODONNELL, MOORHOUSE          (DURHAM, RHEL)IJP

MICHAEL  66 PL 21 93           C MICHAEL                                (OXF)

BAREYRE  68 PR 165 1731        P BAREYRE, C BRICMAN, G VILLET      (SACLAY)IJP
DONNACHI 68 PL 26B 161         A DONNACHIE, R G KIRSOPP, C LOVELACE (CERN)IJP
    ALSO 68 VIENNA 139         DONNACHIE RAPPORTEUR.S TALK             (GLAS)
    ALSO 68 THESIS             R G KIRSOPP                             (EDIN)
RUSH     68 PR 173 1776        J E RUSH                       (UNIV ALABAMA)

BOTKE    69 PR 180 1417        J C BOTKE                               (UCSB)
DEANS    69 PR 185 1797        S DEANS, J WOOTEN             (UNIV S FLORIDA)
ORITO    69 LNC 1 936          S ORITO,S SASAKI                 (TOKYO-OSAKA)
ORITO2   69 INS J 113          S ORITO (THESIS)                       (TOKYO)

AYED     70 KIEV CONF          R AYED,P BAREYRE, G VILLET           (SACL)IJP
CARRERAS 70 NP 16B 35          B CARRERAS, A DONNACHIE           (DARE,MCHS)
DAVIES   70 NP B21 359         A DAVIES                                (GLAS)
SCHORSCH 70 NP  B25 179        +TIETGE,WEILNBOECK                      (MPIM)

WAGNER   71 NP B25 411         F WAGNER, C LOVELACE                    (CERN)

ALMEHED  72 NP B40 157         +LOVELACE                        (LUND,RUTG)IJP
DEANS    72 PN 3 217           +JACOBS, LYONS, HICKS   (U S FL TAMPA+CARN)
OBERLACK 72 PL 43B 44          H.OBERLACK,R.G.MOORHOUSE                 (LBL)
WALKER   73 TO BE PUB.         R.L.WALKER,W.J.METCALF                   (CIT)

                               PAPERS NOT REFERRED TO IN DATA CARDS.

BAREYRE  65 PL 18 342          + BRICMAN, STIRLING, VILLET         (SACLAY)IJP
JOHNSON  67 UCRL-17683 THESIS  C H JOHNSON                              (LRL)
DEANS    69 PR  177 2623       S R DEANS                     (UNIV S FLORIDA)
DONNACHI 69 NP 10B 433         A DONNACHIE, R KIRSOPP             (GLAS+EDIN)
AYED     70 PL 31B 598         +BAREYRE+VILLET                       (SACLAY)
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Data Card Listings

For notation, see key at front of Listings.

N(1700) D''_{13}

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18  N*1/2(1700, JP=3/2-) I=1/2

FOR DISCUSSION CONCERNING RESONANT PARAMETERS,SEE NOTE
PRECEDING N*1/2(1470).
 A NEW, PRELIMINARY ENERGY DEPENDENT ANALYSIS BY AYED 72 INDICATES THE
PRESENCE OF THIS STATE.  IN ADDITION AN ISOBAR MODEL ANALYSIS BY
HERNDON 72 SHOWS EVIDENCE FOR THIS STATE IN THE SIGMA N AND DELTA PI
CHANNELS.  SEE THE N* MINI REVIEW.
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               18  N*1/2(1700) MASS  (MEV)

M  3     (1730.)                    DONNACH2  68 RVUE    PHAS.SHIFT-CERN1 10/69
M  3     (1680.)                    KIRSOPP   68 RVUE    PHASE SHIFT ANAL 10/69
M  3   WHERE MAX. ABSORPTION IS -DONNACH1, 2 ,KIRSOPP EYEBALL FIT CERN 1    10/69
M  A     (1780.0)                   WAGNER     71 IPWA    PI-P TO K LAMB    1/71
M  A  D13 RESONATES ONLY IN ONE OUT OF 3 POSSIBLE SOL.
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               18  N*1/2(1700) WIDTH (MEV)
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               18  N*1/2(1700) PARTIAL DECAY MODES

                                                        DECAY MASSES
P1      N*1/2(1700) INTO PI N                           139+ 938
P2      N*1/2(1700) INTO LAMBDA K                       1115+ 497
P3      N*1/2(1700) INTO N GAMMA                        938+   0
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               18  N*1/2(1700) BRANCHING RATIOS

R1      N*1/2(1700) FROM N GAMMA TO LAMBDA K            SQRT(P2*P3)
R1              (0.008)                 DEANS      72 MPWA              1/73*
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                       REFERENCES FOR N*1/2(1700)
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DONNACH2 68 VIENNA 139        DONNACHIE  RAPPORTEUR.S TALK          (GLAS)
KIRSOPP  68 THESIS            R G KIRSOPP                           (EDIN)
WAGNER   71 NP B25 411        F WAGNER, C LOVELACE                  (CERN)
DEANS    72 PN 3 217          +JACOBS, LYONS, HICKS   (U S FL TAMPA+CARN)

                       PAPERS NOT REFERRED TO IN DATA CARDS.

AYED     72 BATAVIA CONF      R AYED,P BAREYRE, Y LEMOIGNE          (SACL)
HERNDON  72 BATAVIA CONF      +...ROSENFELD...+CASHMORE+...     (LBL,SLAC)
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N(1700) BUMPS

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20  N*1/2(1700, JP=    ) I=1/2    PRODUCTION EXPERIMENTS

PARTIAL WAVE ANALYSIS REQUIRES AT LEAST FOUR I=1/2 STATES IN THE 1670 T
1780 REGION (D15, F15, S11, P11) AND AT LEAST ONE I=3/2 STATE (D33).
OBVIOUSLY,DIFFERENT EXPERIMENTS ARE SEEING DIFFERENT STATES AND OFTEN I
IS NOT CLEAR WHAT ISOSPIN STATE IS BEING OBSERVED.  NO EFFORT WAS MADE
TO SEPARATE THESE EXPERIMENTS ACCORDING TO JP, SINCE NONE OF THE
REPORTED JP IS FIRMLY ESTABLISHED.  WE LIST ALL THE INFORMATION HERE,
BUT WE HAVE NOT USED IT IN THE BARYON TABLE.
   FOR SPIN-PARITY ANALYSIS OF THIS MASS REGION, SEE JOHNSTAD 72 AND
LAMSA 72.
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            20  N*1/2(1700) MASS (MEV) (PROD. EXP.)

M         (1695.0)    (9.0)              A-BORELLI 67 HBC  +  PBAR P 5.7 BEV/C  8/67
M         (1734.0)   (21.0)              ALMEIDA   68 HBC  +  PP 10 BEV/C       9/69
M         (1730.0)   (18.0)              GALLOWAY  68 HBC     PI-P 6 GEV/C      8/69
M  1      (1712.0)    (6.0)              BARNES    69 HBC     K-P TO K-P 2PI    7/70
M  A      (1667.0)    (5.0)              BENVENUTI 69 DBC  0  PI-D 2.26 GEV     5/70
M  B   190(1693.)    (15.)               RHODE     69 HBC     PP 22 GEV/C      10/69
M          (1691.)    (4.)               ANDERSON  70 MMS  -  PI- P TO PI- MMS  2/71
M      177(1710.)    (10.)               CIRBA     70 HBC  +  PI+ P TO P+3PI    2/71
M       40(1763.)    (25.)               COOPER    70 HBC  +  LAMB. K PROD.     2/71
M      505(1730.0)   (15.0)              CRENNELL  70 HBC  +  PI-P,PI+P 6 GEV   1/71
M       60(1710.)                        KUZNETSOV 70 HLBC -  LAMB. K PROD.     2/71
M  A      (1719.0)    (6.0)              WILLMANN  70 HBC  +  PI+P 13. GEV      5/70
M         (1694.0)    (8.0)              AMALDI    71 CNTR    P P AT 24 GEV    10/71
M          (1730.)   (20.)               BALLAM    71 HBC  +- PI+-P AT 16GEV    2/72
M          (1700.)                       BEKETOV   71 HBC  +  PI- P 4.45GEV/C   3/72
M          (1711.)   (10.)               BOESEBEC  71 RVUE    PP,PI-P,K-P PROD  3/72
M         (1672.0)    (4.0)              ELLIS     71 CNTR    MMS PP 3.7 GEV/C 10/71
M       80(1650.0)   (10.0)    80/120    MA        71 HBC  +  P P TO P N PI    10/71
M         (1700.0)   (10.0)              MORSE     71 HBC  +  PI-P  25 GEV/C    3/72
M          1670. TO 1730.                MORSE     71 HBC  +0 PI-P  7   GEV/C   3/72
M          (1720.)   (20.)               RUSHBROOKE71 HBC  +  PP TO P2PI 16GEV  2/72
M         (1690.3)    (4.5)              EDELSTEIN 72 MMS  +  PP 6 TO 30 GEV    1/73*
M         (1668.0)   (19.0)    24/45     KARSHON   72 DBC  +  PD--PD2PI 7 GEV  12/72*
M  C      (1715.0)    (5.0)              LAMSA     72 HBC  +  PI+-P 8TO18 GEV   1/73*
M     2    (1660.)  (15.                 OH        72 DBC  0  PI-N TO PI-PI-P   2/73*
M          (1720.)   (15.)               RONAT     72  HBC    PI+P TO 3PI P     2/73*
M  C    ANALYSIS GIVES JP = 5/2+
M    2  DETERMINE J=5/2,F15 PROBABLE                                            2/73*
M  B  JP IS PROBABLY 5/2+
M  1       IJP CONSISTENT WITH S11(1700) OR P11(1780) IN FORMATION
M  A        J CONSISTENT WITH 5/2 OR 7/2
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            20  N*1/2(1700) WIDTH (MEV) (PROD. EXP.)

W          (70.0)    (20.0)              A-BORELLI 67 HBC                        9/69
W         (140.0)    (57.0)              ALMEIDA   68 HBC  +                     9/69
W          (55.0)    (15.0)              GALLOWAY  68 HBC                        8/69
W  1       (70.0)    (15.0)              BARNES    69 HBC     K-P TO K-P 2PI     7/70
W  A      (105.0)    (16.0)              BENVENUTI 69 DBC  0                     5/70
W  B  190 (235.)     (50.)               RHODE     69 HBC     PP 22 GEV/C       10/69
W         (130.)     (10.)               ANDERSON  70 MMS  -  PI- P TO PI- MMS   2/71
W     177  (66.)     (26.)               CIRBA     70 HBC  +  PI+ P AT 5 GEV/C   2/71
W         (102.)     (40.)               COOPER    70 HBC  +  PI+P, 5.5 GEV/C    2/71
W     505 (130.0)    (30.0)              CRENNELL  70 HBC  +                     1/71
W      60 (220.)                         KUZNETSOV 70 HLBC -  PI-P, 4 GEV/C      2/71
W  A       (63.0)    (12.0)              WILLMANN  70 HBC  +                     5/70
W         (152.0)    (15.0)              AMALDI    71 CNTR    P P AT 24 GEV     10/71
W         (120.)     (50.)               BALLAM    71 HBC  +- PI+-P AT 16GEV     2/72
W          (57.)     (15.)               BOESEBEC  71 RVUE    PP,PI-P,K-P PROD   3/72
W         (102.0)     (9.0)              ELLIS     71 CNTR    MMS PP 3.7 GEV/C  10/71
W      80  (94.0)    (20.0)    80/120    MA        71 HBC  +  P P TO P N PI     10/71
W          (70.)     (20.)               MORSE     71 HBC  +  PI-P   25 GEV/C    3/72
W          70. TO    120.                MORSE     71 HBC  +0 PI-P   7   GEV/C   3/72
W         (120.)     (40.)               RUSHBROOKE71 HBC  +  PP TO P2PI 16GEV   2/72
W         (133.0)    (26.0)              EDELSTEIN 72 MMS  +  PP 6 TO 30 GEV     1/73*
W         (168.0)    (64.0)              KARSHON   72 DBC  +  PD--PD2PI 7 GEV   12/72*
W          (80.0)   APPROX.              LAMSA     72 HBC     PI P  18.5 GEV/C 12/72*
W  2      (128.)    (40.                 OH        72 DBC  0  PI-N TO PI-PI-P    2/73*
W          (60.)     (40.)               RONAT     72  HBC    PI+P TO 3PI P      2/73*
       SEE THE NOTES ACCOMPANYING THE MASSES QUOTED
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            20  N*1/2(1700) PARTIAL DECAY MODES (PROD. EXP.)

                                                        DECAY MASSES
P1      N*1/2(1700) INTO PI N                           139+ 938
P2      N*1/2(1700) INTO N PI PI                        938+ 139+ 139
P3      N*1/2(1700) INTO N*3/2(1236) PI                 1236+ 139
P4      N*1/2(1700)+ INTO NEUTRON PI+                   939+ 139
P5      N*1/2(1700)+ INTO PROTON PI+ PI-                938+ 139+ 139
P6      N*1/2(1700)+ INTO N*3/2(1236)++ PI-             1236+ 139
P7      N*1/2(1700) INTO N ETA                          939+ 548
P8      N*1/2(1700) INTO LAMBDA K                       1115+ 497
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            20  N*1/2(1700) BRANCHING RATIOS (PROD. EXP.)

R1      N*1/2(1700) INTO (PI N)/(PI N*3/2(1236))          (P1)/(P3)
R1            (0.77) OR LESS              LEE       67 HBC     PI-P 3.6 GEV/C  11/67
R1  A         (9.0)  OR MORE              BENVENUTI 69 DBC  0                   5/70

R2      N*1/2(1700) INTO (N ETA)/(N PI + N PI PI)         (P7)/(P1+P2)
R2            (0.025)OR LESS              KRAEMER   64 DBC  +  PI+D 1.2
R2            (0.042)OR LESS  CL=.95      A-BORELLI 67 HBC  +  PBAR P 5.7 BEV/C  9/69

R3      N*1/2(1700) INTO (LAMBDA K)/(P PI+ PI-)           (P8)/(P5)
R3            (0.034)OR LESS              ALEXANDER 67 HBC  +  PP 5.5 BEV/C    11/67
R3            (0.07) OR LESS  CL=.95      CIRBA     70 HBC     PI+P AT 5 GEV/C  2/71

R4      N*1/2(1700) INTO (LAMBDA K)/(N PI + N PI PI)      (P8)/(P1+P2)
R4            (0.013)OR LESS  CL=.95      A-BORELLI 67 HBC  +                   8/67
R4             SEEN                       CHINOWSKY 68 HBC     PP TO K+ Y N     6/68
R4  1       LIMITS 0.025 TO 0.11          BARNES    69 HBC     K-P TO K-P 2PI   7/70
R4      25     0.025     0.005            CRENNELL  70 HBC  +                   1/71
R4  A       LESS THAN    0.025            WILLMANN  70 HBC     PI+P TO 3PI P    6/70
R4      25  SEEN. CONS. WITH J=1/2        MORSE     71 HBC  0  PI-P  7   GEV/C  3/72

R5      N*1/2(1700) INTO (N PI)/(N PI PI)                 (P1)/(P2)
R5            (1.26) OR LESS  CL=.95      A-BORELLI 67 HBC  +                   8/67
R5             0.025     0.13             CRENNELL  70 HBC  +                   1/71

R6      N*1/2(1700) INTO (N*3/2(1236) PI)/(N PI PI)       (P3)/(P2)
R6             NO EVIDENCE                A-BORELLI 67 HBC  +                   8/67
          SEE MERLO 66 FOR A REVIEW.

R7      N*1/2(1700) INTO (NEUTRON PI+)/(P PI+ PI-)        (P4)/(P5)
R7             0.67      0.40             ALEXANDER 67 HBC  +  PP 5.5 BEV/C    11/67
R7             0.47      0.25             A-BORELLI 67 HBC     PBAR P 5.5 GEV/C 7/70
R7          . . . . . . . . .
R7  AVG        0.53      0.21      AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

R8      N*1/2(1700) INTO (N*(1236)++ PI-)/(P PI+ PI-)     (P6)/(P5)
R8             0.74      0.14             ALEXANDER 67 HBC  +  PP 5.5 BEV/C    11/67
R8             1.0       0.3              ALMEIDA   68 HBC  +  PP 10 BEV/C      9/66
R8            (0.83)                      KAYAS     68 HBC     PP 8.1 BEV/C    11/68
R8  1       LESS THAN    0.15             BARNES    69 HBC     K-P TO K-P 2PI   7/70
R8            (0.50) OR LESS  CL=.95      CIRBA     70 HBC     PI+P AT 5 GEV/C  2/71
R8             NO EVIDENCE                CRENNELL  70 HBC  +                   1/71
R8  A         (2.3)     (1.6)             WILLMANN  70 HBC     PI+P TO 3PI P    6/70
R8            (1.0)   OR MORE CL=.95      BEKETOV   71 HBC  +  DEL(1236)++ PI-  3/72
R8             0.75      0.75             BOESEBEC  71 RVUE    PP,PI-P,K-P PROD 3/72
R8             0.35      0.20             RUSHBROOKE71 HBC  +  PP TO P2PI 16GEV 2/72
R8 C           0.65      0.15             LAMSA     72 HBC     PI P  18.5 GEV/C 12/72*
R8          . . . . . . . . .
R8  AVG        0.66      0.10      AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.2)

R9      N*1/2(1700) INTO (SIG K)/(LAMB K)                 PROD. EXP.
R9          LESS THAN    .20              COOPER    70 HBC  +  PI+P, 5.5 GEV/C  2/71

        SEE THE NOTES ACCOMPANYING THE MASSES QUOTED
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                REFERENCES FOR N*1/2(1700) (PROD. EXP.)
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KRAEMER  64 PR 136 B496       +MADANSKY,+  (J HOPKINS,NWESTERN,WOODSTOCK) I
ALEXANDE 67 PR 154 1284       ALEXANDER,BENARY,CZAPEK,+  (WEIZMANN(CERN))
A-BORELL 67 NC 47 232         ALLES-BORELLI,FRENCH,FRISK,MICHEJDA  (CERN)
LEE      67 PR 159 1156       +MOEBS,ROE,SINCLAIR,VANDER VELDE      (MICH)

ALMEIDA  68 PR 174 1638       +RUSHBROOKE, +              (CAVE,DESY(CERN))
CHINOWSK 68 PR 165 1466       CHINOWSKY,KINSEY,KLEIN, +          (LRL,SLAC)
GALLOWAY 68 PL 27B 250        GALLOWAY,ALYEA,CRITTENDEN,PRICKETT,+  (IND)
KAYAS    68 NP B5 169         +GUYADER,SENE,YIOU,ALITTI,+  (ORSAY,SACLAY)
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Baryons
N(1700), N(1780), N(1860)


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BARNES    69 PRL 23 1516          +BASSANO+CHUNG+EISNER+FLAMINIO+KINSON (BNL)IJ
BENVENUT  69 PR 187 1852          BENVENUTI, MARQUIT, OPPENHEIMER (MINN,COLO)
RHODE     69 PR 187 1844          RHODE, LEACOCK, KERNAN, JESPERSEN,+   (ISU)

ANDERSON  70 PRL 25,699           +BLESER,BLIEDEN,COLLINS++        (BNL,CARN)
CIRBA     70 NP B23,533           +VANDERHAGEN+   (EPOL,DURH,NIJM, TORI,BONN)
COOPER    70 NP B23,605           +MANNER,MUSGRAVE,POLLARD,VOYVODIC      (ANL)
CRENNELL  70 PRL 25 187           +LAI, LOUIE, SCARR, SIMS               (BNL)
KUZNETSOV70 SJNP 10,332           +MELNIKOV,RYLTSEVA,CHADRAA,BALINTP    (JINR)
WILLMANN  70 PRL 24 1260          +LAMSA,GAIDOS,EZELL                 (PURD)IJ

AMALDI    71 PL  34B 435          +BIANCASTELLI,BOSIO,+ (I SANITA ROMA+CERN)
BALLAM    71 PR D4 1946           +CHADWICK,GUIRAGOSSIAN,JOHNSON,++  (SLAC) I
BEKETOV   71 SJNP 13 605          ,ZOMBKOVSKII,KONOVALOV,KRUCHININ,++ (ITEP)IJ
BOESEBEC  71 NP B33 445           BOESEBECK,GRAESSLER,KRAUS,+++   (ABBCHLV) I
ELLIS     71 PRL 27 442           +MAGLICH,NOREM,SANNES,SILVERMAN     (RUTG)
MA        71 PRL  26  333         +COLTON                         (MSU+LBL)I
MORSE     71 PR D4 133            +OH,WALKER,CARROLL,LYNCH +    (WISC+TNTO)I
RUSHBROO  71 PR D4 3273           RUSHBROOKE,WILLIAMS+BAREFORD++ (CAVE,LOIC) IJ

EDELSTEI  72 PR D5 1073           EDELSTEIN,CARRIGAN,HIEN,MCMAHON,+(CARN+BNL)
JOHNSTAD  72 NP B42 588           +MOLLERUD+...+JACOBSEN(BOHR,HELS,OSLO,STOH) IJP
KARSHON   72 NP B37 371           +YEKUTIELI,YAFFE,SHAPIRA,RONAT,+    (REHO) I
LAMSA     72 NP B37 364           +WILLMANN+..+GO,BISWAS+...    (PURD,NDAM) IJP
OH        72 PL 42B 497           +FUNG,KERNAN,POE,SCHALK,SHEN        (UCR)IJP
RONAT     72 NP B38 20     40.    +EISENBERG,LYONS,SHAPIRA,TOAFF+     (REHO)

                  PAPERS NOT REFERRED TO IN DATA CARDS.

MERLO     66 P ROY SOC 289 489 J P MERLO, G VALLADAS          (SACLAY)
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N(1780) — P''_{11}

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14  N*1/2(1780, JP=1/2+) I=1/2

FOR DISCUSSION CONCERNING RESONANT PARAMETERS,SEE NOTE
PRECEDING N*1/2(1470).

            14  N*1/2(1780) MASS (MEV)

M   3     (1751.0)                 DONNACHI  68 RVUE   PHASE-SHIFT ANAL  8/69
M         (1640.0)    (70.0)       ORITO     69 RVUE   K LAMBDA PS ANAL  8/69
M         (1700.0)                 ORITO2    69 CNTR   K LAM PHOTOPRO   10/71
M   6     (1645.0)                 AYED      70 IPWA                     1/71
M   6   FROM ENER. DEP. FIT OF ARGAND DIAGRAM
M   4     (1770.0)                 DAVIES    70 RVUE   P-S ANAL  SOL A   8/69
M         (1809.0)                 SCHORSCH  70 DPWA   K LAM PHOTOPRO.  10/71
M   A     (1685.0)OR(1740.0)       WAGNER    71 IPWA   PI-P TO K LAMB    1/71
M   A   THERE ARE 3 SIMILAR SOLUTIONS
M   7     (1720.)                  ALMEHED   72 IPWA                     2/72

            14  N*1/2(1780) WIDTH (MEV)

W   3     (327.0)                  DONNACHI  68 RVUE                     8/69
W         (310.0)    (50.0)        ORITO     69 RVUE                     8/69
W         (210.0)                  ORITO2    69 CNTR   K LAM PHOTOPRO   10/71
W   6     (50.0)                   AYED      70 IPWA                     1/71
W   4     (445.0)                  DAVIES    70 RVUE   SOL A             8/69
W         (280.0)                  SCHORSCH  70 DPWA   K LAM PHOTOPRO.  10/71
W   A     (160.0)OR(220.0)         WAGNER    71 IPWA   PI-P TO K LAMB    1/71
W   7     (160.)                   ALMEHED   72 IPWA                     2/72
        SEE THE NOTES ACCOMPANYING THE MASSES QUOTED.

            14  N*1/2(1780) PARTIAL DECAY MODES

                                                     DECAY MASSES
P1      N*1/2(1780) INTO PI N                        139+ 938
P2      N*1/2(1780) INTO LAMBDA K                   1115+ 497
P3      N*1/2(1780) INTO N ETA                       939+ 548
P4      N*1/2(1780) INTO N GAMMA                     938+   0
P5      N*1/2(1780) INTO GAM P, HELICITY=1/2           0+ 938
P6      N*1/2(1780) INTO GAM N, HELICITY=1/2           0+ 939
P7      N*1/2(1780) INTO N PI PI                     938+ 139+ 139
P8      N*1/2(1780) INTO N EPSILON                   938+ 600
P9      N*1/2(1780) INTO N RHO                       938+ 770

            14  N*1/2(1780) BRANCHING RATIOS

R1      N*1/2(1780) INTO (PI N)/TOTAL                  (P1)
R1  3     (0.32)                   DONNACHI  68 RVUE                     8/69
R1  6     (0.149)                  AYED      70 IPWA                     1/71
R1  4     (0.43)                   DAVIES    70 RVUE   SOL A             8/69
R1  7     (0.2).                   ALMEHED   72 IPWA                     2/72

R2      N*1/2(1780) INTO (LAMBDA K)*(PI N)/TOTAL**2    (P2*P1)
R2        0.004     0.003          ORITO     69 RVUE                     8/69
R2  A     (0.025)OR 0.043          WAGNER    71 IPWA   PI-P TO K LAMB    1/71

R3      N*1/2(1780) INTO (LAMBDA K)/TOTAL              (P2)
R3  8     (0.003)TO 0.065          RUSH      68 MPWA   T POLE + RESON.   8/69
R3  8   PARAMETRIZATION USED COULD BE IN DANGER OF DOUBLE COUNTING

R4      N*1/2(1780) INTO (N ETA)/TOTAL                 (P3)
R4  B     (0.19)                   BOTKE     69 MPWA   T POLE + RESON.  10/69
R4  B     (0.09)    (0.05)         DEANS     69 MPWA   T POLE + RESON.   5/70
R4  B     (0.015)OR 0.035          CARRERAS  70 MPWA   T POLE + RESON.   5/70
R4  B   PARAMETRIZATION USED COULD BE IN DANGER OF DOUBLE COUNTING

R5      N*1/2(1780) FROM N GAMMA TO LAMBDA K           SQRT(P2*P4)
R5        (0.0027)                 ORITO2    69 CNTR   K LAM PHOTOPRO   10/71
R5        (0.0088)                 SCHORSCH  70 DPWA   K LAM PHOTOPRO.  10/71
R5        (0.0104)                 DEANS     72 MPWA                     1/73*

            14  N*1/2(1780) PHOTON DECAY AMPL(GEV**-1/2)

  FOR DEFINITION OF GAMMA-NUCLEON DECAY AMPLITUDES, SEE MINI-
REVIEW PRECEDING THE BARYON LISTINGS.

A1      N*1/2(1780) INTO GAM P, HELICITY=1/2 (GEV**-1/2)
A1        +.026      .028          OBERLACK  72 DPWA   PI N PHOTO-PROD  2/73*
A1        (-.061)                  WALKER    73 DPWA   PI N PHOTO-PROD  2/73*

A2      N*1/2(1780) INTO GAM N, HELICITY=1/2 (GEV**-1/2)
A2        +.027      .022          OBERLACK  72 DPWA   PI N PHOTO-PROD  2/73*
A2        (+.052)                  WALKER    73 DPWA   PI N PHOTO-PROD  2/73*
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                  REFERENCES FOR N*1/2(1780)

DONNACHI  68 PL 26B 161       A DONNACHIE, R G KIRSOPP, C LOVELACE (CERN)IJP
    ALSO  68 VIENNA 139       DONNACHIE  RAPPORTEUR.S TALK          (GLAS)
    ALSO  68 THESIS           R G KIRSOPP                           (EDIN)
RUSH      68 PR 173 1776      J E RUSH                      (UNIV ALABAMA)

BOTKE     69 PR 180 1417      J C BOTKE                             (UCSB)
DEANS     69 PR 185 1797      S DEANS, J WOOTEN          (UNIV S FLORIDA)
ORITO     69 LNC 1 936        S ORITO,S SASAKI              (TOKYO-OSAKA)
ORITO2    69 INS J 113        S ORITO (THESIS)                     (TOKYO)

AYED      70 KIEV CONF        R AYED,P BAREYRE, G VILLET          (SACL)IJP
CARRERAS  70 NP 16B 35        B CARRERAS, A DONNACHIE          (DARE,MCHS)
DAVIES    70 NP B21 359       A DAVIES                              (GLAS)
SCHORSCH  70 NP  B25 179      +TIETGE,WEILNBOECK                    (MPIM)

WAGNER    71 NP B25 411       F WAGNER, C LOVELACE                  (CERN)

ALMEHED   72 NP B40 157       +LOVELACE                     (LUND,RUTG)IJP
DEANS.    72 PN 3 217         +JACOBS, LYONS, HICKS   (U S FL TAMPA+CARN)
OBERLACK  72 PL 43B 44        H.OBERLACK,R.G.MOORHOUSE               (LBL)
WALKER    73 TO BE PUB.       R.L.WALKER,W.J.METCALF                 (CIT)

                  PAPERS NOT REFERRED TO IN DATA CARDS.

DEANS     69 PR  177 2623     S R DEANS                  (UNIV S FLORIDA)
DONNACHI  69 NP 108 433       A DONNACHIE, R KIRSOPP         (GLAS+EDIN)
AYED      70 PL 31B 598       +BAREYRE+VILLET                     (SACLAY)
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N(1860) — P_{13}

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15  N*1/2(1860, JP=3/2+) I=1/2

FOR DISCUSSION CONCERNING RESONANT PARAMETERS,SEE NOTE
PRECEDING N*1/2(1470).

            15  N*1/2(1860) MASS (MEV)

M   3     (1860.0)                 DONNACHI  68 RVUE   PHASE-SHIFT ANAL  6/68
M   X     (1860.0)      APPROX     LEA       69 CNTR   PI-P ELASTIC      8/69
M   X   SEE ALSO APLIN 71
M   6     (1766.0)                 AYED      70 IPWA                     1/71
M   6   FROM ENER. DEP. FIT OF ARGAND DIAGRAM
M   4     (1844.0)                 DAVIES    70 RVUE   P-S ANAL  SOL A   8/69
M   A     (1800.0)                 WAGNER    71 IPWA   PI-P TO K LAMB    1/71
M   A   P13 RESONATES ONLY IN ONE OUT OF 3 POSSIBLE SOLUTIONS
M   7     (1850.)                  ALMEHED   72 IPWA                     2/72

            15  N*1/2(1860) WIDTH (MEV)

W   3     (296.00)                 DONNACHI  68 RVUE                     8/69
W   6     (182.0)                  AYED      70 IPWA                     1/71
W   4     (449.0)                  DAVIES    70 RVUE   SOL A             8/69
W   4   SOL B GIVES 307 MEV                                              2/73*
W   A     (220.0)                  WAGNER    71 IPWA   PI-P TO K LAMB    1/71
W   7     (300.)                   ALMEHED   72 IPWA                     2/72
          SEE THE NOTES ACCOMPANYING THE MASSES QUOTED

            15  N*1/2(1860) PARTIAL DECAY MODES

                                                     DECAY MASSES
P1      N*1/2(1860) INTO PI N                        139+ 938
P2      N*1/2(1860) INTO LAMBDA K                   1115+ 497
P3      N*1/2(1860) INTO N ETA                       939+ 548
P4      N*1/2(1860) INTO N PI PI                     938+ 139+ 139
P5      N*1/2(1860) INTO N GAMMA                     938+   0
P6      N*1/2(1860) INTO N RHO                       938+ 770

            15  N*1/2(1860) BRANCHING RATIOS

R1      N*1/2(1860) INTO (PI N)/TOTAL                  (P1)
R1  3     (0.21)                   DONNACHI  68 RVUE                     8/69
R1  6     (0.149)                  AYED      70 IPWA                     1/71
R1  4     (0.40)                   DAVIES    70 RVUE   SOL A             8/69
R1  7     (0.25)                   ALMEHED   72 IPWA                     2/72

R2      N*1/2(1860) INTO (LAMBDA K)/TOTAL              (P2)
R2  B     (0.014)TO 0.16           RUSH      68 MPWA   T POLE + RESON.   8/69
R2  B   PARAMETRIZATION USED COULD BE IN DANGER OF DOUBLE COUNTING

R3      N*1/2(1860) INTO (N ETA)/TOTAL                 (P3)
R3  B     (0.0364)                 BOTKE     69 MPWA   T POLE + RESON.  10/69
R3  B     (0.003)  (0.003)         DEANS     69 MPWA   T POLE + RESON.   5/70
R3  B     (0.030)OR 0.094          CARRERAS  70 MPWA   T POLE + RESON.   5/70
R3  B   PARAMETRIZATION USED COULD BE IN DANGER OF DOUBLE COUNTING

R4      N*1/2(1860) INTO (LAMBDA K)*(PI N)/TOTAL**2    (P2*P1)
R4  A     (0.015)                  WAGNER    71 IPWA   PI-P TO K LAMB    1/71

R5      N*1/2(1860) FROM N GAMMA TO LAMBDA K           SQRT(P2*P5)
R5        (0.008)                  DEANS     72 MPWA                     1/73*
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Data Card Listings

For notation, see key at front of Listings.

Baryons

N(1860), N(1990), N(2040), N(2100)

REFERENCES FOR N*1/2(1860)

DONNACH1 68 PL 26B 161 — A DONNACHIE, R G KIRSOPP, C LOVELACE (CERN)IJP
ALSO 68 VIENNA 139 — DONNACHIE RAPPORTEUR.S TALK (GLAS)
ALSO 68 THESIS — R G KIRSOPP (EDIN)
RUSH 68 PR 173 1776 — J E RUSH (UNIV ALABAMA)

BOTKE 69 PR 180 1417 — J C BOTKE (UCSB)
DEANS 69 PR 185 1797 — S DEANS, J WOOTEN (UNIV S FLORIDA)
LEA 69 PL 29B 584 — LEA,OADES,WARD,COWAN,+ (RHEL,BRISTOL,DARE)

AYED 70 KIEV CONF — R AYED,P BAREYRE, G VILLET (SACL)IJP
CARRERAS 70 NP 16B 35 — B CARRERAS, A DONNACHIE (DARE,MCHS)
DAVIES 70 NP B21 359 — A DAVIES (GLAS)

WAGNER 71 NP B25 411 — F WAGNER, C LOVELACE (CERN)

ALMEHED 72 NP B40 157 — +LOVELACE (LUND,RUTG)IJP
DEANS 72 PN 3 217 — +JACOBS, LYONS, HICKS (U S FL TAMPA+CARN)

PAPERS NOT REFERRED TO IN DATA CARDS.

DEANS 69 PR 177 2623 — S R DEANS (UNIV S FLORIDA)
DONNACHI 69 NP 10B 433 — A DONNACHIE, R KIRSOPP (GLAS+EDIN)

AYED 70 PL 31B 598 — +BAREYRE,VILLET (SACLAY)
APLIN 71 NP B32 253 — +COWAN,GIBSON,GILMORE++ (RHEL,BRISTOL)

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N(1990)

17 N*1/2(1990, JP=7/2+) I=1/2 **F_{17}**

A NEW, PRELIMINARY ENERGY DEPENDENT ANALYSIS BY AYED 72 NOW FINDS THIS STATE. SEE THE N* MINI REVIEW.

17 N*1/2(1990) MASS (MEV)

M	3	(1983.0)	DONNACH1	68	RVUE	PHASE-SHIFT ANAL	
M	3	(1995.)	KIRSOPP	68	RVUE	PHASE SHIFT ANAL	10/69
M	3	WHERE MAX. ABSORPTION IS -DONNACH1, 2 ,KIRSOPP				EYEBALL FIT CERN 1	10/69
M	X	(2000.0) APPROX	LEA	69	CNTR	PI-P ELASTIC	8/69
M	X	SEE ALSO APLIN 71					
M	7	(2000.)	ALMEHED	72	IPWA		2/72

17 N*1/2(1990) WIDTH (MEV)

W	3	(225.0)	DONNACH1	68	RVUE		8/69
W	3	(250.)	KIRSOPP	68	RVUE	PHASE SHIFT ANAL	10/69
W	7	(200.)	ALMEHED	72	IPWA		2/72

17 N*1/2(1990) PARTIAL DECAY MODES

		DECAY MASSES
P1	N*1/2(1990) INTO PI N	139+ 938
P2	N*1/2(1990) INTO N PI PI	938+ 139+ 139
P3	N*1/2(1990) INTO N ETA	939+ 548
P4	N*1/2(1990) INTO LAMBDA K	1115+ 497
P5	N*1/2(1990) INTO N GAMMA	938+ 0

17 N*1/2(1990) BRANCHING RATIOS

R1 N*1/2(1990) INTO (PI N)/TOTAL (P1)

R1	3	(.09)	KIRSOPP	68	RVUE	PHASE SHIFT ANAL	10/69
R1	7	(0.15)	ALMEHED	72	IPWA		2/72

R2 N*1/2(1990) INTO (N ETA)/TOTAL (P3)

R2	B	(0.02) (0.02)	DEANS	69	MPWA	T POLE + RESON.	5/70
R2	B	PARAMETRIZATION USED COULD BE IN DANGER OF DOUBLE COUNTING					

R3 N*1/2(1990) FROM N GAMMA TO LAMBDA K SQRT(P4*P5)

R3		(0.003)	DEANS	72	MPWA		1/73*

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REFERENCES FOR N*1/2(1990)

DONNACH1 68 PL 26B 161 — A DONNACHIE, R G KIRSOPP, C LOVELACE (CERN)IJP
KIRSOPP 68 THESIS — R G KIRSOPP (EDIN)

DEANS 69 PR 185 1797 — S DEANS, J WOOTEN (UNIV S FLORIDA)
LEA 69 PL 29B 584 — LEA,OADES,WARD,COWAN,+ (RHEL,BRISTOL,DARE)

ALMEHED 72 NP B40 157 — +LOVELACE (RUTG)IJP
DEANS 72 PN 3 217 — +JACOBS, LYONS, HICKS (U S FL TAMPA+CARN)

PAPERS NOT REFERRED TO IN DATA CARDS.

DEANS 69 PR 177 2623 — S R DEANS (UNIV S FLORIDA)
AYED 70 PL 31B 598 — +BAREYRE,VILLET (SACLAY)
APLIN 71 NP B32 253 — +COWAN,GIBSON,GILMORE++ (RHEL,BRISTOL)
AYED 72 BATAVIA CONF — R AYED,P BAREYRE, Y LEMOIGNE (SACL)

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N(2040)

16 N*1/2(2040, JP=3/2-) I=1/2 **D'''_{13}**

FOR DISCUSSION CONCERNING RESONANT PARAMETERS,SEE NOTE PRECEDING N*1/2(1470).

16 N*1/2(2040) MASS (MEV)

M	3	(2057.0)	DONNACH1	68	RVUE	PHASE-SHIFT ANAL	6/68
M	3	(2030.)	DONNACH2	68	RVUE	PHAS.SHIFT-CERN1	10/69
M	3	(2040.)	KIRSOPP	68	RVUE	PHASE SHIFT ANAL	10/69
M	3	WHERE MAX. ABSORPTION IS -DONNACH1, 2 ,KIRSOPP				EYEBALL FIT CERN 1	10/69
M	X	(2030.0) APPROX	LEA	69	CNTR	PI-P ELASTIC	8/69
M	X	SEE ALSO APLIN 71					
M	7	(2075.)	ALMEHED	72	IPWA		2/72

16 N*1/2(2040) WIDTH (MEV)

W		(293.0)	DONNACH1	68	RVUE		8/69
W	3	(290.)	DONNACH2	68	RVUE	PHAS.SHIFT-CERN1	10/69
W	3	(240.)	KIRSOPP	68	RVUE	PHASE SHIFT ANAL	10/69
W	7	(150.)	ALMEHED	72	IPWA		2/72
		SEE THE NOTES ACCOMPANYING THE MASSES QUOTED.					

16 N*1/2(2040) PARTIAL DECAY MODES

		DECAY MASSES
P1	N*1/2(2040) INTO PI N	139+ 938
P2	N*1/2(2040) INTO N PI PI	938+ 139+ 139
P3	N*1/2(2040) INTO N ETA	939+ 548
P4	N*1/2(2040) INTO LAMBDA K	1115+ 497
P5	N*1/2(2040) INTO N GAMMA	938+ 0

16 N(1/2(2040) BRANCHING RATIOS

R1 N*1/2(2040) INTO (PI N)/TOTAL (P1)

R1	3	(.26)	DONNACH2	68	RVUE	PHAS.SHIFT-CERN1	10/69
R1	3	(.15)	KIRSOPP	68	RVUE	PHASE SHIFT ANAL	10/69
R1	7	(0.3)	ALMEHED	72	IPWA		2/72

R2 N*1/2(2040) INTO (N ETA)/TOTAL (P3)

R2	B	(0.) OR 0.009	CARRERAS	70	MPWA	T POLE + RESON.	5/70
R2	B	PARAMETRIZATION USED COULD BE IN DANGER OF DOUBLE COUNTING					

R3 N*1/2(2040) FROM N GAMMA TO LAMBDA K SQRT(P4*P5)

R3		(0.007)	DEANS	72	MPWA		1/73*

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REFERENCES FOR N*1/2(2040)

DONNACH1 68 PL 26B 161 — A DONNACHIE, R G KIRSOPP, C LOVELACE (CERN)IJP
DONNACH2 68 VIENNA 139 — DONNACHIE RAPPORTEUR.S TALK (GLAS)
KIRSOPP 68 THESIS — R G KIRSOPP (EDIN)

LEA 69 PL 29B 584 — LEA,OADES,WARD,COWAN,+ (RHEL,BRISTOL,DARE)

CARRERAS 70 NP 16B 35 — B CARRERAS, A DONNACHIE (DARE,MCHS)

ALMEHED 72 NP B40 157 — +LOVELACE (LUND,RUTG)IJP
DEANS 72 PN 3 217 — +JACOBS, LYONS, HICKS (U S FL TAMPA+CARN)

PAPERS NOT REFERRED TO IN DATA CARDS.

DONNACHI 69 NP 10B 433 — A DONNACHIE, R KIRSOPP (GLAS+EDIN)
AYED 70 PL 31B 598 — +BAREYRE,VILLET (SACLAY)
APLIN 71 NP B32 253 — +COWAN,GIBSON,GILMORE++ (RHEL,BRISTOL)

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N(2100)

04 N*1/2(2100, JP=1/2-) I=1/2 **S'''_{11}**

A NEW, PRELIMINARY ENERGY DEPENDENT ANALYSIS BY AYED 72 NOW FINDS EVIDENCE FOR THIS RESONANCE AT ABOUT 2200 MEV. SEE THE N* MINI REVIEW.

04 N*1/2(2100) MASS (MEV)

M		(2070.)	ROYCHOUD	71	DPWA	3/72
M	7	(2100.)	ALMEHED	72	IPWA	2/72

04 N*1/2(2100) WIDTH (MEV)

W	7	(200.)	ALMEHED	72	IPWA	2/72

04 N*1/2(2100) PARTIAL DECAY MODES

		DECAY MASSES
P1	N*1/2(2100) INTO PI N	139+ 938

Baryons
N(2100), N(2175), N(2190)

Data Card Listings
For notation, see key at front of Listings.

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                    04  N*1/2(2100) BRANCHING RATIOS

R1      N*1/2(2100) INTO (PI N)/TOTAL                     (P1)
R1  7          (0.5)                 ALMEHED    72 IPWA                      2/72

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                              REFERENCES FOR N*1/2(2100)

ROYCHOUD 71 NP B27 125       R K ROYCHOUDHURY,B H BRANSDEN          (DURH)IJP
ALMEHED  72 NP B40 157       +LOVELACE                          (LUND,RUTG)IJP

                              PAPERS NOT REFERRED TO IN DATA CARDS.

AYED     72 BATAVIA CONF     R AYED,P BAREYRE, Y LEMOIGNE           (SACL)

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N(2100) → 05 N*1/2(2100, JP=5/2-) I=1/2 **D''_{15}**

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   A NEW, PRELIMINARY ENERGY DEPENDENT ANALYSIS BY
AYED 72 NOW FINDS EVIDENCE FOR THIS RESONANCE AT
ABOUT 2055 MEV.  SEE THE N* MINI REVIEW.

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                    05  N*1/2(2100) MASS (MEV)

M   7       (2100.)                  ALMEHED    72 IPWA                      2/72

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                    05  N*1/2(2100) WIDTH (MEV)

W   7       (150.)                   ALMEHED    72 IPWA                      2/72

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                    05  N*1/2(2100) PARTIAL DECAY MODES

                                                               DECAY MASSES
P1      N*1/2(2100) INTO PI N                                  139+ 938

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                    05  N*1/2(2100) BRANCHING RATIOS

R1      N*1/2(2100) INTO (PI N)/TOTAL                     (P1)
R1  7          (0.2)                 ALMEHED    72 IPWA                      2/72

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                              REFERENCES FOR N*1/2(2100)

ALMEHED  72 NP B40 157       +LOVELACE                          (LUND,RUTG)IJP

                              PAPERS NOT REFERRED TO IN DATA CARDS.

AYED     72 BATAVIA CONF     R AYED,P BAREYRE, Y LEMOIGNE           (SACL)

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N(2175) → 06 N*1/2(2175, JP=5/2+) I=1/2 **F''_{15}**

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   SEE THE NOTE ON N'S AND DELTAS PRECEDING THE
BARYON DATA CARD LISTINGS.

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                    06  N*1/2(2175) MASS (MEV)

M   7       (2175.)                  ALMEHED    72 IPWA                      2/72

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                    06  N*1/2(2175) WIDTH (MEV)

W   7       (150.)                   ALMEHED    72 IPWA                      2/72

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                    06  N*1/2(2175) PARTIAL DECAY MODES

                                                               DECAY MASSES
P1      N*1/2(2175) INTO PI N                                  139+ 938
P2      N*1/2(2175) INTO LAMBDA K                             1115+ 497
P3      N*1/2(2175) INTO L GAMMA                               938+   0

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                    06  N*1/2(2175) BRANCHING RATIOS

R1      N*1/2(2175) INTO (PI N)/TOTAL                     (P1)
R1  7          (0.25)                ALMEHED    72 IPWA                      2/72

R2      N*1/2(2175) FROM N GAMMA TO LAMBDA K               SQRT(P2*P3)
R2             (0.002)               DEANS      72 MPWA                      1/73*

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                              REFERENCES FOR N*1/2(2175)

ALMEHED  72 NP B40 157       +LOVELACE                              (RUTG)IJP
DEANS    72 PN 3 217         +JACOBS, LYONS, HICKS   (U S FL TAMPA+CARN)

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N(2190) 71 N*1/2(2190, JP=7/2-) I=1/2 **G_{17}**

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ROYCHOUDHURY 71 FIND SOME INDICATION OF P11 AND F17 IN
THIS REGION.BRANSDEN 71 ALSO FIND P11,F15,AND G19 RESO-
NANT NEAR THIS MASS.

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                    71  N*1/2(2190) MASS (MEV)

M          (2190.0)                  DIDDENS   63 CNTR    PI+- P TOTAL
M          (2210.0)                  HOHLER    64 RVUE    DATA + DISP REL
M          (2190.0)      APPROX      YOKOSAWA  66 CNTR    PI- P DSIG + POL   7/66
M   3      (2265.0)                  DONNACH1  68 RVUE    PHASE-SHIFT ANAL   6/68
M          (2000.0)      APPROX      LEA       69 CNTR    PI-P ELASTIC       8/69
M           2180.     25.            ANDERSON  70 MMS   - PI- P TO PI- MMS   2/71
M   6      (2158.0)                  AYED      70 IPWA                       1/71
M   6   FROM ENER. DEP. FIT OF ARGAND DIAGRAM
M          (2260.0)                  HULL      70 MPWA    SMALL ANGLE PI-P   1/71
M          (2160.0)   (50.0)         AMALDI    71 CNTR    P P AT 24 GEV     10/71
M          (2160.)                   BRANSDEN  71 DPWA                       3/72
M          (2200.)                   ROYCHOUD  71 DPWA                       3/72
M   7      (2225.)                   ALMEHED   72 IPWA                       2/72
M          (2190.)                   OTT       72 MPWA  0 PI-P BKWD ELSTC    2/73*

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                    71  N*1/2(2190) WIDTH (MEV)

W           (200.0)                  DIDDENS   63 CNTR
W           (200.0)                  HOHLER    64 RVUE                       7/66
W           (220.0)      APPROX      YOKOSAWA  66 CNTR                       7/66
W   3       (298.0)                  DONNACH1  68 RVUE                       6/68
W            275.     70.            ANDERSON  70 MMS   - PI- P TO PI- MMS   2/71
W   6       (325.0)                  AYED      70 IPWA                       1/71
W           (239.0)                  HULL      70 MPWA    SMALL ANGLE PI-P   1/71
W   7       (150.)                   ALMEHED   72 IPWA                       2/72
        SEE THE NOTES ACCOMPANYING THE MASSES QUOTED.

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                    71  N*1/2(2190) PARTIAL DECAY MODES

                                                          DECAY MASSES
P1      N*1/2(2190) INTO PI N                             139+ 938
P2      N*1/2(2190) INTO LAMBDA K                        1115+1765
P3      N*1/2(2190) INTO N PI PI                          938+ 139+ 139
P4      N*1/2(2190) INTO N GAMMA                          938+   0

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                    71  N*1/2(2190) BRANCHING RATIOS

R1      N*1/2(2190) INTO (PI N)/TOTAL                     (P1)
R1             (0.3)     APPROX      DIDDENS   63 CNTR                       7/66
R1             (0.3)     APPROX      YOKOSAWA  66 CNTR                       7/66
R1  3          (0.349)               DONNACH1  68 RVUE                       6/68
R1  6          (0.150)               AYED      70 IPWA                       1/71
R1             (0.09)                HULL      70 MPWA    SMALL ANGLE PI-P   1/71
R1  7          (0.35)                ALMEHED   72 IPWA                       2/72
R1             (.25)                 OTT       72 MPWA  0 PI-P BKWD ELSTC    2/73*

R2      N*1/2(2190) FROM N GAMMA TO LAMBDA K               SQRT(P2*P4)
R2             (0.016)               DEANS     72 MPWA                       1/73*

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                              REFERENCES FOR N*1/2(2190)

DIDDENS  63 PRL 10 262       +JENKINS, KYCIA, RILEY                  (BNL) I
HOHLER   64 PL 12 149        G HOHLER, J GIESECKE              (KARLSRUHE) I
YOKOSAWA 66 PRL 16 714       +SUWA,HILL,ESTERLING, BOOTH        (ANL,CHIC) JP

DONNACH1 68 PL 26B 161       A DONNACHIE, R G KIRSOPP, C LOVELACE (CERN)IJP
    ALSO 68 VIENNA 139       DONNACHIE  RAPPORTEUR.S TALK             (GLAS)
    ALSO 68 THESIS           R G KIRSOPP                              (EDIN)

LEA      69 PL 29B 584       LEA,OADES,WARD,COWAN,+  (RHEL,BRISTOL,DARE)

ANDERSON 70 PRL 25,699       +BLESER,BLIEDEN,COLLINS++           (BNL,CARN)
AYED     70 KIEV CONF        R AYED,P BAREYRE, G VILLET             (SACL)IJP
HULL     70 PR D2 1783       J HULL, R LEACOCK                         (ISU)

AMALDI   71 PL  34B 435      +BIANCASTELLI,BOSIO,+  (I SANITA ROMA+CERN)
BRANSDEN 71 NP B26 511       ,OGDEN                                 (DURH)IJP
    ALSO 70 NP B16 461       ROYCHOUDHURY,PERRIN, BRANSDEN          (DURH)IJP
ROYCHOUD 71 NP B27 125       R K ROYCHOUDHURY,B H BRANSDEN          (DURH)IJP

ALMEHED  72 NP B40 157       +LOVELACE                          (LUND,RUTG)IJP
DEANS    72 PN 3 217         +JACOBS, LYONS, HICKS   (U S FL TAMPA+CARN)
OTT      72 PL 42B 133       +TRISCHUK,VAVRA,RICHARDS,+ (MCGI,STLO,IOWA)IJP
    ALSO 72 MCGILL THESIS    J.VAVRA                                (MCGI) JP

                              PAPERS NOT REFERRED TO IN DATA CARDS.

AYED     70 PL 31B 598       +BAREYRE,VILLET                       (SACLAY)

               QUANTUM NUMBER DETERMINATIONS NOT REFERRED TO IN DATA CARDS.

BARGER   66 PRL 16 913       V BARGER, D CLINE                        (WISC) P
CARROLL  66 PRL 16 288       +CORBETT,DAMERELL,MIDDLEMAS, +   (RHEL,OXF)J-L
CARROLL  66 PRL 17 1274      +CORBETT,DAMERELL,MIDDLEMAS, +   (RHEL,OXF)J-L
    ERRATUM CHANGING THE RATHER WEAK DETERMINATION OF J-L TO +1        (2.)
KORMANYO 66 PRL 16 709       KORMANYOS,KRISCH,OFALLON, +        (MICH,ANL) P
BUSZA    67 NC 52A 331       +DAVIS,DUFF,HEYMANN, +         (LOUC,WESTFIELD)

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Data Card Listings

For notation, see key at front of Listings.

Baryons

N(2220), N(2650), N(3030), N?(3245)

N(2220) H_{19}

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90  N*1/2(2220, JP=9/2+) I=1/2
FOR DISCUSSION CONCERNING RESONANT PARAMETERS,SEE NOTE
PRECEDING N*1/2(1470).

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              90  N*1/2(2220) MASS (MEV)

M        (2200.)   APPROX.        BUSZA    67 OSPK   LEG.POLYN.ANAL.   2/71
M    6   (2221.0)                 AYED     70 IPWA                     1/71
M    6   FROM ENER. DEP. FIT OF ARGAND DIAGRAM
M        (2245.0)                 HULL     70 MPWA   SMALL ANGLE PI-P  1/71

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              90  N*1/2(2220) WIDTH (MEV)

W    6   (258.0)                  AYED     70 IPWA                     1/71
W        (329.0)                  HULL     70 MPWA   SMALL ANGLE PI-P  1/71

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              90  N*1/2(2220) PARTIAL DECAY MODES

                                                          DECAY MASSES
P1       N*1/2(2220) INTO PI N                          139+ 938
P2       N*1/2(2220) INTO N ETA                         939+ 548

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              90  N*1/2(2220) BRANCHING RATIOS

R1       N*1/2(2220) INTO (PI N)/TOTAL                 (P1)
R1   6       (0.140)              AYED     70 IPWA                     1/71
R1           (0.15)               HULL     70 MPWA   SMALL ANGLE PI-P  1/71

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                         REFERENCES FOR N*1/2(2220)

BUSZA    67 NC 52A 331       +DAVIS,DUFF,HEYMANN,NIMMON +    (LOUC+LOWC)
AYED     70 KIEV CONF        R AYED,P BAREYRE, G VILLET          (SACL)IJP
HULL     70 PR D2 1783       J HULL, R LEACOCK                   (ISU)

                         PAPERS NOT REFERED TO IN DATA CARDS

AYED     70 PL 31B 598       +BAREYRE,VILLET                     (SACLAY)
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N(2650) BUMPS

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72  N*1/2(2650, JP=    -) I=1/2  PRODUCTION EXPERIMENTS

ROYCHOUDHURY 71 CLAIM F15(2400) AND G19(2400) TO BE
POSSIBLE RESONANCES. BRANSDEN 71 FIND THE POSSIBLE
RESONANT CANDIDATES S11(2520) AND H19(2590).

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              72  N*1/2(2650) MASS (MEV) (PROD. EXP.)

M        (2700.0)                 ALVAREZ  64 CNTR   PI PHOTOPROD
M        (2660.0)                 HOHLER   64 RVUE   DATA + DISP REL
M        (2600.0)     APPROX      WAHLIG   64 OSPK  0 PI-P CH EX
M        (2633.0)                 BARGER   66 FIT    TOTAL + CH EX    11/67
M         2649.0     10.0         CITRON   66 CNTR   PI+- P TOTAL      7/66

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              72  N*1/2(2650) WIDTH (MEV) (PROD. EXP.)

W        (100.0)                  ALVAREZ  64 CNTR
W        (200.0)                  HOHLER   64 RVUE                     7/66
W        (425.0)                  BARGER   66 FIT    TOTAL + CH EX    11/67
W         360.0      20.0         CITRON   66 CNTR                     7/66

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              72  N*1/2(2650) PARTIAL DECAY MODES (PROD. EXP.)

                                                          DECAY MASSES
P1       N*1/2(2650) INTO PI N                          139+ 938
P2       N*1/2(2650) INTO LAMBDA K                     1115+ 497
P3       N*1/2(2650) INTO N PI PI                       938+ 139+ 139

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           -  72  N*1/2(2650) BRANCHING RATIOS (PROD. EXP.)

R1       N*1/2(2650) INTO (PI N)/TOTAL                 (P1)
R1     ONLY (J+1/2)*( PI N/TOTAL) MEASURED FOR THIS STATE
R1   B       (0.456)  (0.018)     BARGER   66 RVUE   TOTAL + CH EXC.  11/67
R1            0.436    0.028      CITRON   66 CNTR   TOTAL CROSS-SEC. 11/67
R1   B       (0.30)               BARGER   67 RVUE   USES KORMANYOS67 11/67
R1   B   USES REGGE AMP.+RESON. TO CALCULATE DIF. CROSS SECTIONS AT 180 DEGRE
R1   B   FOR CRITICISM OF THIS METHOD, SEE DOLEN 68.
R1   D       (0.24)               DIKMEN   67 RVUE   USES KORMANYOS66 11/67
R1   D   USES ONLY RESONANCES TO CALCULATE DIF. CROSS SECTIONS AT 180 DEGREES
R1           (0.06)               KORMANYOS 67 CNTR   PI-P AT 180 DEG. 11/67

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                         REFERENCES FOR N*1/2(2650) (PROD. EXP.)

ALVAREZ  64 PRL 12 710       +BAR-YAM,KERN,LUCKEY,OSBORNE, +   (MIT,CEA)
HOHLER   64 PL 12 149        G HOHLER, J GIESECKE            (KARLSRUHE) I
WAHLIG   64 PRL 13 103       +MANNELLI,SODICKSON,FACKLER,WARD, +   (MIT)
BARGER   66 PR 151 1123      V BARGER, M OLSSON                  (WISC)
CITRON   66 PR 144 1101      +GALBRAITH,KYCIA,LEONTIC,PHILLIPS, +  (BNL) I
BARGER   67 PR 155 1792      V BARGER, D CLINE                   (WISC) P
DIKMEN   67 PRL 18 798       F N DIKMEN                          (MICH)
KORMANYO 67 PR 164 1661      KORMANYOS, KRISCH, OFALLON, +    (MICH,ANL) P

                         PAPERS NOT REFERRED TO IN DATA CARDS.

BAACKE   67 NC 51A 761       J BAACKE, M YVERT         (KARLSRUHE,ORSAY)J-L
DOLEN    68 PR 166 1768      R DOLEN, D HORN, C SCHMID           (CIT)
WAHLIG   68 PR 168 1515      M A WAHLIG, I MANNELLI           (MIT,PISA)
    FINAL VERSION OF DATA USED IN WAHLIG 64.  IN CONFUNCTION WITH
    CITRON 66 TOTAL CROSS SECTIONS, THIS CHARGE EXCHANGE DATA GIVES
    COMPLEX ELASTIC SCATTERING AMPLITUDE AT 0 DEGREES.

BRANSDEN 71 NP B26 511       ,OGDEN                              (DURH)IJP
    ALSO 70 NP B16 461       ROYCHOUDHURY,PERRIN,BRANSDEN        (DURH)IJP
ROYCHOUD 71 NP B27 125       R K ROYCHOUDHURY,B H BRANSDEN       (DURH)IJP
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N(3030) BUMPS

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73  N*1/2(3030, JP=     ) I=1/2  PRODUCTION EXPERIMENTS

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              73  N*1/2(3030) MASS (MEV) (PROD. EXP.)

M        (3080.0)                 HOHLER   64 RVUE   DATA + DISP REL   7/66
M        (3030.0)                 CITRON   66 CNTR   PI+- P TOTAL      7/66

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              73  N*1/2(3030) WIDTH (MEV) (PROD. EXP.)

W        (400.0)                  CITRON   66 CNTR                     7/66

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              73  N*1/2(3030) PARTIAL DECAY MODES (PROD. EXP.)

                                                          DECAY MASSES
P1       N*1/2(3030) INTO PI N                          139+ 938
P2       N*1/2(3030) INTO N PI PI                       938+ 139+ 139

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              73  N*1/2(3030) BRANCHING RATIOS (PROD. EXP.)

R1       N*1/2(3030) INTO (PI N)/TOTAL                 (P1)
R1     ONLY (J+1/2)*( PI N/TOTAL) MEASURED FOR THIS STATE
R1   B       (0.088)  (0.016)     BARGER   66 RVUE   TOTAL + CH EXC.  11/67
R1           (0.048)              CITRON   66 CNTR   TOTAL CROS.SEC.  11/67
R1   B       (0.12)               BARGER   67 CNTR   USES KORMANYOS66 11/67
R1   B   USES REGGE AMP.+RESON. TO CALCULATE DIF. CROSS SECTIONS AT 180 DEGRE
R1   B   FOR CRITICISM OF THIS METHOD, SEE DOLEN 68.
R1   D       (0.016)              DIKMEN   67 RVUE   USES KORMANYOS67 11/67
R1   D   USES ONLY RESONANCES TO CALCULATE DIF. CROSS SECTIONS AT 180 DEGREES

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                         REFERENCES FOR N*1/2(3030) (PROD. EXP.)

HOHLER   64 PL 12 149        G HOHLER, J GIESECKE            (KARLSRUHE) I
BARGER   66 PR 151 1123      V BARGER, M OLSSON                  (WISC)
CITRON   66 PR 144 1101      +GALBRAITH,KYCIA,LEONTIC;PHILLIPS, +  (BNL) I
BARGER   67 PR 155 1792      V BARGER, D CLINE                   (WISC) P
DIKMEN   67 PRL 18 798       F N DIKMEN                          (MICH)

                         PAPERS NOT REFERRED TO IN DATA CAROS

KORMANYO 67 PR 164 1661      KORMANYOS, KRISCH, OFALLON, +    (MICH,ANL) P
DOLEN    68 PR 166 1768      R DOLEN, D HORN, C SCHMID           (CIT)
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N?(3245) BUMPS

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74  N* /2(3245, JP=    +)        PRODUCTION EXPERIMENTS

EXISTENCE NOT CONCLUSIVELY ESTABLISHED.  I-SPIN
NOT DETERMINED, BUT THE NARROW WIDTH PRECLUDES
IDENTIFICATION WITH THE N*3/2(3230).
OMITTED FROM TABLE.

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              74  N* /2(3245) MASS (MEV) (PROD. EXP.)

M         3245.0     10.0         KORMANYOS 67 CNTR   PI-P 180 DEG EL   6/68

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              74  N* /2(3245) WIDTH (MEV) (PROD. EXP.)

W        (35.0)   OR LESS         KORMANYOS 67 CNTR                     6/68

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              74  N* /2(3245) PARTIAL DECAY MODES (PROD. EXP.)

                                                          DECAY MASSES
P1       N* /2(3245) INTO PI N                          139+ 938

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              74  N* /2(3245) BRANCHING RATIOS (PROD. EXP.)

R1       N* /2(3245) INTO (PI N)/TOTAL                 (P1)
R1     J IS NOT KNOWN.  FOLLOWING IS (J+1/2)*(PI N)/TOTAL
R1           (0.37)               KORMANYOS 67 CNTR                     6/68

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                         REFERENCES FOR N* /2(3245) (PROD. EXP.)

KORMANYO 67 PR 164 1661      KORMANYOS, KRISCH, OFALLON, +    (MICH,ANL) P
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Baryons
N(3690), N?(3755), Δ(1236)

Data Card Listings
For notation, see key at front of Listings.

N(3690) BUMPS

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75 N*1/2(3690, JP=    ) I=1/2  PRODUCTION EXPERIMENTS
A BUMP SEEN IN THE INVARIANT MASS OF A VERY COMPLI-
CATED STATE (N + SEVEN PIS), SO AS EVIDENCE FOR
A NEW RESONANCE IT IS NOT CONCLUSIVE.  NOT INCLUDED
IN TABLE.

              75  N*1/2(3690) MASS (MEV) (PROD. EXP.)

M      3690.0    10.0         BARTKE    67 HBC  +  PI+P 8 PRONGS    8/67

              75  N*1/2(3690) WIDTH (MEV) (PROD. EXP.)

W        50.0    30.0         BARTKE    67 HBC  +                   8/67

              75  N*1/2(3690) PARTIAL DECAY MODES (PROD. EXP.)
                                                        DECAY MASSES
P1     N*1/2(3690) INTO N + 7 PIS

                        REFERENCES FOR N*1/2(3690) (PROD. EXP.)

BARTKE    67 PL 24B 118        +CZYZEWSKI,DANYSZ,+       (CRACOW,ORSAY) I
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N?(3755) BUMPS

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76  N* /2(3755, JP=    )          PRODUCTION EXPERIMENTS
A SMALL PEAK IN THE (P P PBAR) INVARIANT MASS FROM
8.4 BEV/C PI+ P TO PI+ P P PBAR EVENTS.  AS EVIDENCE
FOR A NEW RESONANCE IT IS NOT CONCLUSIVE.  OMITTED
FROM TABLE.

              76  N* /2(3755) MASS (MEV) (PROD. EXP.)

M      3755.0     8.0         EHRLICH   68 HBC  +  PI+ P P PBAR     6/68

              76  N* /2(3755) WIDTH (MEV) (PROD. EXP.)

W        40.0    20.0         EHRLICH   68 HBC  +                   6/68

              76  N* /2(3755) PARTIAL DECAY MODES (PROD. EXP.)
                                                        DECAY MASSES
P1     N* /2(3755) INTO PI+ P P PBAR                139+ 938+ 938+ 938

                        REFERENCES FOR N* /2(3755) (PROD. EXP.)

EHRLICH   68 PRL 20 686        R EHRLICH,R J PLANO,J B WHITTAKER (RUTGERS)
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Comments on the Mass and Width of Δ(1236)

In our last edition, we presented an exhaustive discussion of the relative "uniqueness" of the pole position. On the basis of that study we have entered the pole position in both the Table and the Data Card Listings. We remind the reader of our conclusions.

1) Over a reasonable energy interval on the real axis, all parametrizations of the amplitude are equally good provided:

a) they fit the data,

b) they are unitary and have sensible "cut" features (e.g., $\delta_\ell \propto q^{2\ell+1}$).

2) For good fits to the same data, the resonance mass and width on the real axis depend upon the parametrization used (background + BW, different BW's, etc.). Indeed, we found that the fitted mass parameter ranged from 1230 to 1235 MeV, and the width from 109 to 124 MeV. Clearly, it is meaningless for us to average masses and widths corresponding to either different parametrizations or significantly different sets of data.

3) For good fits to the same data, the pole position is essentially independent of the parametrization.

Δ(1236) **P'_{33}**

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33  N*3/2(1236, JP=3/2+) I=3/2
CARTER 71 REPORT NEW PRECISE CROSS SECTION MEASURE-
MENTS FOR PI+P,PI-P AND CHARGE EXCHANGE. THEIR ANALYSIS
COMBINES TOTAL CROSS SECTION DATA WITH THE PHASE SHIFTS
OF DONNACHIE 68 (USED FOR THE BACKGROUND UNDER THE P33)
THE CHARGE EXCHANGE DATA WERE NOT USED.
   OLSON 65 HAS DONE A SIMILAR ANALYSIS ON OLDER DATA, USING ROPER 65
PHASE SHIFTS WITH A FREE OVERALL NORMALIZATION.
   SEE THE ACCOMPANYING NOTE, 'COMMENTS ON THE MASS AND WIDTH OF
DELTA(1236)'.

                   33  N*3/2(1236)  MASS (MEV)

M        (1234.)               ROPER     65 DPWA ++0 PHASE SHIFT AN.
M        (1235.)               ALMEHED   72 IPWA                       2/72
M++       1236.0     0.55      OLSSON    65 RVUE ++ TOTAL-SIGMA DATA
M++       1230.0     0.6       CARTER    71 MPWA ++ PI+P SIG. TOTAL    1/71
M++      . . . . . . . . . . .
M++ AVERAGE MEANINGLESS (SCALE FACTOR = 7.4)

MO        1236.45    0.65      OLSSON    65 RVUE  0
MO        1232.9     0.6       CARTER    71 MPWA  0 PI-P SIG. TOTAL    1/71
MO       . . . . . . . . . . .
MO  AVERAGE MEANINGLESS (SCALE FACTOR = 4.0)

                   33  N*3/2(1236) WIDTH (MEV)

W        (120.)                ROPER     65 DPWA ++0 PHASE SHIFT AN.
W        (129.)                ALMEHED   72 IPWA                       2/72
W++       120.0     2.0        OLSSON    65 RVUE ++
W++       112.8     3.0        CARTER    71 MPWA ++ PI+P SIG TOT.      1/71
W++      . . . . . . . . . . .
W++ AVERAGE MEANINGLESS (SCALE FACTOR = 2.0)

WO        119.6     2.4        OLSSON    65 RVUE  0
WO        114.7     3.0        CARTER    71 MPWA  0 PI-P SIG TOT.      1/71
WO       . . . . . . . . . . .
WO  AVERAGE MEANINGLESS (SCALE FACTOR = 1.3)

                   33  N*3/2(1236) REAL PART OF POLE POSITION(MEV)

REE      (1211.)               BALL      72                            2/73*
REE  P    1211.6    0.7        PDG       72          FIT DELTA 33      2/73*
REE  P  ERROR EST. FROM FITS WITH SOMEWHAT VARYING ASSUMPTIONS

                   33  N*3/2(1236) IMAG PART OF POLE POSITION(MEV)

IME  P     49.5     1.8        PDG       72          FIT DELTA 33      2/73*
IME        (50.)               BALL      72                            2/73*

                   33  (N*0) - (N*++) MASS DIFFERENCE (MEV)

D    R     (0.45)   (0.85)     OLSSON    65 RVUE
D    R     (2.9)    (0.85)     CARTER    71 MPWA   PI+- P SIG.TOT.     2/71
D    R     REDUNDANT WITH DATA IN MASS LISTING.

                   33  N*3/2(1236) PARTIAL DECAY MODES
                                                        DECAY MASSES
P1     N*3/2(1236) INTO N PI                           938+ 139
P2     N*3/2(1236) INTO N GAMMA                        938+   0
P3     N*3/2(1236) INTO N PI PI                        938+ 139+ 139
P4     N*3/2(1236) INTO GAM NUCLEON, HELICITY=1/2        0+ 938
P5     N*3/2(1236) INTO GAM NUCLEON, HELICITY=3/2        0+ 938

                   33  N*3/2(1236) BRANCHING RATIOS

R1     N*3/2(1236) INTO (N GAMMA)/(N PI) (PERCENT)      (P2)/(P1)
R1           0.55      0.02    DALITZ    66 RVUE                       7/68
R1           0.53      0.025   BERENDS   71 IPWA   PHOTOPROD. ANAL.   10/71
R1       . . . . . . . . . . .
R1  AVG      0.542     0.016   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

R2     N*3/2(1236)0 INTO (N PI)/TOTAL                   (P1)
R2          (0.99)             CARTER    71 MPWA  0 PI-P FORM. EXPER   1/71
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Data Card Listings

For notation, see key at front of Listings.

Baryons
Δ(1236), Δ(1650), Δ(1670)

33 N*3/2(1236) PHOTON DECAY AMPL(GEV**-1/2)

FOR DEFINITION OF GAMMA-NUCLEON DECAY AMPLITUDES, SEE MINI-REVIEW PRECEDING THE BARYON LISTINGS.

A1	N*3/2(1236) INTO GAM NUCLEON, HELICITY=1/2 (GEV**-1/2)					
A1	-.142	.006	OBERLACK	72 DPWA	PI N PHOTO-PROD	2/73*
A1	(-.139)		WALKER	73 DPWA	PI N PHOTO-PROD	2/73*
A2	N*3/2(1236) INTO GAM NUCLEON, HELICITY=3/2 (GEV**-1/2)					
A2	-.259	.016	OBERLACK	72 DPWA	PI N PHOTO-PROD	2/73*
A2	(-.253)		WALKER	73 DPWA	PI N PHOTO-PROD	2/73*

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REFERENCES FOR N*3/2(1236)

OLSSON 65 PRL 14 118 M G OLSSON (WISC)
ROPER 65 PR 138 B190 L D ROPER, R M WRIGHT, B T FELD (LRL+MIT)IJP

DALITZ 66 PR 146 1180 DALITZ,SUTHERLAND (OXFORD)
CONTAINS REFERENCES TO EARLIER WORK ON DELTA PHOTOPRODUCTION.

BERENDS 71 NP B30 575 +WEAVER (CEA,MIT,TUFT)
CARTER 71 NP B26 445 +WILLIAMS, BUGG, BUSSEY, DANCE (CAVE,RHEL)

ALMEHED 72 NP B40 157 +LOVELACE (LUND,RUTG)IJP
BALL 72 PRL 28 1143 +CAMPBELL,LEE,SHAW (UTAH,BOISE,UCI)
OBERLACK 72 PL 43B 44 H.OBERLACK,R.G.MOORHOUSE (LBL)
POG 72 PL 39B 103
WALKER 73 TO BE PUB. R.L.WALKER,W.J.METCALF (CIT)

PAPERS NOT REFERRED TO IN DATA CARDS.

DONNACHI 68 PL 26B 161 DONNACHIE,LOVELACE,KIRSOPP (CERN)

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Δ(1236) BUMPS

81 N*3/2(1236, JP=3/2+) I=3/2 PRODUCTION EXPERIMENTS

81 N*3/2(1236) MASS (MEV) (PROD. EXP.)

M	1217.	8.	ANDERSON	70 MMS	-	PI- P TO PI- MMS	2/71
M	1227.0	7.0	ELLIS	71 CNTR		MMS PP 3.7 GEV/C	10/71
M	. . . . . .	. . . .					
M AVG	1222.7	5.3	AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)				
M++	(1232.0)	(6.0)	FERRO-LUZ	65 HBC	++	K+P TO KO P PI+	
M++	(1236.0)		DEANS	66 RVUE	++	PI+P TOTAL	7/66
M++	(1233.4)	(4.4)	GIDAL	66 DBC	++	D D TO NN(NN) PI	7/66
M++	(1224.0)	(2.0)	HABER	70 DBC		K-D TO 4 BOD(P)	7/70
M++	1236.0	2.0	COLTON	72 HBC	++	PP TO PI+PN 7GEV	1/73*
M++	1226.0	2.0	COLTON	72 HBC	++	TO PI+PI-PP	1/73*
M++	1222.0	3.0	COLTON	72 HBC	++	TO PI+PI-PIOPP	1/73*
M++	1226.0	2.0	COLTON	72 HBC	++	TO PI+PI-PI-PN	1/73*
M++	. . . . . .	. . . .					
M++ AVG	1228.4	2.9	AVERAGE (ERROR INCLUDES SCALE FACTOR OF 2.7)				
M-	(1241.3)	(5.1)	GIDAL	66 DBC	-		7/66
M-	1239.0	5.0	COLTON	72 HBC	-	TO PI+PI-PI-PN	1/73*

81 (N*-) - (N*++) MASS DIFFERENCE (MEV) (PROD. EXP.)

D	7.9	6.8	GIDAL	66 DBC

81 N*3/2(1236) WIDTH (MEV) (PROD. EXP.)

W	115.	5.	ANDERSON	70 MMS	-	PI- P TO PI- MMS	2/71
W	105.0	7.0	ELLIS	71 CNTR		MMS PP 3.7 GEV/C	10/71
W	. . . . . .	. . . .					
W AVG	111.6	4.7	AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.2)				
W++	(125.0)	(30.0)	FERRO-LUZ	65 HBC	++		
W++	(121.0)		DEANS	66 RVUE	++		7/66
W++	(124.0)	(14.0)	GIDAL	66 DBC	++		7/66
W++	(120.0)	(8.0)	HABER	70 DBCC		K-D TO 4 BOD(P)	7/70
W++	115.0	6.0	COLTON	72 HBC	++	PP TO PI+PN 7GEV	1/73*
W++	127.0	5.0	COLTON	72 HBC	++	TO PI+PI-PP	1/73*
W++	122.0	9.0	COLTON	72 HBC	++	TO PI+PI-PIOPP	1/73*
W++	106.0	7.0	COLTON	72 HBC	++	TO PI+PI-PI-PN	1/73*
W++	. . . . . .	. . . .					
W++ AVG	118.8	4.7	AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.5)				
W-	(149.0)	(18.0)	GIDAL	66 DBC	-		7/66
W-	237.0	22.0	COLTON	72 HBC	-	TO PI+PI-PI-PN	1/73*

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REFERENCES FOR N*3/2(1236) (PROD. EXP.)

FERRO-LU 65 NC 36 1101 FERRO-LUZZI,GEORGE, + (CERN)
DEANS 66 PREPRINT S R DEANS, W G HOLLADAY (VANDERBILT)
GIDAL 66 PR 141 1261 G GIDAL, A KERNAN, S KIM (LRL)

ANDERSON 70 PRL 25 699 +BLESER,BLIEDEN,COLLINS++ (BNL,CARN)
HABER 70 NP 17B 289 +SHAPIRA,MERRILL,MONARI++ (SABRE COLL)
ELLIS 71 PRL 27 442 +MAGLICH,NOREM,SANNES,SILVERMAN (RUTG)
COLTON 72 PR D6 95 E COLTON, A KIRSCHBAUM (LBL)

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Δ(1650) S_{31}

82 N*3/2(1650, JP=1/2-) I=3/2

FOR DISCUSSION CONCERNING RESONANT PARAMETERS,SEE NOTE PRECEDING N*1/2(1470).

82 N*3/2(1650) MASS (MEV)

M		(1648.0)	(12.0)	DEVLIN	65 CNTR	PI+- P TOTAL	
M	1	(1695.0)		BAREYRE	68 RVUE	PHASE-SHIFT ANAL	11/67
M	1	WHERE CROSS SECTION IS GREATEST - EYEBALL FIT					
M	3	(1635.0)		DONNACH1	68 RVUE	PHASE-SHIFT ANAL	6/68
M	6	(1614.0)		AYED	70 IPWA		1/71
M	6	ENER. DEP. FIT OF ARGAND DIAGRAM					
M	4	(1617.0)		DAVIES	70 RVUE	P-S ANAL SOL A	8/69
M	7	(1620.)		ALMEHED	72 IPWA		2/72

82 N*3/2(1650) WIDTH (MEV)

W	1	(250.0)	BAREYRE	68 RVUE		11/67
W	3	(177.0)	DONNACH1	68 RVUE		6/68
W	6	(142.0)	AYED	70 IPWA		1/71
W	4	(141.0)	DAVIES	70 RVUE	P-S ANAL SOL A	8/69
W	7	(140.)	ALMEHED	72 IPWA		2/72
W		SEE THE NOTES ACCOMPANYING THE MASSES QUOTED.				

82 N*3/2(1650) PARTIAL DECAY MODES

		DECAY MASSES
P1	N*3/2(1650) INTO PI N	139+ 938
P2	N*3/2(1650) INTO N PI PI	938+ 139+ 139
P3	N*3/2(1650) INTO GAM NUCLEON, HELICITY=1/2	0+ 938
P4	N*3/2(1650) INTO N*3/2(1236) PI	1236+ 139
P5	N*3/2(1650) INTO N RHO	938+ 770

82 N*3/2(1650) BRANCHING RATIOS

R1		N*3/2(1650) INTO (PI N)/TOTAL			(P1)	
R1	3	(0.284)	DONNACH1	68 RVUE		6/68
R1	6	(0.317)	AYED	70 IPWA		1/71
R1	4	(0.28)	DAVIES	70 RVUE	P-S ANAL SOL A	8/69
R1	7	(0.35)	ALMEHED	72 IPWA		2/72

82 N*3/2(1650) PHOTON DECAY AMPL(GEV**-1/2)

FOR DEFINITION OF GAMMA-NUCLEON DECAY AMPLITUDES, SEE MINI-REVIEW PRECEDING THE BARYON LISTINGS.

A1	N*3/2(1650) INTO GAM NUCLEON, HELICITY=1/2 (GEV**-1/2)					
A1	+.090	.076	OBERLACK	72 DPWA	PI N PHOTO-PROD	2/73*
A1	(+.112)		WALKER	73 DPWA	PI N PHOTO-PROD	2/73*

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REFERENCES FOR N*3/2(1650)

DEVLIN 65 PRL 14 1031 T J DEVLIN,J SOLOMON,G BERTSCH (PRINCETON) I

BAREYRE 68 PR 165 1731 P BAREYRE, C BRICMAN, G VILLET (SACLAY)IJP
DONNACHI 68 PL 26B 161 A DONNACHIE, R G KIRSOPP, C LOVELACE (CERN)IJP
ALSO 68 VIENNA 139 DONNACHIE RAPPORTEUR'S TALK (GLAS)
ALSO 68 THESIS R G KIRSOPP (EDIN)

AYED 70 KIEV CONF R AYED,P BAREYRE, G VILLET (SACL)IJP
DAVIES 70 NP B21 359 A DAVIES (GLAS)

ALMEHED 72 NP B40 157 +LOVELACE (LUND,RUTG)IJP
OBERLACK 72 PL 43B 44 H.OBERLACK,R.G.MOORHOUSE (LBL)
WALKER 73 TO BE PUB. R.L.WALKER,W.J.METCALF (CIT)

PAPERS NOT REFERRED TO IN DATA CARDS.

CARRUTHE 60 PRL 4 303 P CARRUTHERS (CORNELL) I
DEVLIN 62 PR 125 690 T J DEVLIN, B J MOYER, V PEREZ-MENDEZ (LRL) I
HELLAND 64 PR 134 B1062 +DEVLIN,HAGGE,LONGO,MOYER,WOOD (LRL) I
BAREYRE 65 PL 18 342 + BRICMAN, STIRLING, VILLET (SACLAY)IJP
JOHNSON 67 UCRL-17683 THESIS C H JOHNSON (LRL)
DONNACHI 69 NP 10B 433 A DONNACHIE, R KIRSOPP (GLAS+EDIN)
AYED 70 PL 31B 598 +BAREYRE,VILLET (SACLAY)
BOWLER 70 NP 17B 331 +CASHMORE (U. OXFORD)

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Δ(1670) D_{33}

10 N*3/2(1670, JP=3/2-) I=3/2

FOR DISCUSSION CONCERNING RESONANT PARAMETERS,SEE NOTE PRECEDING N*1/2(1470).

10 N*3/2(1670) MASS (MEV)

M	3	(1691.0)	DONNACH1	68 RVUE	PHASE-SHIFT ANAL	8/69
M	6	(1722.0)	AYED	70 IPWA		1/71
M	6	ENER. DEP. FIT OF ARGAND DIAGRAM				
M	4	(1649.0)	DAVIES	70 RVUE	P-S ANAL SOL A	8/69
M	7	(1700.)	ALMEHED	72 IPWA		2/72

Baryons
Δ(1670), Δ(1690), Δ(1890)

Data Card Listings
For notation, see key at front of Listings.

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               10  N*3/2(1670) WIDTH (MEV)

W   3     (269.0)                    DONNACH1   68 RVUE                     8/69
W   6     (258.0)                    AYED       70 IPWA                     1/71
W   4     (188.0)                    DAVIES     70 RVUE   SOL A             8/69
W   7     (260.)                     ALMEHED    72 IPWA                     2/72
      SEE THE NOTES ACCOMPANYING THE MASSES QUOTED.

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               10  N*3/2(1670) PARTIAL DECAY MODES

                                                         DECAY MASSES
P1       N*3/2(1670) INTO PI N                          139+ 938
P2       N*3/2(1670) INTO N PI PI                       938+ 139+ 139
P3       N*3/2(1670) INTO K SIGMA                       493+1189
P4       N*3/2(1670) INTO GAM NUCLEON, HELICITY=1/2       0+ 938
P5       N*3/2(1670) INTO GAM NUCLEON, HELICITY=3/2       0+ 938
P6       N*3/2(1670) INTO N*3/2(1236) PI               1236+ 139

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               10  N*3/2(1670) BRANCHING RATIOS

R1       N*3/2(1670) INTO (PI N)/TOTAL                   (P1)
R1  3         (0.14)                 DONNACH1   68 RVUE                     8/69
R1  6         (0.217)                AYED       70 IPWA                     1/71
R1  4         (0.12)                 DAVIES     70 RVUE   SOL A             8/69
R1  7         (0.16)                 ALMEHED    72 IPWA                     2/72

R2       N*3/2(1670) INTO (K SIGMA)/TOTAL                (P3)
R2  1       (.00002)OR LESS                FEUERBACH 70 RVUE . PI P TO K+ SIG+   7/70
R2  1      ASSUME MASS, WIDTH, X(ELAST) OF DONNACHIE 68
R2  1      MODEL USED MAY DOUBLE COUNT.

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               10  N*3/2(1670) PHOTON DECAY AMPL(GEV**-1/2)

      FOR DEFINITION OF GAMMA-NUCLEON DECAY AMPLITUDES, SEE MINI-
   REVIEW PRECEDING THE BARYON LISTINGS.

A1       N*3/2(1670) INTO GAM NUCLEON, HELICITY=1/2 (GEV**-1/2)
A1           +.068      .042           OBERLACK  72 DPWA    PI N PHOTO-PROD  2/73*

A2       N*3/2(1670) INTO GAM NUCLEON, HELICITY=3/2 (GEV**-1/2)
A2           +.022      .052           OBERLACK  72 DPWA    PI N PHOTO-PROD  2/73*
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                          REFERENCES FOR N*3/2(1670)

DONNACH1 68 PL 26B 161       A DONNACHIE, R G KIRSOPP, C LOVELACE (CERN)IJP
    ALSO 68 VIENNA 139       DONNACHIE  RAPPORTEUR'S TALK          (GLAS)
    ALSO 68 THESIS           R G KIRSOPP                           (EDIN)

AYED     70 KIEV CONF        R AYED,P BAREYRE, G VILLET            (SACL)IJP
DAVIES   70 NP B21 359       A DAVIES                              (GLAS)
FEUERBAC 70 NP 16B 85        FEUERBACHER+HOLLADAY              (VANDERBILT)

ALMEHED  72 NP B40 157       +LOVELACE                        (LUND,RUTG)IJP
OBERLACK 72 PL 43B 44        H.OBERLACK,R.G.MOORHOUSE              (LBL)

                             PAPERS NOT REFERRED TO IN DATA CARDS.

DONNACHI 69 NP 10B 433       A DONNACHIE, R KIRSOPP             (GLAS+EDIN)
AYED     70 PL 31B 598       +BAREYRE,VILLET                     (SACLAY)
BOWLER   70 NP 17B 331       +CASHMORE                        (U. OXFORD)

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Δ(1690) 19 N*3/2(1690, JP=3/2+) I=3/2 **P''_{33}**

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      FOR DISCUSSION CONCERNING RESONANT PARAMETERS,SEE NOTE
      PRECEDING N*1/2(1470).
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               19  N*3/2(1690) MASS (MEV)

M   3     (1690.)                    DONNACH2   68 RVUE    PHAS.SHIFT-CERN1 10/69
M   3     (1690.)                    KIRSOPP    68 RVUE    PHASE SHIFT ANAL 10/69
M   3   WHERE MAX. ABSORPTION IS -DONNACH1, 2 ,KIRSOPP EYEBALL FIT CERN 1   10/69
M   6     (1801.0)                   AYED       70 IPWA                     1/71
M   6   ENER. DEP. FIT OF ARGAND DIAGRAM
M   7     (1680.)                    ALMEHED    72 IPWA                     2/72

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               19  N*3/2(1690) WIDTH (MEV)

W   3     (281.)                     DONNACH2   68 RVUE    PHAS.SHIFT-CERN1 10/69
W   3     (240.)                     KIRSOPP    68 RVUE    PHASE SHIFT ANAL 10/69
W   6     (598.0)                    AYED       70 IPWA                     1/71
W   7     (220.)                     ALMEHED    72 IPWA                     2/72

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               19  N*3/2(1690) PARTIAL DECAY MODES

                                                         DECAY MASSES
P1       N*3/2(1690) INTO PI N                          139+ 938
P2       N*3/2(1690) INTO K SIGMA                       493+1189

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               19  N*3/2(1690) BRANCHING RATIOS

R1       N*3/2(1690) INTO (PI N)/TOTAL                   (P1)
R1  3         (.10)                  DONNACH2   68 RVUE    PHAS.SHIFT-CERN1 10/69
R1  3         (.08)                  KIRSOPP    68 RVUE    PHASE SHIFT ANAL 10/69
R1  6         (0.135)                AYED       70 IPWA                     1/71
R1  7         (0.1)                  ALMEHED    72 IPWA                     2/72

R2       N*3/2(1690) INTO (K SIGMA)/TOTAL                (P2)
R2  1       (.00002)OR LESS                FEUERBACH 70 RVUE   PI P TO K+ SIG+   7/70
R2  1      ASSUME MASS, WIDTH, X(ELAST) OF DONNACHIE 68
R2  1      MODEL USED MAY DOUBLE COUNT.

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                          REFERENCES FOR N*3/2(1690)

DONNACH2 68 VIENNA 139       DONNACHIE  RAPPORTEUR'S TALK          (GLAS)
KIRSOPP  68 THESIS           R G KIRSOPP                           (EDIN)

AYED     70 KIEV CONF        R AYED,P BAREYRE, G VILLET            (SACL)IJP
FEUERBAC 70 NP 16B 85        FEUERBACHER+HOLLADAY              (VANDERBILT)

ALMEHED  72 NP B40 157       +LOVELACE                        (LUND,RUTG)IJP

                             PAPERS NOT REFERRED TO IN DATA CARDS.

AYED     70 PL 31B 598       +BAREYRE,VILLET                     (SACLAY)
BOWLER   70 NP 17B 331       +CASHMORE                        (U. OXFORD)

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Δ(1890) 11 N*3/2(1890, JP=5/2+) I=3/2 **F_{35}**

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      FOR DISCUSSION CONCERNING RESONANT PARAMETERS,SEE NOTE
      PRECEDING N*1/2(1470).

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               11  N*3/2(1890) MASS (MEV)

M   3     (1913.0)                   DONNACH1   68 RVUE    PHASE-SHIFT ANAL  8/69
M   6     (1837.0)                   AYED       70 IPWA                      1/71
M   6   FROM ENER. DEP. FIT OF ARGAND DIAGRAM
M   4     (1841.0)                   DAVIES     70 RVUE    P-S ANAL  SOL A   8/69
M   7     (1875.)                    ALMEHED    72 IPWA                      2/72
M         (1890.0)                   MEHTANI    72 DPWA    PI+P TO D1236 PI  1/73*

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               11  N*3/2(1890) WIDTH (MEV)

W   3     (350.0)                    DONNACH1   68 RVUE                      8/69
W   6     (198.0)                    AYED       70 IPWA                      1/71
W   4     (136.0)                    DAVIES     70 RVUE    SOL A             8/69
W   7     (250.)                     ALMEHED    72 IPWA                      2/72
W         (300.0)                    MEHTANI    72 DPWA    PI+P TO D1236 PI  1/73*
      SEE NOTES ACCOMPANYING MASSES QUOTED AS FOR N*1/2(1910)

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               11  N*3/2(1890) PARTIAL DECAY MODES

                                                         DECAY MASSES
P1       N*3/2(1890) INTO PI N                          139+ 938
P2       N*3/2(1890) INTO N PI PI                       938+ 139+ 139
P3       N*3/2(1890) INTO K SIGMA                       493+1189
P4       N*3/2(1890) INTO N*3/2(1236) PI               1236+ 139
P5       N*3/2(1890) INTO GAM NUCLEON, HELICITY=1/2       0+ 938
P6       N*3/2(1890) INTO GAM NUCLEON, HELICITY=3/2       0+ 938
P7       N*3/2(1890) INTO N RHO                         938+ 770

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               11  N*3/2(1890) BRANCHING RATIOS

R1       N*3/2(1890) INTO (PI N)/TOTAL                   (P1)
R1  3         (0.16)                 DONNACH1   68 RVUE                      8/69
R1  6         (0.147)                AYED       70 IPWA                      1/71
R1  4         (0.20)                 DAVIES     70 RVUE    SOL A             8/69
R1  7         (0.18)                 ALMEHED    72 IPWA                      2/72

R2       N*3/2(1890) INTO (K SIGMA)/TOTAL                (P3)
R2  1       (0.008)OR LESS                 FEUERBACH 70 RVUE . PI P TO K+ SIG+   7/70
R2  1      ASSUME MASS, WIDTH, X(ELAST) OF DONNACHIE 68
R2  1      MODEL USED MAY DOUBLE COUNT.

R3       N*3/2(1890) INTO (SIGMA K)*(PI N)/TOTAL**2     (P3*P1)
R3          (.0016)OR LESS           KALMUS     70 DPWA    PI+P TO K+ SIG+   1/71

R4       N*3/2(1890), FROM PI N TO D(1236) PI           SQRT(P1*P4)
R4            (0.23)                 MEHTANI    72 DPWA                      1/73*

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               11  N*3/2(1890) PHOTON DECAY AMPL(GEV**-1/2)

      FOR DEFINITION OF GAMMA-NUCLEON DECAY AMPLITUDES, SEE MINI-
   REVIEW PRECEDING THE BARYON LISTINGS.

A1       N*3/2(1890) INTO GAM NUCLEON, HELICITY=1/2 (GEV**-1/2)
A1            (+.044)                WALKER     73 DPWA    PI N PHOTO-PROD  2/73*

A2       N*3/2(1890) INTO GAM NUCLEON, HELICITY=3/2 (GEV**-1/2)
A2            (-.027)                WALKER     73 DPWA    PI N PHOTO-PROD  2/73*

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                          REFERENCES FOR N*3/2(1890)

DONNACH1 68 PL 26B 161       A DONNACHIE, R G KIRSOPP, C LOVELACE (CERN)IJP
    ALSO 68 VIENNA 139       DONNACHIE  RAPPORTEUR'S TALK          (GLAS)
    ALSO 68 THESIS           R G KIRSOPP                           (EDIN)

AYED     70 KIEV CONF        R AYED,P BAREYRE, G VILLET            (SACL)IJP
DAVIES   70 NP B21 359       A DAVIES                              (GLAS)
FEUERBAC 70 NP 16B 85        FEUERBACHER+HOLLADAY              (VANDERBILT)
KALMUS   70 PR D2 1824       G KALMUS, G BORREANI, J LOUIE          (LRL)

ALMEHED  72 NP B40 157       +LOVELACE                        (LUND,RUTG)IJP
MEHTANI  72 PRL 29 1634      +FUNG, KERNAN, SCHALK, +          (UCR +LBL)
WALKER   73 TO BE PUB.       R.L.WALKER,W.J.METCALF                (CIT)
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Data Card Listings

For notation, see key at front of Listings.

Baryons

Δ(1890), Δ(1910), Δ(1950)

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                     PAPERS NOT REFERRED TO IN DATA CARDS.
AYED      70 PL 31B 598        +BAREYRE+VILLET                        (SACLAY)

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Δ(1910) P31

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          12  N*3/2(1910, JP=1/2+) I=3/2

          FOR DISCUSSION CONCERNING RESONANT PARAMETERS,SEE NOTE
          PRECEDING N*1/2(1470).

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                     12  N*3/2(1910) MASS (MEV)

M   3     (1934.0)                   DONNACHI  68 RVUE    PHASE-SHIFT ANAL  8/69
M   6     (1783.0)                   AYED      70 IPWA                      1/71
M   6   FROM ENER. DEP. FIT OF ARGAND DIAGRAM
M   4     (1914.0)                   DAVIES    70 RVUE    P-S ANAL  SOL A   8/69
M   7     (1900.)                    ALMEHED   72 IPWA                      2/72

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                     12  N*3/2(1910) WIDTH (MEV)

W   3     (339.0)                    DONNACHI  68 RVUE                      8/69
W   6     (308.0)                    AYED      70 IPWA                      1/71
W   4     (290.)                     DAVIES    70 RVUE    SOL A             8/69
W   7     (200.)                     ALMEHED   72 IPWA                      2/72
        SEE NOTES ACCOMPANYING MASSES QUOTED

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                     12  N*3/2(1910) PARTIAL DECAY MODES

                                                          DECAY MASSES
P1      N*3/2(1910) INTO PI N                             139+ 938
P2      N*3/2(1910) INTO N PI PI                          938+ 139+ 139
P3      N*3/2(1910) INTO K SIGMA                          493+1189
P4      N*3/2(1910) INTO N*3/2(1236) PI                   1236+ 139
P5      N*3/2(1910) INTO GAM NUCLEON, HELICITY=1/2           0+ 938
P6      N*3/2(1910) INTO N RHO                            938+ 770

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                     12  N*3/2(1910) BRANCHING RATIOS

R1      N*3/2(1910) INTO (PI N)/TOTAL                  (P1)
R1  3      (0.30)                    DONNACHI  68 RVUE                      8/69
R1  6      (0.128)                   AYED      70 IPWA                      1/71
R1  4      (0.18)                    DAVIES    70 RVUE    SOL A             8/69
R1  7      (0.33)                    ALMEHED   72 IPWA                      2/72

R2      N*3/2(1910) INTO (K SIGMA)/TOTAL               (P3)
R2  1      (0.008)OR LESS            FEUERBACH 70 RVUE    PI P TO K+ SIG+   7/70
R2  1    ASSUME MASS, WIDTH, X(ELAST) OF DONNACHIE 68
R2  1    MODEL USED MAY DOUBLE COUNT.

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                     12  N*3/2(1910) PHOTON DECAY AMPL(GEV**-1/2)

    FOR DEFINITION OF GAMMA-NUCLEON DECAY AMPLITUDES, SEE MINI-
  REVIEW PRECEDING THE BARYON LISTINGS.

A1      N*3/2(1910) INTO GAM NUCLEON, HELICITY=1/2 (GEV**-1/2)
A1         (-.027)                   WALKER    73 DPWA    PI N PHOTO-PROD   2/73*

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REFERENCES FOR N*3/2(1910)


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DONNACHI 68 PL 26B 161         A DONNACHIE, R G KIRSOPP, C LOVELACE (CERN)IJP
    ALSO 68 VIENNA 139         DONNACHIE  RAPPORTEUR'S TALK          (GLAS)
    ALSO 68 THESIS             R G KIRSOPP                           (EDIN)

AYED     70 KIEV CONF          R AYED,P BAREYRE, G VILLET           (SACL)IJP
DAVIES   70 NP B21 359         A DAVIES                              (GLAS)
FEUERBAC 70 NP 16B 85          FEUERBACHER+HOLLADAY             (VANDERBILT)

ALMEHED  72 NP B40 157         +LOVELACE                        (LUND,RUTG)IJP
WALKER   73 TO BE PUB.         R.L.WALKER,W.J.METCALF                 (CIT)

                     PAPERS NOT REFERRED TO IN DATA CARDS.

CARYANN  65 PR 138 B433        CARAYANNOPOULOS,TAUTFEST,WILLMANN      (PURD)
   A PARTIAL WAVE ANALYSIS OF PI+P TO SIGMA+ K+
AYED     70 PL 31B 598         +BAREYRE+VILLET                      (SACLAY)
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Δ(1950) F37

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          83  N*3/2(1950, JP=7/2+) I=3/2

          FOR DISCUSSION CONCERNING RESONANT PARAMETERS,SEE NOTE
          PRECEDING N*1/2(1470).

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                     83  N*3/2(1950) MASS (MEV)

M         (1920.0)                   DUKE      65 CNTR    PI-P EL + POL     6/68
M         (1950.0)        APPROX     YOKOSAWA  66 CNTR    PI- P DSIG + POL  7/66
M   1     (1975.0)                   BAREYRE   68 RVUE    PHASE-SHIFT ANAL 11/67
M   1            WHERE CROSS SECTION IS GREATEST - EYEBALL FIT
M   3     (1946.0)                   DONNACHI  68 RVUE    PHASE-SHIFT ANAL  6/68
M   6     (1931.0)                   AYED      70 IPWA                      1/71
M   6   FROM ENER. DEP. FIT OF ARGAND DIAGRAM
M   4     (1935.0)                   DAVIES    70 RVUE    P-S ANAL  SOL A   8/69
M         (1950.0)   (30.0)          KALMUS    70 DPWA    PI+P TO K+ SIG+   1/71
M         (1930.)    (20.)           MEHTANI   71 MPWA ++ PI+P 1.8-2.1 GEV  2/72
M         (1930.)                    ROYCHOUD  71 DPWA                      3/72
M   7     (1925.)                    ALMEHED   72 IPWA                      2/72
M         (1920.0)                   MEHTANI   72 DPWA    PI+P TO D1236 PI  1/73*

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                     83  N*3/2(1950) WIDTH (MEV)

W         (170.0)                    DUKE      65 CNTR                      7/66
W         (200.0)         APPROX     YOKOSAWA  66 CNTR                      7/66
W   1     (180.0)                    BAREYRE   68 RVUE                     11/67
W   3     (221.0)                    DONNACHI  68 RVUE                      6/68
W   6     (197.0)                    AYED      70 IPWA                      1/71
W   4     (221.0)                    DAVIES    70 RVUE    SOL A             8/69
W         (300.0)   (60.0)           KALMUS    70 DPWA    PI+P TO K+ SIG+   1/71
W         (227.)    (12.)     (30.)  MEHTANI   71 MPWA ++ PI+P TO (1236)PI  2/72
W   7     (200.)                     ALMEHED   72 IPWA                      2/72
W         (269.0)                    MEHTANI   72 DPWA    PI+P TO D1236 PI  1/73*
        SEE THE NOTES ACCOMPANYING THE MASSES QUOTED.

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                     83  N*3/2(1950) PARTIAL DECAY MODES

                                                          DECAY MASSES
P1      N*3/2(1950) INTO PI N                             139+ 938
P2      N*3/2(1950) INTO SIGMA K                          1189+ 493
P3      N*3/2(1950) INTO N*3/2(1236) PI                   1236+ 139
P4      N*3/2(1950) INTO Y*1(1385) K                      1384+ 493
P5      N*3/2(1950) INTO N*3/2(1236) RHO                  1236+ 770
P6      N*3/2(1950) INTO NEUTRON PI+ PI+                   939+ 139+ 139
P7      N*3/2(1950) INTO N*3/2(1236) PI PI (NOT RHO)      1236+ 139+ 139
P8      N*3/2(1950) INTO GAM NUCLEON, HELICITY=1/2           0+ 938
P9      N*3/2(1950) INTO GAM NUCLEON, HELICITY=3/2           0+ 938
P10     N*3/2(1950) INTO N RHO                             938+ 770

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                     83  N*3/2(1950) BRANCHING RATIOS

R1      N*3/2(1950) INTO (PI N)/TOTAL                  (P1)
R1         (0.41)                    DUKE      65 CNTR    VERY ENERGY DEP   7/66
R1         (0.4)          APPROX     YOKOSAWA  66 CNTR                      7/66
R1  1      (0.57)                    BAREYRE   68 RVUE                     11/67
R1  3      (0.386)                   DONNACHI  68 RVUE                      6/68
R1  6      (0.496)                   AYED      70 IPWA                      1/71
R1  4      (0.51)                    DAVIES    70 RVUE    SOL A             8/69
R1  7      (0.4)                     ALMEHED   72 IPWA                      2/72
        SEE THE NOTES ACCOMPANYING THE MASSES QUOTED.

R2      N*3/2(1950) INTO (SIGMA K)*(PI N)/TOTAL**2     (P2*P1)
R2           SEEN                    BORREANI  68 HBC     PI+P 1.35-1.68   10/69
R2  1      (0.004)  (0.008)          FEUERBACH 70 RVUE    PI P TO K+ SIG+   7/70
R2  1    ASSUME MASS, WIDTH, X(ELAST) OF DONNACHIE 68
R2  1    MODEL USED MAY DOUBLE COUNT.
R2         0.0081   0.0013           KALMUS    70 DPWA    PI+P TO K+ SIG+   1/71

R3      N*3/2(1950)  FROM PI N TO D(1236) PI              SQRT(P1*P3)
R3         0.23     0.04             FUNG      68 HBC  ++ PI+P TO PI+PI0 P 11/68
R3         0.24     0.01      0.03   MEHTANI   71 MPWA ++                   2/72
R3         (0.48)                    MEHTANI   72 DPWA                      1/73*
R3         . . . . . . . . .
R3  AVG    0.238    0.018     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

   MORE INFORMATION ON INELASTIC DECAY MODES OF BUMPS, SEEN IN PRODUCTION
   EXPERIMENTS AROUND 1950 MEV, MAY BE FOUND IN THE NEXT ENTRY

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                     83  N*3/2(1950) PHOTON DECAY AMPL(GEV**-1/2)

    FOR DEFINITION OF GAMMA-NUCLEON DECAY AMPLITUDES, SEE MINI-
  REVIEW PRECEDING THE BARYON LISTINGS.

A1      N*3/2(1950) INTO GAM NUCLEON, HELICITY=1/2 (GEV**-1/2)
A1         (-.059)                   WALKER    73 DPWA    PI N PHOTO-PROD   2/73*

A2      N*3/2(1950) INTO GAM NUCLEON, HELICITY=3/2 (GEV**-1/2)
A2         (-.089)                   WALKER    73 DPWA    PI N PHOTO-PROD   2/73*

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REFERENCES FOR N*3/2(1950)


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DUKE     65 PRL 15 468         +JONES,KEMP,MURPHY,PRENTICE, +   (RHEL,OXF)IJP
YOKOSAWA 66 PRL 16 714         +SUWA, HILL, ESTERLING, BOOTH.   (ANL,CHIC)IJP

BAREYRE  68 PR 165 1731        P BAREYRE, C BRICMAN, G VILLET     (SACLAY)IJP
BORREANI 68 UCRL 18350          BORREANI,KALMUS                         (LRL)
DONNACHI 68 PL 26B 161         A DONNACHIE, R G KIRSOPP, C LOVELACE (CERN)IJP
    ALSO 68 VIENNA 139         DONNACHIE  RAPPORTEUR'S TALK            (GLAS)
    ALSO 68 THESIS             R G KIRSOPP                             (EDIN)
FUNG     68 VIENNA CONF.       FUNG, KERNAN, KALMUS, BIRGE (RIVERSIDE,LRL)

AYED     70 KIEV CONF          R AYED,P BAREYRE, G VILLET             (SACL)IJP
DAVIES   70 NP B21 359         A DAVIES                                (GLAS)
FEUERBAC 70 NP 16B 85          FEUERBACHER+HOLLADAY               (VANDERBILT)
KALMUS   70 PR D2 1824         G KALMUS, G BORREANI, J LOUIE            (LRL)

MEHTANI  71 AMSTERDAM CONF.    +FUNG,KERNAN,WILLIAMSON+BIRGE,++ (UCR,LBL)IJP
ROYCHOUD 71 NP B27 125         R K ROYCHOUDHURY,B H BRANSDEN        (DURH)IJP

ALMEHED  72 NP B40 157         +LOVELACE                         (LUND,RUTG)IJP
MEHTANI  72 PRL 29 1634        +FUNG, KERNAN, SCHALK, +            (UCR +LBL)
WALKER   73 TO BE PUB.         R.L.WALKER,W.J.METCALF                   (CIT)

                     PAPERS NOT REFERRED TO IN DATA CARDS.

HOHLER   63 NP 48 470          G HOHLER, G EBEL                   (KARLSRUHE) I
LAYSON   63 NC 27 724          W M LAYSON                              (CERN) IJ
AUVIL    64 NC 33 473          P AUVIL, C LOVELACE                   (LOIC)IJP
HELLAND  64 PR 134 B1062       +DEVLIN,HAGGE,LONGO,MOYER,WOOD          (LRL) IJ
HOHLER   64 PL 12 149          G HOHLER, J GIESECKE               (KARLSRUHE) I
HOLLADAY 65 PR 139 B1348       W G HOLLADAY                        (VANDERBILT)
JOHNSON  67 UCRL-17683 THESIS  C H JOHNSON                              (LRL)
DONNACHI 69 NP 10B 433         A DONNACHIE, R KIRSOPP              (GLAS+EDIN)
AYED     70 PL 31B 598         +BAREYRE+VILLET                       (SACLAY)
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Baryons
Δ(1960), Δ(2160)

Data Card Listings
For notation, see key at front of Listings.

Δ(1960) → 13 N*3/2(1960, JP=5/2-) I=3/2 **D_{35}**

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A NEW PRELIMINARY ANALYSIS BY AYED 72 FINDS
EVIDENCE FOR THIS EFFECT AT 1870 MEV.  SEE THE N*
MINI REVIEW.
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              13  N*3/2(1960) MASS (MEV)

M  3    (1954.0)                   DONNACHI  68 RVUE   PHASE-SHIFT ANAL  6/68
M  3    (1970.)                    KIRSOPP   68 RVUE   PHASE SHIFT ANAL 10/69
M  X    (1950.0)      APPROX       LEA       69 CNTR   PI-P ELASTIC      8/69
M  X  SEE ALSO APLIN 70
M  3   WHERE MAX. ABSORPTION IS -DONNACHI, 2 ,KIRSOPP EYEBALL FIT CERN 1 10/69
M  7    (2200.)                    ALMEHED   72 IPWA                     2/72
M       (1824.0)                   MEHTANI   72 DPWA    PI+P TO D1236 PI 1/73*
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              13  N*3/2(1960) WIDTH (MEV)

W  3    (311.00)                   DONNACHI  68 RVUE                     8/69
W  3    (400.)                     KIRSOPP   68 RVUE   PHASE SHIFT ANAL 10/69
W  7    (600.)                     ALMEHED   72 IPWA                     2/72
W       (138.0)                    MEHTANI   72 DPWA    PI+P TO D1236 PI 1/73*
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              13  N*3/2(1960) PARTIAL DECAY MODES

                                                      DECAY MASSES
P1     N*3/2(1960) INTO PI N                           139+ 938
P2     N*3/2(1960) INTO K SIGMA                        493+1189
P4     N*3/2(1960) INTO N*3/2(1236) PI                1236+ 139
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              13  N*3/2(1960) BRANCHING RATIOS

R1     N*3/2(1960) INTO (PI N)/ TOTAL              (P1)
R1 3        (.154)                 DONNACHI  68 RVUE   PHASE SHIFT ANA. 10/69
R1 3        (.12)                  KIRSOPP   68 RVUE   PHASE SHIFT ANAL 10/69
R1 7        (0.25)                 ALMEHED   72 IPWA                     2/72

R2     N*3/2(1960) INTO (K SIGMA)/TOTAL              (P2)
R2 1      (0.013)  (0.01)          FEUERBACH 70 RVUE    PI P TO K+ SIG+  7/70
R2 1     ASSUME MASS, WIDTH, X(ELAST) OF DONNACHIE 68
R2 1     MODEL USED MAY DOUBLE COUNT.

R3     N*3/2(1960) FROM PI  N TO D(1236) PI          SQRT(P1*P4)
R3          (0.19)                 MEHTANI   72 DPWA                     1/73*
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                     REFERENCES FOR N*3/2(1960)

DONNACHI 68 PL 26B 161       A DONNACHIE, R G KIRSOPP, C LOVELACE (CERN)IJP
KIRSOPP  68 THESIS           R G KIRSOPP                          (EDIN)

LEA      69 PL 29B 584       LEA,OADES,WARD,COWAN,+  (RHEL,BRISTOL,DARE)

FEUERBAC 70 NP 16B 85        FEUERBACHER+HOLLADAY           (VANDERBILT)

ALMEHED  72 NP B40 157       +LOVELACE                      (LUND,RUTG)IJP
MEHTANI  72 PRL 29 1634      +FUNG, KERNAN, SCHALK, +.        (UCR +LBL)

                             PAPERS NOT REFERRED TO IN DATA CARDS.

DONNACHI 69 NP 10B 433       A DONNACHIE, R KIRSOPP            (GLAS+EDIN)
AYED     70 PL 31B 598       +BAREYRE+VILLET                      (SACLAY)
APLIN    71 NP B32 253       +COWAN,GIBSON,GILMORE++        (RHEL,BRISTOL)
AYED     72 BATAVIA CONF     R AYED,P BAREYRE, Y LEMOIGNE           (SACL)
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Δ(1950) BUMPS 70 N*3/2(1950, JP=) I=3/2 PRODUCTION EXPERIMENTS

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              70  N*3/2(1950) MASS (MEV) (PROD. EXP.)

M       (1922.0)      APPROX       COOL      56 CNTR   PI+ P TOTAL       7/66
M       (1912.0)    (15.0)         BRISSON   61 CNTR   PI+ P TOTAL       7/66
M       (1900.0)     (9.0)         DEVLIN    65 CNTR   PI+ P TOTAL
M  N    (2080.0)    (12.0)         YOON      67 HBC  +  3 BEV/C PI-P     8/67
M  N     THIS BUMP IS NOT SEEN BY CHUNG 68 AT 3.2 GEV/C
M       (1860.0)                   COLTON    72 HBC  ++ PP TO PI+PN 7GEV 1/73*
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              70  N*3/2(1950) WIDTH (MEV) (PROD. EXP.)

W       (256.0)     (39.0)         DEVLIN    65 CNTR
W         40.0       20.0          YOON      67 HBC  +                   8/67
W       (180.0)                    COLTON    72 HBC  ++ PP TO PI+PN 7GEV 1/73*
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              70  N*3/2(1950) PARTIAL DECAY MODES (PROD. EXP.)

                                                      DECAY MASSES
P1     N*3/2(1950) INTO PI N                           139+ 938
P2     N*3/2(1950) INTO SIGMA K                       1189+ 493
P3     N*3/2(1950) INTO N*3/2(1236) PI                1236+ 139
P4     N*3/2(1950) INTO Y*1(1385) K                   1384+ 493
P5     N*3/2(1950) INTO N*3/2(1236) RHO               1236+ 770
P6     N*3/2(1950) INTO NEUTRON PI+ PI+                939+ 139+ 139
P7     N*3/2(1950) INTO N*3/2(1236) PI PI (NOT RHO)   1236+ 139+ 139
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              70  N*3/2(1950) BRANCHING RATIOS (PROD. EXP.)

R1     N*3/2(1950) INTO (PI N)/TOTAL                     (P1)
R1        (0.57)    (0.12)          DEVLIN    65 CNTR
R2     N*3/2(1950) INTO (SIGMA K)/(PI N)                 (P2)/(P1)
R2        0.059     0.024           CHINOWSKY 68 HBC  ++ PP TO P SIG K    11/68
R3     N*3/2(1950) INTO N*3/2(1236) PI PI (NOT RHO)      (P7)
R3        SEEN                      CHINOWSKY 68 HBC  ++ PP TO (P 3PI) N  11/68
R3        SEEN                      BOGGILD   70  HBC    PP TO N3PI(NTRL)  6/70
R4     N 3/2(1950) INTO (PI N)/(N*3/2(1236) PI)          (P1)/(P3)
R4        (0.55) OR LESS            LEE       67 HBC     PI-P 3.63 BEV/C  11/67
R5     N*3/2(1950) INTO ((PI N)*(NEUTRON PI+ PI+))/TOTAL**2
R5                                                       (P1*P6)
R5        0.05      0.013           GALLOWAY  68 RVUE ++ PI+P TO N 2PI+    6/68
R6     N*3/2(1950) INTO (Y*1(1385) K)/(PI N)             (P4)/(P1)
R6        0.035     0.015           CHINOWSKY 68 HBC  ++ PP TO P LAM K PI 11/68
R7     N*3/2(1950) INTO (N*3/2(1236) RHO)/(PI N)         (P5)/(P1)
R7        (0.45)    APPROX          CHINOWSKY 68 HBC  ++ PP TO (P 3PI) N  11/68
R7     THIS INCLUDES CORRECTION FOR UNSEEN DECAY (ISPIN FACTOR 5/3).
R8     N*3/2(1950) INTO (N*3/2(1236) RHO)/TOTAL          (P5)
R8        SEEN                      YOON      67 HBC  +                    8/67
R8        NOT SEEN                  BOGGILD   70  HBC    PP TO N3PI(NTRL)  6/70
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                     REFERENCES FOR N*3/2(1950) (PROD. EXP.)

COOL      56 PR 103 1082      R COOL, O PICCIONI, D CLARK            (BNL) I
BRISSON   61 NC 19 210        +DETOEUF,FALK-VAIRANT,VAN ROSSUM,+ (SACLAY) I
DEVLIN    65 PRL 14 1031      T J DEVLIN,J SOLOMON,G BERTSCH  (PRINCETON) I
LEE       67 PR 159 1156      +MOEBS,ROE,SINCLAIR,VANDER VELDE      (MICH)
YOON      67 PL 24B 307       +BERENYI,KEY,PRENTICE, +      (TORONTO,WISC)

CHINOWSK  68 PR 171 1421      CHINOWSKY,CONDON,KINSEY,KLEIN,+  (LRL,SLAC)
CHUNG     68 PR 165 1491      S U CHUNG,DAHL,KIRZ,MILLER              (LRL)
GALLOWAY  68 PL 26B 334       K F GALLOWAY                       (INDIANA) I
BOGGILD   70 NP B16 503       +KOREA-AHO+JACOBSEN+ (BOHR+ HELS+OSLO+STOH)
COLTON    72 PR D6 95         E COLTON, A KIRSCHBAUM                  (LBL)
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Δ(2160) → 9 N*3/2(2160, JP=3/2+) I=3/2 **P'''_{33}**

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ROYCHOUDHURY 71 FIND POSSIBLE EVIDENCE FOR P31,D33,AND
D35 RESONANCES IN THIS MASS REGION. IN A SIMILAR ANALYS
BRANSDEN 71 FOUND SOME EVIDENCE FOR S31,D33,AND D35 RES
NANCES INTHIS REGION. VON SCHLIPPE 72 SUGGESTS A G39.
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              9  N*3/2(2160) MASS  (MEV)

M  3    (2160.)                    KIRSOPP   68 RVUE   PHASE SHIFT ANAL 10/69
M       (2120.)                    ROYCHOUD  71 DPWA                     3/72
M  7    (2150.)                    ALMEHED   72 IPWA                     2/72
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              9  N*3/2(2160) WIDTH (MEV)

W  3    (260.)                     KIRSOPP   68 RVUE   PHASE SHIFT ANAL 10/69
W  7    (200.)                     ALMEHED   72 IPWA                     2/72
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              9  N*3/2(2160) PARTIAL DECAY MODES

                                                      DECAY MASSES
P1     N*3/2(2160) INTO PI N                           139+ 938
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              9  N*3/2(2160) BRANCHING RATIOS

R1     N*3/2(2160) INTO (PI N)/TOTAL                 (P1)
R1 3        (.25)                  KIRSOPP   68 RVUE   PHASE SHIFT ANAL 10/69
R1 7        (0.3)                  ALMEHED   72 IPWA                     2/72
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                     REFERENCES FOR N*3/2(2160)

KIRSOPP  68 THESIS            R G KIRSOPP                          (EDIN).

ROYCHOUD 71 NP B27 125        R K ROYCHOUDHURY,B H BRANSDEN      (DURH)IJP

ALMEHED  72 NP B40 157        +LOVELACE                      (LUND,RUTG)IJP

                              PAPERS NOT REFERRED TO IN DATA CARDS.

DONNACHI 69 NP 10B 433        A DONNACHIE,R KIRSOPP            (GLAS+EDIN)
BRANSDEN 71 NP B26 511        ,OGDEN                             (DURH)IJP
   ALSO  70 NP B16 461        ROYCHOUDHURY,PERRIN,BRANSDEN       (DURH)IJP
VON SCHL 72 LNC 4 767         VON SCHLIPPE                       (LOWC)IJP
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Data Card Listings

For notation, see key at front of Listings.

Baryons
Δ(2420), Δ(2850), Δ(3230)

Δ(2420) H3 11

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84  N*3/2(2420, JP=11/2+)  I=3/2
BOTH ROYCHOUDHURY 71 AND BRANSDEN 71 SEE A POSSIBLE
RESONANT F35 IN THIS MASS REGION. IN ADDITION BRANSDEN
71 FIND A RESONANT P33 AT 2600 MEV.
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              84  N*3/2(2420) MASS (MEV)

M   6     (2312.0)                       AYED       70 IPWA                   1/71
M   6   FROM ENER. DEP. FIT OF ARGAND DIAGRAM
M         (2400.)                        BRANSDEN   71 DPWA                   3/72
M         (2400.)                        ROYCHOUD   71 DPWA                   3/72
M         (2440.)                        OTT        72 MPWA   0 PI-P BKWD ELSTC 2/73*
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              84  N*3/2(2420) WIDTH (MEV)

W   6     (347.0)                        AYED       70 IPWA                   1/71
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              84  N*3/2(2420) PARTIAL DECAY MODES

                                                              DECAY MASSES
P1     N*3/2(2420) INTO PI N                                  139+ 938
P2     N*3/2(2420) INTO SIGMA K                               1197+ 493
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              84  N*3/2(2420) BRANCHING RATIOS

R1     N*3/2(2420) INTO (PI N)/TOTAL                  (P1)
R1  6      (0.113)                       AYED       70 IPWA                   1/71
R1  7       (94)                         OTT        72 MPWA   0 PI-P BKWD ELSTC 2/73*
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              REFERENCES FOR N*3/2(2420)

AYED      70 KIEV CONF          R AYED,P BAREYRE, G VILLET              (SACL)IJP

BRANSDEN 71 NP B26 511          +OGDEN                                  (DURH)IJP
   ALSO  70 NP B16 461          ROYCHOUDHURY,PERRIN,BRANSDEN            (DURH)IJP
ROYCHOUD 71 NP B27 125          R K ROYCHOUDHURY,B H BRANSDEN           (DURH)IJP
OTT      72 PL 42B 133          +TRISCHUK,VAVRA,RICHARDS,+ (MCGI,STLO,IOWA)IJP
   ALSO  72 MCGILL THESIS       J. VAVRA                                (MCGI) JP

              PAPERS NOT REFERRED TO IN DATA CARDS.

BELLAMY   67 PRL 19 476         +BUCKLEY,DOBINSON, +       (WESTFIELD,LOUC) JP

AYED      70 PL 31B 598         +BAREYRE+VILLET                         (SACLAY)
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Δ(2420) BUMPS

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69  N*3/2(2420, JP=     ) I=3/2    PRODUCTION EXPERIMENTS
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              69  N*3/2(2420) MASS (MEV) (PROD. EXP.)

M         (2360.0)                       DIDDENS    63 CNTR    PI+ P TOTAL
M         (2520.0)   (40.0)              ALVAREZ    64 CNTR    PI PHOTOPROD       7/66
M         (2440.0)                       HOHLER     64 RVUE    DATA + DISP REL
M         (2400.0)         APPROX        WAHLIG     64 OSPK  0 PI-P CH EX
M   B     (2452.0)                       BARGER     66 RVUE    TOTAL + CH EX     11/67
M   B   USES REGGE AMP.+RESON. TO CALCULATE DIF. CROSS SECTIONS AT 180 DEGRE
M   B   FOR CRITICISM OF THIS METHOD, SEE DOLEN 68.
M          2423.0    10.0                CITRON     66 CNTR    PI+ P TOTAL        7/66
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              69  N*3/2(2420) WIDTH (MEV) (PROD. EXP.)

W          (200.0)                       DIDDENS    63 CNTR
W          (245.0)                       HOHLER     64 RVUE                       7/66
W   B      (275.0)                       BARGER     66 RVUE    TOTAL + CH EX     11/67
W           310.0    20.0                CITRON     66 CNTR                       7/66
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              69  N*3/2(2420) PARTIAL DECAY MODES (PROD. EXP.)

                                                              DECAY MASSES
P1     N*3/2(2420) INTO PI N                                  139+ 938
P2     N*3/2(2420) INTO SIGMA K                               1197+ 493
P3     N*3/2(2420) INTO N*3/2(1236) PI                        1236+ 139
P4     N*3/2(2420) INTO NEUTRON PI+ PI+                       939+ 139+ 139
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              69  N*3/2(2420) BRANCHING RATIOS (PROD. EXP.)

R1     N*3/2(2420) INTO (PI N)/TOTAL                  (P1)
R1        (0.067)         APPROX         DIDDENS    63 CNTR    ASSUMING J=11/2    7/66
R1         0.113     0.0036              CITRON     66 CNTR    ASSUMING J=11/2    7/66
R1  B     (0.12)                         BARGER     67 FIT     ASSUMING J=11/2   11/67
R1  D     (0.163)                        DIKMEN     67 FIT     ASSUMING J=11/2   11/67
R1  D   USES ONLY RESONANCES TO CALCULATE DIF. CROSS SECTIONS AT 180 DEGREES
R1        (0.06)                         KORMANYOS 67 CNTR     ASSUMING J=11/2   11/67

R2     N*3/2(2420) INTO (PI N)*(NEUTRON PI+ PI+)/(TOTAL**2)
R2                                                    (P1*P4)
R2          0.0195   0.0048              GALLOWAY   68 RVUE                       6/68
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              REFERENCES FOR N*3/2(2420) (PROD. EXP.)

DIDDENS  63 PRL 10 262          +JENKINS, KYCIA, RILEY                   (BNL) I
ALVAREZ  64 PRL 12 710          +BAR-YAM,KERN,LUCKEY,OSBORNE, +     (MIT,CEA)
HOHLER   64 PL 12 149           G HOHLER, J GIESECKE               (KARLSRUHE) I
WAHLIG   64 PRL 13 103          +MANNELLI,SODICKSON,FACKLER,WARD, +    (MIT)
BARGER   66 PR 151 1123         V BARGER, M OLSSON                      (WISC)
CITRON   66 PR 144 1101         +GALBRAITH,KYCIA,LEONTIC,PHILLIPS, +  (BNL) I

BARGER   67 PR 155 1792         V BARGER, D CLINE                      (WISC) P
DIKMEN   67 PRL 18 798          F N DIKMEN                             (MICH)
KORMANYO 67 PR 164 1661         KORMANYOS, KRISCH, OFALLON, +     (MICH,ANL) P
GALLOWAY 68 PL 26B 334          K F GALLOWAY                        (INDIANA) I

              PAPERS NOT REFERRED TO IN DATA CARDS.

BAACKE   67 NC 51A 761          J BAACKE, M YVERT            (KARLSRUHE,ORSAY)J-L
DOBROWOL 67 PL 24B 203          DOBROWOLSKI,GUSKOV,LIKHACHEV, +      (DUBNA) P
DOLEN    68 PR 166 1768         R DOLEN, D HORN, C SCHMID               (CIT)
WAHLIG   68 PR 168 1515         M A WAHLIG, I MANNELLI              (MIT,PISA)
   FINAL VERSION OF DATA USED IN WAHLIG 64.  IN CONJUNCTION WITH
   CITRON 66 TOTAL CROSS SECTIONS, THIS CHARGE EXCHANGE DATA GIVES
   COMPLEX ELASTIC SCATTERING AMPLITUDE AT 0 DEGREES.
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Δ(2850) BUMPS

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85  N*3/2(2850, JP=    +) I=3/2  PRODUCTION EXPERIMENTS
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              85  N*3/2(2850) MASS (MEV) (PROD. EXP.)

M         (2870.0)                     HOHLER     64 RVUE    DATA + DISP REL
M         (2700.0)         APPROX      WAHLIG     64 OSPK  0 PI-P CH EX
M         (2850.0)                     BARDADIN   66 HBC  ++ N* TO P + 3 PIS    7/66
M          2850.0    12.0              CITRON     66 CNTR    PI+ P TOTAL        7/66
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              85  N*3/2(2850) WIDTH (MEV) (PROD. EXP.)

W          (150.0)                     BARDADIN   66 HBC  ++                    7/66
W           400.0    40.0              CITRON     66 CNTR                       7/66
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              85  N*3/2(2850) PARTIAL DECAY MODES (PROD. EXP.)

                                                              DECAY MASSES
P1     N*3/2(2850) INTO PI N                                  139+ 938
P2     N*3/2(2850) INTO P PI PI PI                            938+ 139+ 139+ 139
P3     N*3/2(2850) INTO N PI PI                               938+ 139+ 139
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              85  N*3/2(2850) BRANCHING RATIOS (PROD. EXP.)

R1     N*3/2(2850) INTO (PI N)/TOTAL                  (P1)
R1   ONLY (J+1/2)*( PI N/TOTAL) MEASURED FOR THIS STATE
R1  B     (0.224)  (0.016)             BARGER     66 RVUE    TOTAL + CH EXC.   11/67
R1         0.261    0.048              CITRON     66 CNTR    TOTAL CROSS.SEC.  11/67
R1  B     (0.40)                       BARGER     67 RVUE    USES KORMANYOS66  11/67
R1  B   USES REGGE AMP.+RESON. TO CALCULATE DIF. CROSS SECTIONS AT 180 DEGRE
R1  B   FOR CRITICISM OF THIS METHOD, SEE DOLEN 68.
R1  C     (0.49)                       DIKMEN     67 RVUE    USES KORMANYOS67  11/67
R1  C   USES ONLY RESONANCES TO CALCULATE DIF. CROSS SECTIONS AT 180 DEGREES
R1        (0.39)                       DOBROWOLS 67 CNTR     PI+P AT 180 DEG
R1        (0.10)                       KORMANYOS 67 CNTR     PI-P AT 180 DEG.  11/67
R1  D     (0.06) OR LESS  CL=.95       HALDORSE   72 HBC     PP  19  GEV/C     12/72*
R1  D   UPPER LIMIT ON ELASTICITY.ALSO FIND J=9/2 OR MORE.
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              REFERENCES FOR N*3/2(2850) (PROD. EXP.)

HOHLER   64 PL 12 149           G HOHLER, J GIESECKE               (KARLSRUHE) I
WAHLIG   64 PRL 13 103          +MANNELLI,SODICKSON,FACKLER,WARD, +    (MIT)
BARDADIN 66 PL 21 357           BARDADIN-OTWINOWSKA,DANYSZ, +        (WARSAW)
BARGER   66 PR 151 1123         V BARGER, M OLSSON                      (WISC)
CITRON   66 PR 144 1101         +GALBRAITH,KYCIA,LEONTIC,PHILLIPS, +  (BNL) I

BARGER   67 PR 155 1792         V BARGER, D CLINE                      (WISC) P
DIKMEN   67 PRL 18 798          F N DIKMEN                             (MICH)
DOBROWOL 67 PL 24B 203          DOBROWOLSKI,GUSKOV,LIKHACHEV, +      (DUBNA) P
KORMANYO 67 PR 164 1661         KORMANYOS, KRISCH, OFALLON, +     (MICH,ANL) P
HALDORSE 72 NC 10A 468          HALDORSEN,JACOBSEN                     (OSLO) IJ

              PAPERS NOT REFERRED TO IN DATA CARDS.

BAACKE   67 NC 51A 761          J BAACKE, M YVERT            (KARLSRUHE,ORSAY)J-L
DOLEN    68 PR 166 1768         R DOLEN, D HORN, C SCHMID               (CIT)
WAHLIG   68 PR 168 1515         M A WAHLIG, I MANNELLI              (MIT,PISA)
   FINAL VERSION OF DATA USED IN WAHLIG 64.  IN CONJUNCTION WITH
   CITRON 66 TOTAL CROSS SECTIONS, THIS CHARGE EXCHANGE DATA GIVES
   COMPLEX ELASTIC SCATTERING AMPLITUDE AT 0 DEGREES.
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Δ(3230) BUMPS

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86  N*3/2(3230, JP=     ) I=3/2  PRODUCTION EXPERIMENTS
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              86  N*3/2(3230) MASS (MEV) (PROD. EXP.)

M         (3230.0)                     CITRON     66 CNTR    PI+ P TOTAL        7/66
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                    86  N*3/2(3230) WIDTH (MEV) (PROD. EXP.)

W        (440.0)                     CITRON    66 CNTR                      7/66

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                    86  N*3/2(3230) PARTIAL DECAY MODES (PROD. EXP.)

                                                            DECAY MASSES
P1      N*3/2(3230) INTO PI N                              139+ 938
P2      N*3/2(3230) INTO N PI PI                           938+ 139+ 139

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                    86  N*3/2(3230) BRANCHING RATIOS

R1      N*3/2(3230) INTO (PI N)/TOTAL                   (P1)
R1     ONLY (J+1/2)*( PI N/TOTAL) MEASURED FOR THIS STATE
R1  B        (0.03)   (0.01)         BARGER    66 RVUE   TOTAL + CH EXC.  11/67
R1           (0.06)                  CITRON    66 CNTR   TOTAL CROS. SEC. 11/67
R1  B        (0.03)  TO  0.1         BARGER    67 CNTR   USES KORMANYOS66 11/67
R1  B   USES REGGE AMP.+RESON. TO CALCULATE DIF. CROSS SECTIONS AT 180 DEGRE
R2  B   FOR CRITICISM OF THIS METHOD, SEE DOLEN 68.
R1  D        (0.25)                  DIKMEN    67 RVUE   USES KORMANYOS67 11/67
R1  D   USES ONLY RESONANCES TO CALCULATE DIF. CROSS SECTIONS AT 180 DEGREES

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                            REFERENCES FOR N*3/2(3230) (PROD. EXP.)

BARGER   66 PR 151 1123       V BARGER, M OLSSON                       (WISC)
CITRON   66 PR 144 1101       +GALBRAITH,KYCIA,LEONTIC,PHILLIPS, +     (BNL) I
BARGER   67 PR 155 1792       V BARGER, D CLINE                        (WISC) P
DIKMEN   67 PRL 18 798        F N DIKMEN                               (MICH)

                            PAPERS NOT REFERRED TO IN DATA CARDS

KORMANYO 67 PR 164 1661       KORMANYOS, KRISCH, OFALLON, +       (MICH,ANL) P
DOLEN    68 PR 166 1768       R DOLEN, D HORN, C SCHMID                 (CIT)

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EXOTIC NUCLEON

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        THIS IS NOT A COMPLETE LIST. WE WILL TABULATE EXOTICS FROM NOW ON
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EX(1640)

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                    92  EX(1640, JP=     ) I=5/2

                    AMMANN 71 AND JOHNSON 71 WITH COMPARABLE (OR
         ---->      BETTER) STATISTICS AND AT MOMENTA NEAR 4.91 ARGUE
                    STRONGLY THAT THE EFFECT SEEN BY PRICE 70 IS A
                    STATISTICAL FLUCTUATION.

                    IN A MISSING MASS EXPERIMENT, PI+ P TO PI- X+++,
    BIRULEV 71 FIND NO EVIDENCE FOR EXOTIC (I=5/2) RESONANCES IN THE
    MASS INTERVAL 1.2 TO 2.2 GEV.

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                    92  EX(1640) MASS (MEV)

M   A   29(1627.)    (12.)           PRICE     70 DBC  -- K-D AT 4.91GEV/C  3/71
M   A   FOUR S. D. EFFECT

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                    92  EX(1640) WIDTH (MEV)

W   B   29   (30.)  OR LESS  CL=.90  PRICE     70 DBC  -- PI-PI-N BUMP      3/71
W   B   CROSS SECTION 13.0+-3.9 MICROBARNS

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                    92  EX(1640) CROSS SECTION LIMITS (MICROBARN)

CS  B        (40.)  OR LESS          BANNER    70 OSPK +++ PI+P,1.9 GEV/C   7/70
CS  B   I=5/2 LIMIT GIVEN ABOVE IS FOR MASS RANGE 1540-1750 MEV

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                            REFERENCES FOR EX(1640)

BANNER   70 NP B15 205        +CHEZE,HAMEL,TEIGER,ZACCONE +       (SACLAY)
PRICE    70 PL 33B,533        +BERG,SALANT,WATERS,WEBSTER,WEINBERG (VAND)

                            PAPERS NOT REFERRED TO IN DATA CARDS

AMMANN   71 PL   34B 533      +CARMONY,GARFINKEL,GUTAY,MILLER,YEN  (PURD)
BIRULEV  71 SJNP 12  536      +VOVENKO,GUSKOV,DOBROVOLSKII,++      (JINR)
JOHNSON  71 PL   34B 428      D JOHNSON                             (ANL)

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Note on Possible Z*'s

Although much work has been done on the strangeness +1 reactions during the past few years, it is not yet clear whether the peaks seen in total KN cross sections near 1 GeV/c are resonances; see Fig. 1. Since positive-strangeness baryons cannot be made from three quarks, it is very important to find out if these peaks are resonances.

(a) I = 0 System. New K^+p total cross section data have been reported by the Arizona group in the 0.57 to 1.16 GeV/c region (BOWEN 73) and by the BNL group (CARROLL 73) in the 0.4 to 1.06 GeV/c region. The cross-sections of both groups fail to exhibit the dip at 0.7 GeV/c previously reported. The absence of the dip is also observed in the K^+p elastic data reported by ADAMS 72. A curve through the K^+p total cross section data as drawn by CARROLL 73 is shown in Fig. 1. The new K^+d cross section data around 0.7 GeV/c also show smoother behavior than before, and both effects result in the I = 0 cross section shown in Fig. 1. The data points after unfolding and the smooth curve drawn by CARROLL 73 are shown in Fig. 2a. The double humped structure reported by ABRAMS 69, COOL 70, and DOWELL 70 now looks more like a shoulder and a bump, which is associated with the rapid increase in the inelastic cross section.

Fig. 2a shows large disagreement at low momenta between BOWEN 73 and CARROLL 73 points. However, only part of this disagreement is due to a difference in the measured K^+d cross sections (for $P > 0.8$ GeV/c, there is no systematic difference between the two sets of data); the rest can be attributed to differences in the unfolding procedures.

There is, however, no doubt about there being a large broad peak in the isospin 0 elastic cross section. The inelastic cross section increases smoothly until the K^*N threshold at 1.08 GeV/c is approached where, as shown in Fig. 2b, the K^*N cross section comes in strongly (HIRATA 70). The total $KN\pi$ and $KN\pi\pi$ cross sections are shown in Fig. 1 as eyeball curves drawn through the data (GIACOMELLI 72). Subtracting these from the total cross section one gets σ_0(elastic) also shown in Fig. 1. The resonance (if it

Data Card Listings

For notation, see key at front of Listings.

Baryons
Z^*'s

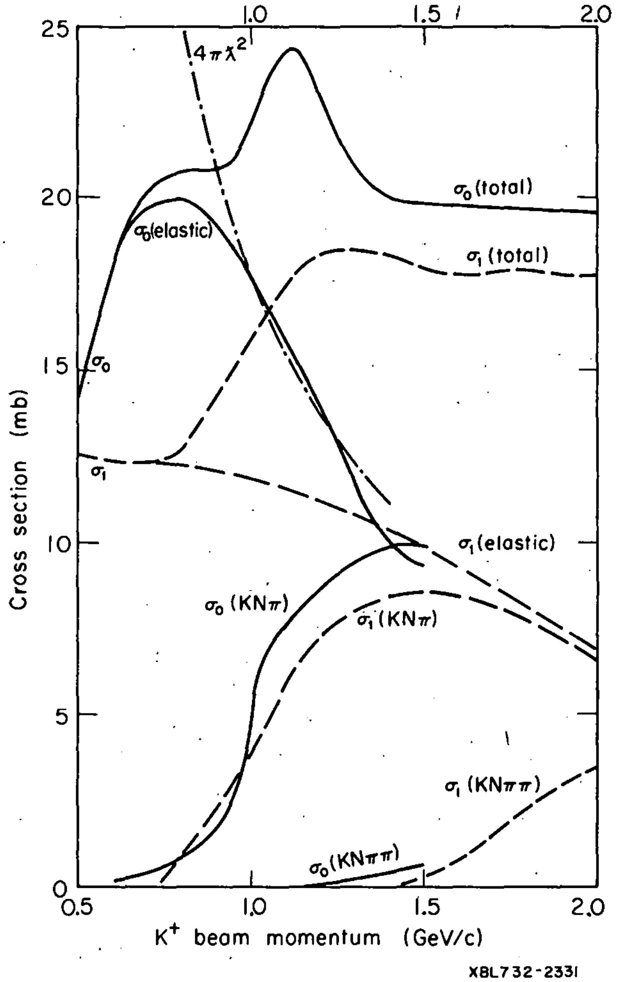

Fig. 1. KN total and partial cross sections. Subscripts indicate isospin. Total cross section curves from CARROLL 73, which uses new data of BOWEN 73 as well as previous data. Elastic I=1 curve is hand-drawn through new and old elastic data. I=0 inelastic curves taken from GIACOMELLI 72. Isospin 1 inelastic curves taken from LOKEN 72.

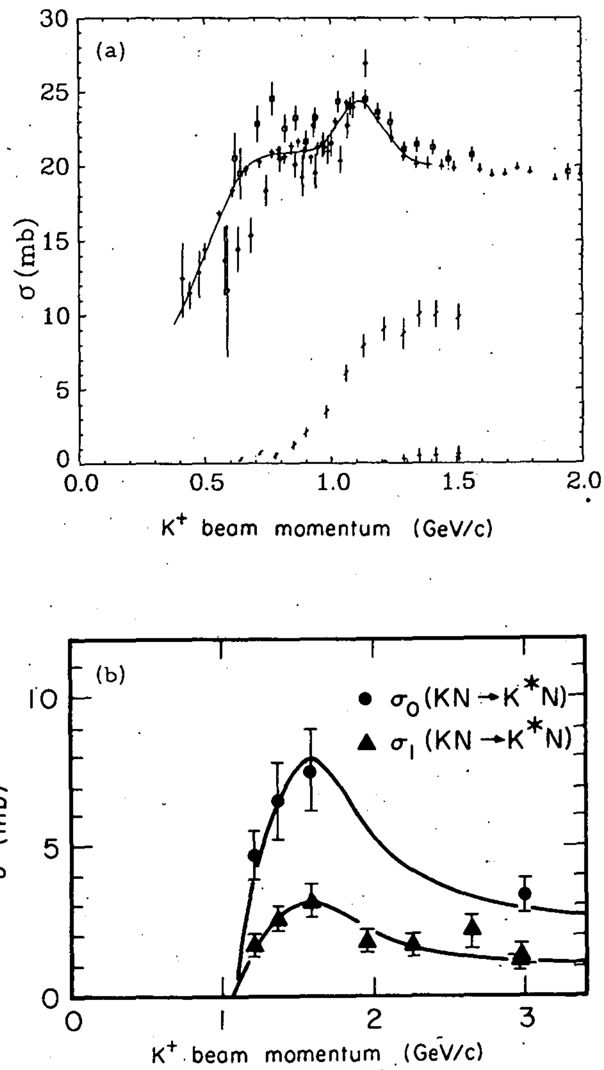

Fig. 2.
(a) Unfolded I=0 cross sections as quoted by the various authors discussed in the Z^* mini-review:

◊ BOWEN 73 σ_T
▫ BUGG 68 σ_T (as unfolded by CARROLL 73)
▿ CARROLL 73 σ_T
▵ COOL 70 σ_T
⁄ GIACOMELLI 72 $\sigma(\pi KN)$
– GIACOMELLI 72 $\sigma(\pi\pi KN)$

(b) Energy dependence of the isospin 0 and isospin 1 cross sections for the reaction $KN \to K^*N$ (HIRATA 70).

exists) would have a mass M ~ 1780 MeV, would be very wide, and would be very elastic because the inelastic cross section is small at the peak. If J were greater than 1/2, the resonant peak would exceed the observed height of ~ $4\pi\lambda^2$. This fixes the spin as 1/2, and means that there is little cross section left over for other partial waves. Of course it is quite possible that in fact the peak is not caused by a resonance at all.

Differential cross section data on the elastic charge exchange have been reported by HIRATA 71 (5 momenta in the 0.87 to 1.59 GeV/c region) and by GIACOMELLI1 72 (13 momenta in the 0.64 to 1.51 GeV/c region). More recently GIACOMELLI 2 72 reported data on the $K^+n \to K^+n$ elastic scattering in the 0.6 to 1.6 GeV/c region, and ARMITAGE 72 has reported very preliminary data of $K^0p \to K^+n$. Attempts to perform partial-wave analyses for the I = 0 system have also been reported recently. HIRATA 71, which does not include the most recent elastic and total cross section data, finds a large P_{01} partial wave which does not go through 90° as expected for an elastic resonance. WILSON 72 report energy-dependent and energy-independent analyses, which did not include the K^+n elastic data. S, P, and D waves only were included in the fit and six classes of solutions were found. The addition of the K^+n data has reduced the solutions to four with two being favored over the others (called C and D).[1] Solution D shows a resonant-like P_{01} partial wave which crosses the imaginary axis at P = 1200 MeV/c and turns back in toward the center of the Argand plot. The other solution also has a large P_{01} partial wave, but it does not look resonant. Note, however, that very little polarization data have gone into these analyses; therefore a conclusion on the existence of $Z_0^*(1780)$ must await more data.

(b) I = 1 System. As discussed above there are new elastic cross section data reported by ADAMS 72 (0.4 to 0.9 GeV/c) and new K^+p total cross section measurements by BOWEN 73 and CARROLL 73. Elastic cross section results have also been reported by CHARLES 72 (0.9 to 1.9 GeV/c). For the inelastic channels new data have been reported by LOKEN 72. Fig. 1 shows smooth curves drawn through the new total cross section data, the new elastic data, and the inelastic data of LOKEN 72.

Many partial-wave analyses have been performed on the K^+p data since the I = 1 bump first appeared in 1966. We mention here only the most recent ones and refer the reader to our previous edition for a review of the others.[2] MILLER 72 has reported an analysis which uses a new method, ACE (accelerated convergence expansion), in which high partial waves are included through conformal mapping as suggested by CUTKOSKY 70. The results of ACE are then compared with the two solutions obtained by the same group through conventional partial-wave analysis. CUTKOSKY 72 is a new analysis by the same group with energy smoothing added to a more extensive random search. CHARLES 72 have performed a comparison of their data to existing phase-shift analysis and find that the ALBROW 71 α, β, γ solutions are the preferred ones, although they cannot choose among them. EHRLICH 72 have reported an analysis of data between 1.3 and 2.3 GeV/c employing the ACE method. Then they use the shortest path method to link the energy-independent solutions and find 25 least path solutions, some resembling previously published solutions, in addition to new ones. Another new analysis has been reported by Martin and Miller (MARTIN 72), who use an energy-dependent parametrization based on partial-wave dispersion relations. As a starting point the ALBROW 71 solution γ is used and they obtain a new solution which is not very different from the starting one.

In conclusion the new analyses, as the old ones, yield more than one solution to choose from, which indicates that the data are not good enough to eliminate some of the possibilities. More data of the conventional type, measurements of the R and A parameters, and the simultaneous analysis of elastic and

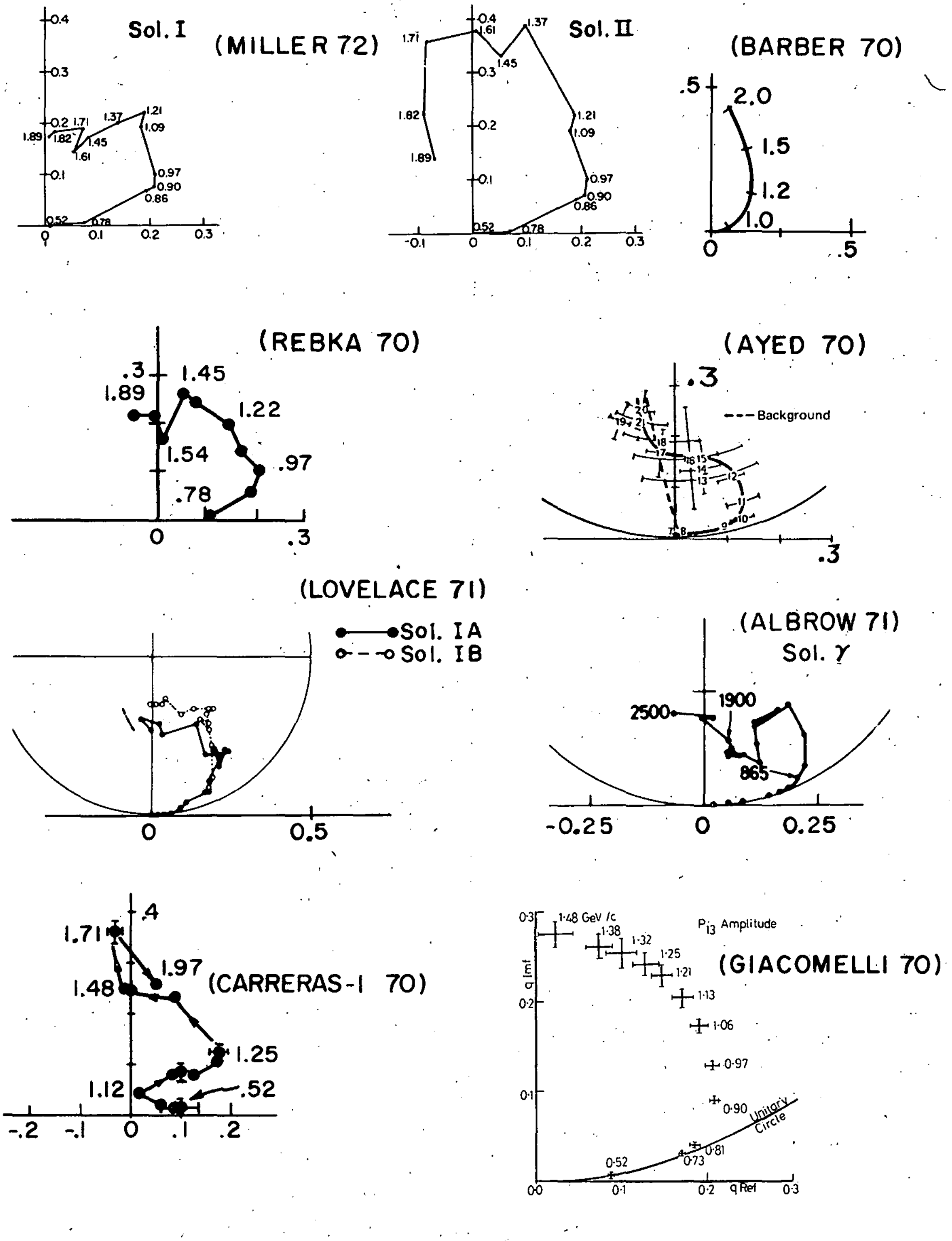

Fig. 3. Argand plots for the P_{13} partial wave as obtained in partial-wave analyses performed by the authors indicated. (CARRERAS-1 70 plotted by us from η, δ.)

Baryons

Z*'s, $Z_0(1780)$, $Z_0(1865)$

inelastic channels (copious inelastic data are desirable at the moment) could improve the understanding of this system.

The P_{13} amplitude still remains the best candidate for a resonance in the K^+p system. The preferred P_{13} Argand plots obtained by some of the groups are shown in Fig. 3. Each analysis in one way or another gets at least one solution with a counterclockwise P_{13} amplitude. Resonant P_{13} is preferred by REBKA 70, GIACOMELLI 70, and ALBROW 71; the results of the other analyses are not so clear cut.

Threshold effects. An alternative way to describe the P_{13} amplitude would be in terms of a coupled-channel threshold effect: the KN amplitude becomes rapidly absorptive as it feeds the rapidly increasing KΔ channel. The main question still remains: Is it also a resonance? If it is, its elasticity is small (≈ 0.2) and it decays mainly into KΔ. Partial-wave analyses in this channel do not seem to favor the resonant hypothesis at this time. See BLAND 67, BLAND 70, and GRIFFITHS 72. But a definite conclusion has yet to be made and awaits much more data.

Production experiments. One more comment on exotic resonances is that, as pointed out by ERNE 70, the present upper limits for the cross sections for production of broad exotic resonances are not very small; that is, they are of the same order as cross sections for Y^* or N^* production.

References

1. A description of the new WILSON 72 analysis as well as an excellent review of recent work on the Z^*'s can be found in: J. D. Dowell, "The Search for Z^*'s", Proceedings of the XVI International Conference on High Energy Physics, Chicago-Batavia (1972).
2. Particle Data Group, Physics Letters 43B, No. 1 (1972).

$Z_0(1780)$

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95  Z*0(1780, JP=1/2 ) I=0

SEE THE MINI-REVIEW PRECEDING THIS LISTING.

THIS EFFECT, IF A RESONANCE, MUST HAVE SPIN=1/2,
BECAUSE THE INELASTIC CROSS SECTION IS VERY SMALL
AND THE TOTAL CROSS SECTION IS ABOUT 4*PI/K**2.

      HIRATA 71 ARGUE THAT IT IS THE P01 WAVE THAT
IS LARGE. HOWEVER, THEY CONCLUDE THAT P01 NEED NOT PASS THROUGH 90
DEGREES TO EXPLAIN THE RELEVANT DATA IN THE 1 GEV/C REGION.
  WILSON 72 FIND SOME SOLUTIONS WITH RESONANT-LIKE BEHAVIOR IN THE P01
PARTIAL WAVE.

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              95  Z*0(1780) MASS (MEV)

M           1780.0     10.0          COOL      70 CNTR +  K+P, D TOTAL     1/71
M   D       SEEN                     DOWELL    70 CNTR    K+P,D TOTAL      7/70
M   D       SEE ALSO DISCUSSION OF LYNCH 70                                7/70
M   W      (1800.)                   WILSON    72 PWA     K+N P01 WAVE     3/72
M   W    ESTIMATE OF PARAMETERS FROM BW + QUADRATIC BACKGROUND FIT TO P01. 3/72

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              95  Z*0(1780) WIDTH (MEV)

W           (565.0)                  COOL      70 CNTR +  K+P, D TOTAL     1/71
W   W       (300.)                   WILSON    72 PWA     K+N P01 WAVE     3/72

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              95  Z*0(1780) PARTIAL DECAY MODES

                                                        DECAY MASSES
P1     Z*0(1780) INTO K N                               493+ 939

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              95  Z*0(1780) BRANCHING RATIOS

R1     Z*0(1780) INTO (K N)/TOTAL                     (P1)
R1          (0.95)                   COOL      70 CNTR +  K+P, D TOTAL     1/71
R1  W       (0.85)                   WILSON    72 PWA     K+N P01 WAVE     3/72

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                        REFERENCES FOR Z*0(1780)

COOL     70 DUKE CONF 47       R L COOL                                (BNL)
    ALSO 69 PL 30B 564         ABRAMS,COOL,GIACOMELLI,KYCIA,LI +       (BNL)
    ALSO 70 PR D1 1887         COOL,GIACOMELLI,KYCIA,LEONTIC,LI +      (BNL)
DOWELL   70 DUKE 53            J.D. DOWELL                            (BIRM)
WILSON   72 NP B42 445         +GRIFFITHS,HIRATA +   (BGNA+GLAS+ROMA+TRST)

                        PAPERS NOT REFERRED TO IN DATA CARDS

LYNCH    70 DUKE 9             G LYNCH (REVIEWER OF CR.SEC. DATA)      (LRL)
HIRATA   71 NP B30 157         +GOLDHABER,HALL,SEEGER,THRILLING,WOHL (LBL)IJP
BOWEN    73 PR D7 22           +JENKINS,KALBACH,PETERSEN +       (ARIZ+MICH)
CARROLL  73  BNL PREPRINT      +KYCIA,LI,MICHAEL,MOCKETT               (BNL)

     EXPERIMENTS MAINLY ABOUT ELASTIC CHANNELS --
ARMITAGE 72  NAL PAPER 391     +ASTON,DUERDOTH,ELLISON,  +       (MCHS+DARE)
GIACOME1 72 NP B42 437         GIACOMELLI +          (BGNA+GLAS+ROMA+TRST)
GIACOME2 72  NP SUBMITTED      GIACOMELLI +          (BGNA+GLAS+ROMA+TRST)

     EXPERIMENTS MAINLY ABOUT INELASTIC CHANNELS --
GIACOMEL 72 NP B37 577         GIACOMELLI +          (BGNA+GLAS+ROMA+TRST)

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$Z_0(1865)$

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96  Z*0(1865, JP=     ) I=0

THIS EFFECT IS STRONGLY ASSOCIATED WITH THE K* N
THRESHOLD. SEE HIRATA 68 AND 70. WILSON 72 REPORTS A
PARTIAL WAVE ANALYSIS.  SEE ALSO Z*0(1780)

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              96  Z*0(1865) MASS (MEV)

M          (1860.0)   (15.0)         CARTER    67 THEO    DISPERSION REL.  8/67
M          (1868.0)   (10.0)         COOL      70 CNTR    K+P, D TOTAL     8/67

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              96  Z*0(1865) WIDTH (MEV)

W           (200.0)   (50.0)         CARTER    67 THEO                     8/67
W           (160.0)   (30.0)         COOL      70 CNTR                     8/67

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              96  Z*0(1865) PARTIAL DECAY MODES

                                                        DECAY MASSES
P1     Z*0(1865) INTO K N                               493+ 939
P2     Z*0(1865) INTO N K*(892)                         938+ 891

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              96  Z*0(1865) BRANCHING RATIOS

R1     Z*0(1865) INTO (K N)/TOTAL                     (P1)
R1           (0.31)   (0.05)         CARTER    67 THEO    IF J=1/2         8/67
R1           (0.40)   (0.05)         COOL      70 CNTR    IF J=1/2         8/67

R2     Z*0(1865) INTO N K*(892)                       (P2)
R2           MAIN INELASTIC DECAY    HIRATA    68 HBC                     11/68

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REFERENCES FOR Z*0(1865)

CARTER 67 PRL 18 801 — A A CARTER (CAVENDISH)
HIRATA 68 PRL 21 1485 — HIRATA, WOHL, GOLDHABER, TRILLING (LRL)
COOL 70 PR D1 1887 — COOL, GIACOMELLI, KYCIA, LEONTIC, LI + (BNL)
ALSO 66 PRL 17 102 — +GIACOMELLI, KYCIA, LEONTIC, LI, LUNDBY, + (BNL) I
ALSO 69 PL 30B 564 — ABRAMS, COOL, GIACOMELLI, KYCIA, LI + (BNL)

PAPERS NOT REFERRED TO IN DATA CARDS

HIRATA 70 DUKE 429 — +GOLDHABER, SEEGER, TRILLING+WOHL (LRL)
AARON 71 PRL 26 407 — +AMADO+SILBAR (NEAS, PENN, LASL) IJP
HIRATA-1 71 NP B33 445 — +GOLDHABER, HALL, SEEGER, TRILLING, WOHL (LBL)
GIACOMEL 72 NP B37 577 — GIACOMELLI + (BGNA+GLAS+ROMA+TRST)
WILSON 72 NP B42 445 — +GRIFFITHS, HIRATA + (BGNA+GLAS+ROMA+TRST)

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$Z_1(1900)$

97 Z*1(1900, JP=) I=1

THIS EFFECT IS STRONGLY ASSOCIATED WITH THE K N* THRESHOLD. IF A RESONANCE, THE SPIN-PARITY IS ALMOST CERTAINLY 3/2+.
SEE THE MINIREVIEW PRECEDING Z*0

97 Z*1(1900) MASS (MEV)

M	1	(1932.0)		AYED	70 IPWA		P13, SOL.I	6/70
M	1	(1899.0)		AYED	70 IPWA		P13, SOL.II	6/70
M	1	(2030.0)		AYED	70 IPWA		S11, SOL.III	6/70
M	1	THREE SOLNS IN ORDER OF DECREASING SIGNIFICANCE. THOUGH AYED 70						
M	1	GIVE PARAMETERS, THEY CONCLUDE RESONANT INTERPRETATION DOUBTFUL.						
M	2	(1840.0)		BARNETT	70 IPWA		P13, SOLN III	7/70
M	2	RESONANCE SIGNAL BARELY ABOVE BACKGROUND DUE TO THE LARGE ERRORS						
M	2	IN THE AMPLITUDES RESULTING FROM THE ANALYSIS						
M		1900.0	10.0	COOL	70 CNTR	++	K+P TOTAL	1/71
M		(1880.)		ALBROW	71 IPWA	++	SOL. GAMMA	10/71
M	K	(1890.)		KATO	71 IPWA		SOL I(FIT BW)	10/71
M	K	(2040.)		KATO	71 IPWA		SOL II(FIT BW)	10/71
M	K	KATO 71 ESTIMATE RESONANCE PARAMETERS — UPDATED PHASE SHIFTS						3/72
M	K	PUBLISHED IN MILLER 72.						3/72

97 Z*1(1900) WIDTH (MEV)

W	1	(520.0)	AYED	70 IPWA		K+P	6/70
W	1	(397.0)	AYED	70 IPWA		K+P	6/70
W	1	(557.0)	AYED	70 IPWA		K+P	6/70
W	2	(80.0)	BARNETT	70 IPWA		K+P EIPWA	7/70
W		(240.0)	COOL	70 CNTR	++	K+P TOTAL	1/71
W		(190.)	ALBROW	71 IPWA	++	SOL. GAMMA	10/71
W	K	(280.)	KATO	71 IPWA		SOL I(FIT BW)	10/71
W	K	(260.)	KATO	71 IPWA		SOL II(FIT BW)	10/71

SEE THE NOTES ACCOMPANYING MASSES QUOTED.

97 Z*1(1900) PARTIAL DECAY MODES

		DECAY MASSES
P1	Z*1(1900) INTO K N	493+ 938
P2	Z*1(1900) INTO N*3/2(1236) K	1236+ 493

97 Z*1(1900) BRANCHING RATIOS

R1 Z*1(1900) INTO (K N)/TOTAL (P1)

R1		(0.10) OR LESS	CARTER	67 THEO		DISPERSION REL.	8/67
R1	1	(0.16)	AYED	70 IPWA			6/70
R1	1	(0.20)	AYED	70 IPWA			6/70
R1	1	(0.17)	AYED	70 IPWA			6/70
R1	2	(0.09)	BARNETT	70 IPWA		K+P EIPWA	7/70
R1		(0.12) (ASSUMING J=3/2)	COOL	70 CNTR	++	K+P TOTAL	1/71
R1		(0.15)	ALBROW	71 IPWA	++	SOL. GAMMA	10/71
R1	K	(0.22)	KATO	71 IPWA		SOL I(FIT BW)	10/71
R1	K	(0.27)	KATO	71 IPWA		SOL II(FIT BW)	10/71

SEE NOTES ACCOMPANYING THE MASSES QUOTED.

R2 Z*1(1900) INTO K N*3/2(1236) (P2)

R2	MAIN INELASTIC DECAY	BLAND	67 HBC	++	8/67
R2	NO EVIDENCE, SPEED HAS MINIM.	GRIFFITHS	72 HBC	K+P .9-1.5 GEV/C	3/72

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REFERENCES FOR Z*1(1900)

BLAND 67 PRL 18 1077 — +BOWLER, BROWN, G+S GOLDHABER, SEEGER, + (LRL)
CARTER 67 PRL 18 801 — A A CARTER (CAVENDISH)

AYED 70 PL 32B 404 — +BAREYRE, FELTESSE, VILLET (SACLAY) IJP
BARNETT 70 DUKE 443 — +GOLDMAN, LAASANEN, STEINBERG (MARYLAND) IJP
COOL 70 PR D1 1887 — +GIACOMELLI, KYCIA, LEONTIC, LI, + (BNL) I
ALSO 66 PRL 17 102 — COOL, GIACOMELLI, KYCIA, LEONTIC, LI + (BNL)

ALBROW 71 NP B30 273 — +ANDERSON, ALMEHED, ..., UDO, WAGNER (CERN) IJP
ALSO 70 DUKE 375 — ERNE, SENS, WAGNER (CERN) IJP
KATO 71 H.E.PHEN., MORIOND — +KOEHLER, ..., YOKOSAWA+BURLESON (ANL, NWES) IJP
ALSO 70 DUKE 367 — A. YOKOSAWA (ANL) IJP
ALSO 70 PRL 24 615 — KATO, KOEHLER, NOVEY, YOKOSAWA+ (ANL, NWES) IJP

GRIFFITH 72 NP B38 365 — +HIRATA, HUGHES + (BGNA+GLAS+ROMA+TRST)
MILLER 72 NP B37 401 — +NOVEY, YOKOSAWA, CUTKOSKY + (ANL+CARN+NWES) IJP

PAPERS NOT REFFERED TO IN Z*1 DATA CARDS

TOTAL-CROSS-SECTION EXPERIMENTS ---
BUGG 68 PR 168 1466 — +GILMORE, KNIGHT, + (RHEL, BIRM, CAVE) I
BOWEN 70 PR D2 2599 — +CALDWELL, DIKMEN, JENKINS, KALBACH, +(ARIZ) I
BOWEN 73 PR D7 22 — +JENKINS, KALBACH, PETERSEN + (ARIZ+MICH)
CARROLL 73 BNL PREPRINT — +KYCIA, LI, MICHAEL, MOCKETT (BNL)

A K-MATRIX ANALYSIS OF SOME OF THE EARLY K+P DATA ---
HITE 67 THESIS — G E HITE (ILLINOIS)

REGGE-POLE ANALYSES --
CARRERAS 70 NP B19 349 — B CARRERAS, A DONNACHIE (DARESBURY, MCHS)

EXPERIMENTS MAINLY ABOUT INELASTIC CHANNELS ---
BLAND 68 UCRL-18131 THESIS — R W BLAND (LRL)
BLAND 69 NP B13 595 — +BOWLER, BROWN, KADYK, GOLDHABER, + (LRL)
BLAND 70 NP B18 537 — +BOWLER, BROWN, GOLDHABER, (LRL)
BLAND 69 AND BLAND 70 REPLACE BLAND 67 AND BLAND 68.
HIRATA-1 71 NP B33 445 — +GOLDHABER, HALL, SEEGER, TRILLING, WOHL (LBL)
GRIFFITH 72 NP B38 365 — +HIRATA, HUGHES, JACOBS+(BGNA, GLAS, ROMA, TRST) IJP
LOKEN 72 PR D6 2346 — +BARISH, GOMEZ, DAVIES, SCHLEIN, + (CIT, UCLA)

THE MAIN ELASTIC SCATTERING AND POLARIZATION EXPERIMENTS —
CARROLL 68 PRL 21 1282 — +FISCHER, LUNDBY, PHILLIPS, + (BNL, ROCH)
ANDERS-1 69 PL 28B 611 — ANDERSSON, DAUM, ERNE, LAGNAUX, + (CERN)
ANDERS-2 69 PL 30B 56 — ANDERSSON, DAUM, ERNE, LAGNAUX, + (CERN)
ASBURY 69 PRL 23 194 — +DOWELL, KATO, LUNDQUIST, NOVEY, +(ANL, UMD)
BLAND 69 PL 29B 618 — R W BLAND, G GOLDHABER, G H TRILLING (LRL)
BARBER 70 PL 32B 214 — +BROOME, DUFF, HEYMANN, IMRIE, + (LOUC, RHEL) IJP
GIACOMEL 70 NP B20 301 — GIACOMELLI, GRIFFITHS, (BGNA, GLAS, ROMA, TRST) IJP
HALL 70 DUKE 435 — +BLAND, GOLDHABER, TRILLING (LRL)
REBKA 70 PRL 24 160 — +ROTHBERG, ETKINS, GLODIS, + (YALE) IJP
ADAMS 71 PR D4 2637 — +DAVIES, DOWELL, GRAYER, HATTERS+ (BIRM+RHEL)
BARNETT 71 PL 34B 655 — +LAASANEN, STEINBERG + (UMD+ANL+NWES+NAL)
EHRLICH 71 PRL 26 925 — +ETKIN, GLODIS, HUGHES, KONDO, LU, MORI+ (YALE)
WHITMORE 71 PR D3 1092 — +ABRAMS, EISENSTEIN, KIM, OHALLORAN, + (ILL)
ADAMS 72 NAL PAPER 326 — +COX, DAVIES, DOWELL, GRAYER + (BIRM+RHEL)
CHARLES 72 PL 40B 289 — +COWAN, EDWARDS, GIBSON, + (BRIS, RHEL, SHMP)
ALSO 72 NAL PAPER 287 — CHARLES, COWAN, EDWARDS + (BRIS+RHEL+SHMP)
DANYSZ 72 NP B42 29 — +PENNEY, STEWART, THOMPSON, + (LOIC, CDEF, LOWC)

PHASE SHIFT ANALYSES
CARRERA1 70 NP B23 525 — B CARRERAS, A DONNACHIE (DARE) IJP
ALSO 70 DUKE 447 — +DONNACHIE, KIRSOPP (DARE+MCHS+ EDIN)
LEA 71 NP B26 413 — +MARTIN, THOMPSON (RHEL, LOUC) IJP
LOVELACE 71 NP B28 141 — +WAGNER (CERN) IJP
EHRLICH 72 NAL PAPER 447 — +ETKIN, GLODIS, HUGHES, LU, PATTON + (YALE)
CUTKOSKY 72 NAL PAPER 210 — +HICKS, KELLY, SHIH, JOHNSON CARN+ILL+ANL
MARTIN 72 PREPRINT — B.R.MARTIN, C.E.MILLER (LOUC)

EARLIER ANALYSES THAT DO NOT INCLUDE RECENT POLARIZATION DATA --
LEA 68 PR 165 1770 — LEA, MARTIN, OADES (RHEL, BNL, CERN)
MARTIN 68 PRL 21 1286 — B R MARTIN (BNL)
CUTKOSKY 70 PR D1 2547 — R E CUTKOSKY, B B DEO (CARNEGIE-MELLON) I

LATEST REVIEW TALKS
LEVISETT 69 LUND CONF 341 — R LEVI SETTI (RAPPORTEUR) (CHICAGO)
GOLDHABE 70 DUKE 407 — G. GOLDHABER (REVIEWER) (LRL)
DOWELL 72 NAL REVIEW — REVIEW TALK IN BARYON SESSION (BIRM)
LOVELACE 72 NAL REVIEW — RAPPORTEUR'S TALK (RUTG)

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$Z_1(2150)$

93 Z*1(2150, JP=) I=1

A SMALL BUMP IN TOTAL CROSS SECTION AT PK=1.8 GEV/C

93 Z*1(2150) MASS (MEV)

M	2150.	20.	ABRAMS	70 CNTR	++	K+P TOTAL	10/71

93 Z*1(2150) WIDTH (MEV)

W	(175.)	ABRAMS	70 CNTR	+	K+P TOTAL	10/71

93 Z*1(2150) PARTIAL DECAY MODES

		DECAY MASSES
P1	Z*1(2150) INTO K N	493+ 938

93 Z*1(2150) BRANCHING RATIOS

R1 Z*1(2150) INTO (K N)/TOTAL (P1)
R1 J IS NOT KNOWN, THE FOLLOWING IS (J+1/2)*P1

R1	(0.04)	ABRAMS	70 CNTR	+	K+P TOTAL	10/71

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REFERENCES FOR Z*1(2150)

ABRAMS 70 PR D1 1917 — +COOL, GIACOMELLI, KYCIA, LEONTIC, LI + (BNL)
ALSO 67 PRL 19 257 — ABRAMS, COOL, GIACOMELLI, KYCIA, LEONTIC+ (BNL)

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$Z_1(2500)$

94 Z*1(2500, JP=) I=1

A SMALL BUMP IN TOTAL CROSS SECTION AT PK=2.7 GEV/C

94 Z*1(2500) MASS (MEV)

M	2500.	20.	ABRAMS	70 CNTR	++	K+P TOTAL	10/71

Baryons
$Z_1(2500)$, Λ's and Σ's


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                  94  Z*1(2500) WIDTH (MEV)

W         (160.)                   ABRAMS    70 CNTR ++ K+P TOTAL       10/71
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                  94  Z*1(2500) PARTIAL DECAY MODES

                                                          DECAY MASSES
P1     Z*1(2500) INTO K N                               493+ 938
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                  94  Z*1(2500) BRANCHING RATIOS

R1     Z*1(2500) INTO (K N)/TOTAL                       (P1)
R1      J IS NOT KNOWN, THE FOLLOWING IS (J+1/2)*P1
R1          (0.03)                 ABRAMS    70 CNTR ++ K+P TOTAL       10/71
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                             REFERENCES FOR Z*1(2500)

ABRAMS   70 PR  D1 1917          +COOL,GIACOMELLI,KYCIA,LEONTIC,LI +    (BNL)
   ALSO 67 PRL 19 257            ABRAMS,COOL,GIACOMELLI,KYCIA,LEONTIC+ (BNL)

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Z_1 CROSS SECTION LIMITS

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     SEE MINIREVIEW PRECEDING Z*0

CS  UNITS MICROBARNS
CS         LESS THAN  50.               BASSOMPIE 68 HBC     K+P TO Z*+ PI+   10/69
CS  A LESS THAN .2     +.3       -.1    ANDERSON  69 ASPK +  PI-P TO K-Z*+    10/69
CS  A      ABOVE LIMIT FOR  M=1.2 TO 1.4 GEV -  CL= 99 P.C.
CS  B LESS THAN 1.4    +1.9      -.5    ANDERSON  69 ASPK +  PI-P TO K-Z*+    10/69
CS  B      ABOVE LIMIT FOR  M=1.5 TO 2.5 GEV
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                   REFERENCES FOR Z*1 CROSS SECTION LIMITS

BASSOMPI 68 PL 27B 468        BASSOMPIERRE, +               (CERN,BRUXELLES)
ANDERSON 69 PL 29B 136        +BLESER, BLIEDEN, COLLINS, + (BNL,CARNEGIE)

                   PAPERS NOT REFERRED TO IN DATA CARDS

TYSON    67 PRL 19 255        +GREENBERG,HUGHES,LU,MINEHART,MORI,  (YALE)
MORI     68 PL 28B 152        +GREENBERG,HUGHES,LU,ROTHBERG, +     (YALE)
MORI     69 PR 185 1687       +GREENBERG, HUGHES, LU, MINEHART, +  (YALE)
    MORI 69 REPLACES TYSON 67 AND MORI 68.

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Note on Y^*'s

The number of known or suspected Y^* states has increased considerably in the last few years, following closely a similar increase in the number of N^* states. Just as the recently discovered N^*'s are only weakly coupled in the $\pi N \to \pi N$ reaction, so also are the recently discovered Y^*'s only weakly coupled in the $\bar{K}N \to \bar{K}N$, $\bar{K}N \to \Lambda\pi$, and $\bar{K}N \to \Sigma\pi$ reactions. For this reason the newer Y^*'s are more difficult to uncover; they usually appear as small peaks in invariant mass distributions or make no appearance at all. Rather when the 2-body reactions are partial-wave analyzed, some of the amplitudes are found to traverse resonance-like counterclockwise circles. Clearly the results of partial-wave analysis give the J^P information, whereas a peak seen in an invariant mass distribution or a total cross section often cannot be analyzed for its quantum numbers. We will keep information coming from formation experiments and from production experiments separate, whenever necessary.

Production experiments. These types of experiments are often difficult to analyze. Information on I = 0 states is possible only when there is no I = 1 state at similar mass. The main controversies at the present time concern resonances in the 1600 to 1700 MeV region. See the mini-reviews on $\Sigma(1620)$ and on $\Sigma(1670)$ in these Listings. A good review is given by MILLER 70.[1] Also, the branching ratios of $\Sigma(1915)$ F_{15} as measured in formation and productions experiments do not agree. This is probably due to two facts: 1) the elasticity is small, 2) the nearby $D_{13}(1940)$ may contribute to production experiments.

Formation experiments. Partial-wave analyses have been performed on $\bar{K}N$, $\Lambda\pi$, $\Sigma\pi$ and ΞK channels. Given the present accuracy of the data it is not possible to perform a completely energy-independent analysis, that is, solve for the partial-wave amplitudes at each energy in a model-independent way. Usually many solutions are found and even when it is required that solutions at neighboring energies join smoothly, it is not possible to select a unique overall solution. To overcome this, one specifies the form of the energy dependence of some or all of the partial-wave amplitudes. Analyses in which the energy dependence of all the amplitudes is specified are called energy dependent. When referring to results of this type of analysis, the technique listed is DPWA. Thus an amplitude known to resonate will be given a Breit-Wigner form, whereas an amplitude not *a priori* known to resonate may be tried alternately with a resonance form and with some simple nonresonant form, the choice between these then being made by comparing the goodness-of-fit for the two fits. Analyses in which the energy dependence of most of the amplitudes is left unspecified are called (not quite correctly) energy independent. These may involve some fixed input resonances in some of the partial waves and/or some method for selecting solutions that join together smoothly as functions of energy. The technique used for these analyses is listed as IPWA.

Three recent analyses have attempted to fit data on three channels ($\bar{K}N$, $\Sigma\pi$, and $\Lambda\pi$) at lab momenta below 1226 MeV/c. ARMENTEROS 70 (CH) fit each channel separately. They first fit Legendre series to the available data at each momentum in the range 436-1200 MeV/c, and then obtained smooth curves through the Legendre coefficients by fitting a polynomial in

p_{lab} to each coefficient. Finally, the partial wave amplitudes were fit to the smoothed Legendre coefficients (or reconstructed smoothed angular distributions in the case of $\overline{K}N$), and the continuity of the "data" was used to enforce continuity of the amplitudes. With a few exceptions the S and P waves were varied freely, while the higher waves were fixed as sums of Breit-Wigners (BW's) with no background, representing some well known resonances. Single channel inelastic unitarity was imposed during the fitting, and the results were checked against the three-channel unitarity constraint

$$\mathrm{Im}\, T_{\overline{K}N} \geq |T_{\overline{K}N}|^2 + |T_{\Sigma\pi}|^2 + |T_{\Lambda\pi}|^2 \qquad (1)$$

for each isospin. Resonance parameters were estimated visually.

KIM 71 (K) fit data from threshold to 1226 MeV/c using the Ross and Shaw[2] effective-range expansion of the inverse multi-channel K-matrix. The data in each of seven energy intervals bounded by 0, 534, 658, 806, 916, 1022, 1117, and 1226 MeV/c, were fit with a constant effective-range matrix. An extra channel was included for each isospin to approximate the effects of three-particle final states. The parameters for these extra channels were constrained by information on the total three-particle cross sections. Only the $F_{15}(1915)$ was fixed to a BW form, all other waves included being parametrized by the K-matrix formalism. Resonances were identified on the basis of loops in the Argand diagram correlated with a peak in the speed plot and a pole in the K-matrix. The radius of the loop, the speed criterion, and the residue of the K-matrix were used to determine resonance parameters.

LANGBEIN 72 (LW) performed single energy fits at 40 momenta between 436 and 1226 MeV/c. The partial waves at each energy were parametrized in a form that automatically satisfied Eq. (1), and that could easily be specialized to a BW form by setting one of the parameters to zero. This capability was used to constrain the $D_{03}(1690)$, $D_{15}(1765)$, $F_{05}(1815)$, and $F_{17}(2030)$ to pure BW forms in the range $|E-M_R| < \Gamma$. The resonant parameters were fit to known values. Approximately 90 acceptable single-energy fits per energy were generated and were used in shortest path searches over two regions, 1536 to 1700 MeV and 1700 to 1900 MeV. Several candidates for acceptable shortest paths were generated, and a preferred path was chosen by rejecting those that failed to reproduce known resonance behavior. Resonances in this solution were identified by loops in Argand diagrams correlated with peaks in the ≥3-body final state cross section. Resonance parameters were then extracted by fitting BW's with both multiplicative and additive background.

Partial-wave amplitudes from these three analyses are shown in Figs. 1-3. These analyses show, in addition to the well-established states (which we have classified with three or four stars in Table II at the end of this note), other states which we report in Table I. The table includes effects which show as a clear signal in at least one of the analyses (i.e., this is a list of promising "rookies").

Table I. Comparison of recent Y^* claims. Notation is mass (MeV)/width (MeV)/strongest two-body channel; CH = CERN-Heidelberg, K = Kim, LW = Langbein and Wagner.

Wave	CH	K	LW
S_{01}		1780/40/$\overline{K}N$	1830/70/$\overline{K}N$
P_{01}		1570/50/?	1620/60/?
P_{01}	1750/70/$\Sigma\pi$ 1800/30/$\overline{K}N$	1755/35/$\overline{K}N$	1780/120/$\overline{K}N$
P_{03}			1850/125/$\overline{K}N$
S_{11}		1620/40/$\Lambda\pi$	1630/65/$\Sigma\pi$
S_{11}	1730/80/$\Lambda\pi$	1790/50/$\overline{K}N$	1790/100/$\overline{K}N$
P_{11}	1500-1600/50/$\Sigma\pi$	1670/50/$\Sigma\pi$	
P_{13}			1840/120/$\overline{K}N$

Although a certain amount of qualitative agreement is apparent, there are many quantitative discrepancies. Some of these effects have been seen elsewhere, and there is also considerable disagreement with some of these other observations. The branching ratios into $\overline{K}N$, $\Sigma\pi$, and $\Lambda\pi$ are particularly poorly determined (this is also true of some of the better established resonances).

In addition to analyses which treat all of the channels $\overline{K}N$, $\Sigma\pi$, and $\Lambda\pi$, there have been a number of energy-dependent analyses of a single channel. We will describe three of the most recent of these. CONFORTO 71 fit data on the $\overline{K}N$ channel between 777 and 1226 MeV/c. The procedure was to parametrize each wave as a term linear in the lab momentum plus (possibly) BW's with adjustable phase. The data were first fit with BW's representing only known resonances. Three more resonances were then added, one at a time,

Baryons
Λ's and Σ's

Data Card Listings
For notation, see key at front of Listings.

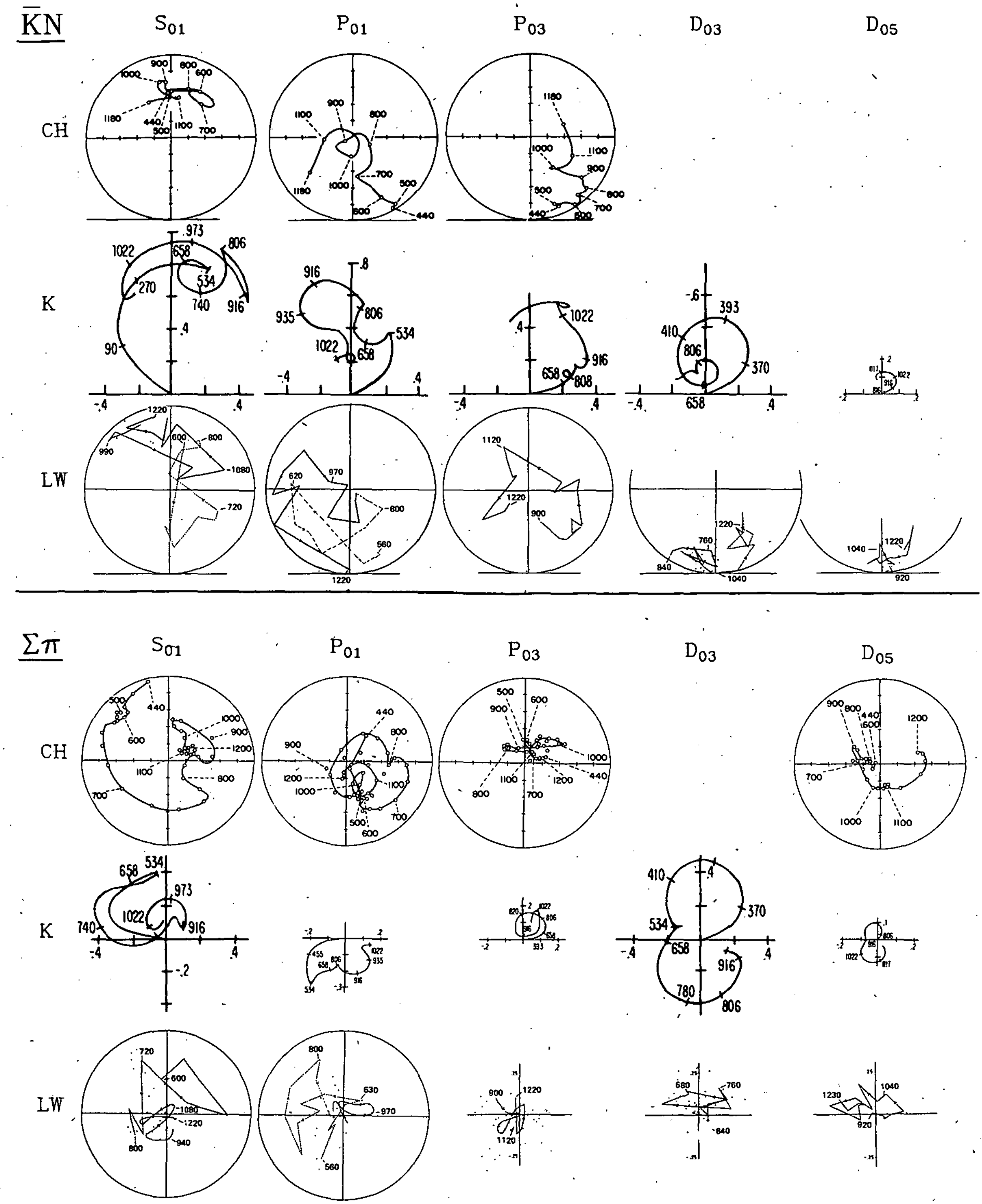

Fig. 1. I=0 partial wave amplitudes for the reactions $\bar{K}N \rightarrow \bar{K}N$ and $\bar{K}N \rightarrow \Sigma\pi$ from the analyses of ARMENTEROS 70 (CH), KIM 71 (K), and LANGBEIN 72 (LW). The $\bar{K}$ laboratory momenta are indicated.

0 0 0 0 3 6 0 4 8 3 7

Data Card Listings

For notation, see key at front of Listings.

Baryons
Λ's and Σ's

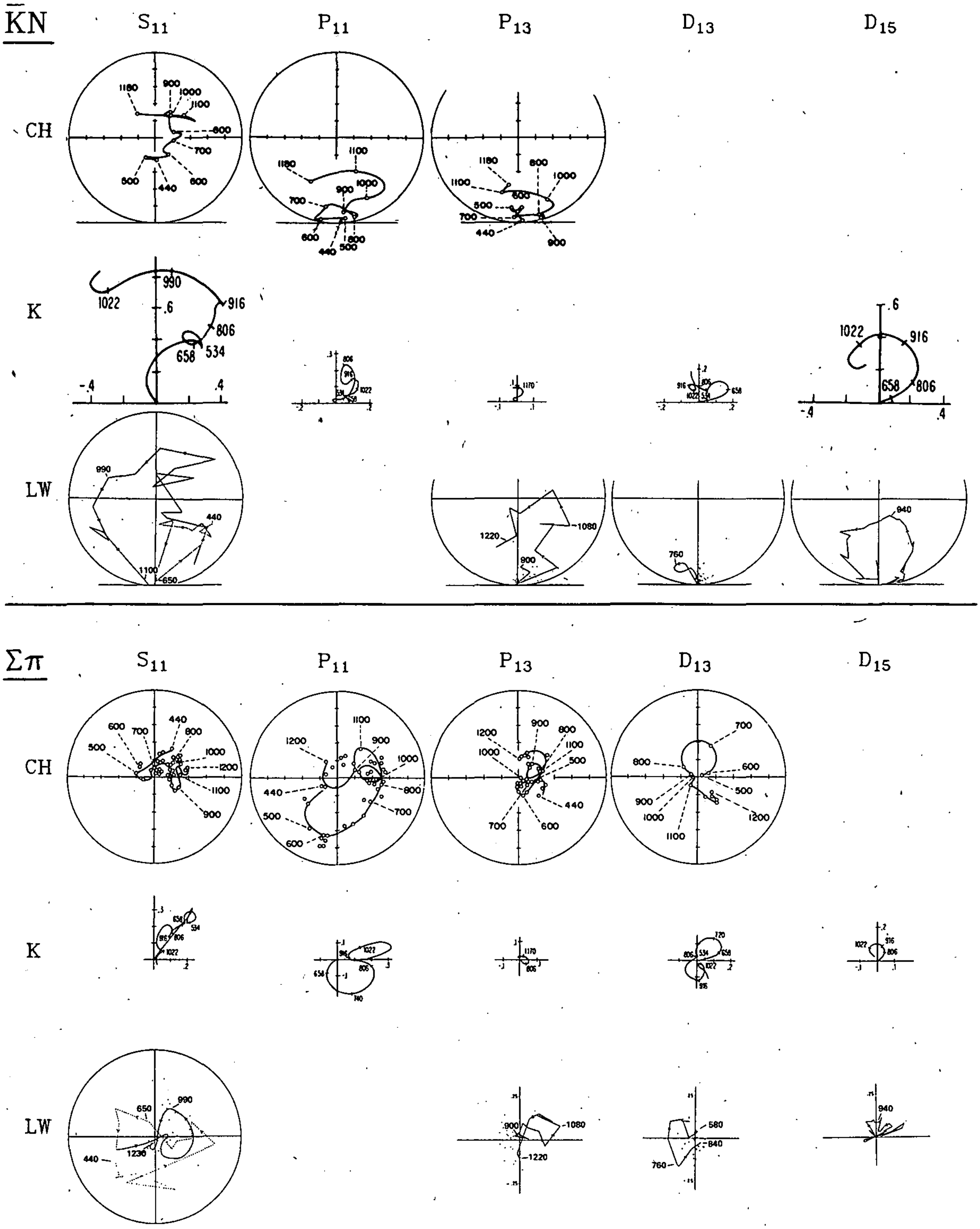

Fig. 2. I=1 partial wave amplitudes for the reactions $\overline{K}N \to \overline{K}N$ and $\overline{K}N \to \Sigma\pi$ from the analyses of ARMENTEROS 70 (CH), KIM 71 (K), and LANGBEIN 72 (LW). The $\overline{K}$ laboratory momenta are indicated.

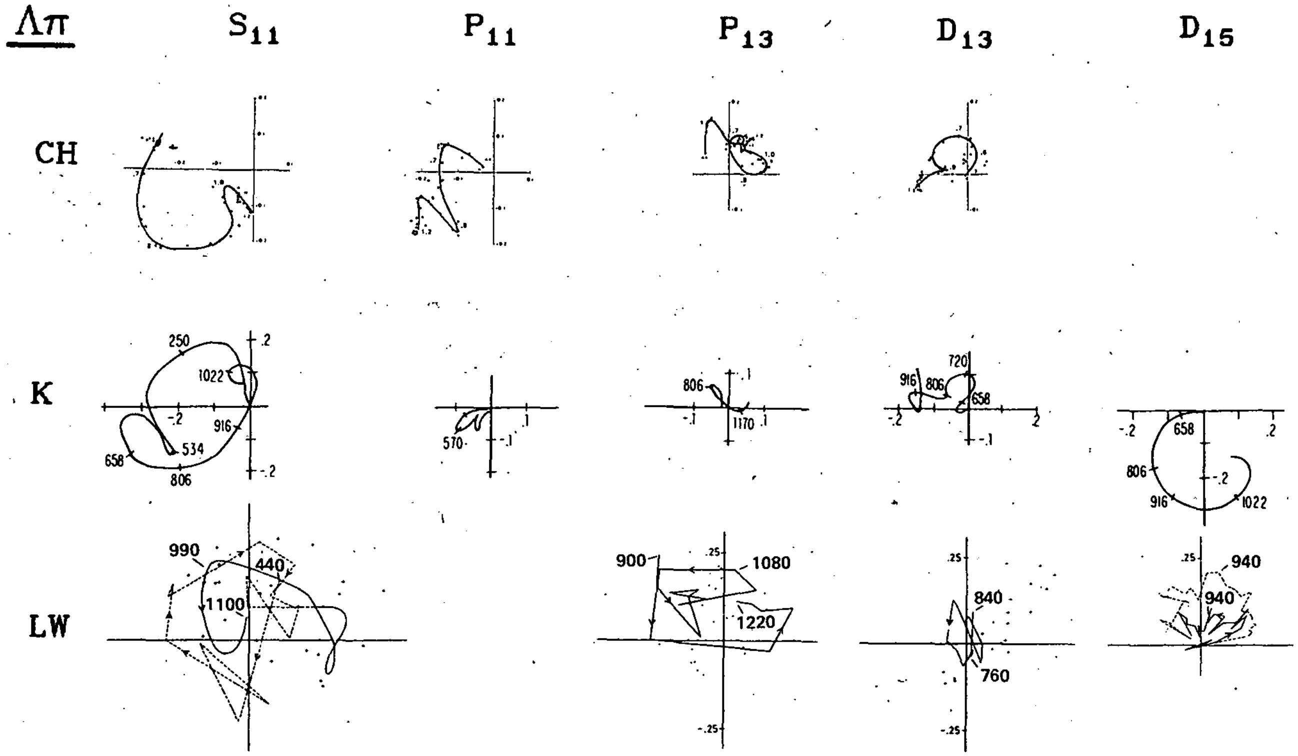

Fig. 3. Partial wave amplitudes for the reaction $\overline{K}N \to \Lambda\pi$ from the analyses of ARMENTEROS 70 (CH), KIM 71 (K), and LANGBEIN 72 (LW). The $\overline{K}$ laboratory momenta are indicated.

to the waves where they had the most effect on χ^2. Best results were obtained by adding a $D_{05}(1830)$, $P_{03}(1883)$, and $S_{11}(1757)$. KANE 72 reported an analysis of bubble chamber cross section and polarization data on the $\Sigma\pi$ channel between 870 and 1694 MeV/c. Legendre coefficients obtained from this data were used to fit an energy-dependent background + BW form for each wave, and the results were checked against the angular distributions from this experiment and against a compilation of Legendre coefficient data. In addition to known resonances, signals for a $F_{05}(2141)$, $F_{15}(2057)$, and a $D_{13}(1985)$ were seen. VAN HORN 72 fit data on the $\Lambda\pi$ channel Legendre coefficients over the range 1537-2215 MeV, including new bubble chamber data between 1865 and 2106 MeV. An energy dependent parametrization similar to KANE 72 was used for the fitting; the 20 best solutions indicate (in addition to established resonances) the probable resonances $S_{11}(1697)$, $D_{13}(1949)$, $P_{11}(1668)$, and four possibilities in other waves. VAN HORN 72 also used the Barrelet[3] method to generate ambiguous solutions that correspond to the same cross sections and polarizations as the best energy-dependent solutions. Seven ambiguous solutions were found that preserved the established resonance behavior of the $D_{13}(1670)$, $D_{15}(1765)$, $F_{15}(1915)$, and $F_{17}(2030)$, but with varying couplings for these resonances to the $\Lambda\pi$ channel, and with widely different resonant structures in the lower waves.

Errors on masses and widths. Often the quoted errors are only statistical, but the values of masses and widths can change well above these errors when a new parametrization is used. For this reason we report the values of M, Γ, and x_i obtained by different authors even if they analyze the same data. The spread of these masses and widths is certainly a better estimate of the uncertainties than the statistical errors.

Data Card Listings

For notation, see key at front of Listings.

Baryons

Λ's and Σ's, Λ, Λ(1330)

Recently it has become the custom to quote errors as obtained by inspection of various fits done with different hypotheses [see for example BERTHON 70 and GALTIERI 70 under Σ(1915)]. These errors are probably more realistic. On the other hand, the value of the parameter itself may be consistent with other determinations and often may even be the best available value. In such circumstances we put only the error in parentheses to remind the reader of the additional uncertainty due to model dependent assumptions. For two states, Λ(1820) and Σ(1765), there is enough data available to perform an overall fit of the various x_i of the type discussed in the main text (section V C). In this case we are forced to use the errors, however small they may be, but we warn the reader that the final errors are not to be taken seriously.

In conclusion, we chose not to give errors on masses and total widths determined in partial-wave analyses, but, whenever necessary, we give a range of values. As for the branching ratios, we use the errors when needed to perform an overall fit, but we caution the reader.

Conclusions. Table II is an attempt to evaluate the status of the various Y^*'s. The evaluations are of course partly subjective. A blank indicates that there is no corresponding evidence at all. This may mean either that the relevant couplings are small or that the resonance does not really exist. The Baryon Table includes only the well-established resonances. It seems clear, however, that whereas any particular one of the questionable resonances may disappear with the next analysis, there definitely are many new resonances underlying those we are more familiar with.

References

1. D. H. Miller, in Proceedings of the Duke Conference on Hyperon Resonances (1970), p. 229.
2. M. Ross and G. Shaw, Ann. Phys. (N. Y.) 13, 147 (1961).
3. E. Barrelet, N.C. 8A, 331 (1972).
4. A. Barbaro-Galtieri in Proceedings of the Duke Conference on Hyperon Resonances (1970), p. 173.

TABLE II. STATUS OF Y* RESONANCES
THOSE WITH AN OVERALL STATUS OF *** OR **** ARE INCLUDED IN THE MAIN BARYON TABLE. THE OTHERS AWAIT CONFIRMATION.

PARTICLE	LIJ	OVERALL STATUS	STATUS AS SEEN IN -- TOTAL≠ CR. SEC.	KBAR N	LAM PI	SIG PI	OTHER CHANNELS
LAM(1115)	P01	****					WEAK TO N PI
LAM(1330)		DEAD					
LAM(1405)	S01	****		****	F	****	
LAM(1520)	D03	****	****	****	O	****	LAM2PI,LAM GAM
LAM(1670)	S01	****		****	R	****	LAM ETA
LAM(1690)	D03	****	****	****	B	****	LAM2PI,SIG2PI
LAM(1750)	P01	**		**	I	**	
LAM(1815)	F05	****	****	****	D	****	SIG(1385) PI
LAM(1830)	D05	***		***	D	****	
LAM(1860)	P03	**	**	**	E	*	
LAM(1870)	S01	**		**	N	*	
LAM(2010)	D03	**			F	*	LAM OMG
LAM(2020)	F07	**		*	O	*	
LAM(2100)	G07	****	****	****	R	***	XI K,LAM OMG
LAM(2110)		*		*	B	*	LAM OMG
LAM(2350)		****	****	****	I		
LAM(2585)		***	***	*	D		
SIG(1190)	P11	****					WEAK TO N PI
SIG(1385)	P13	****			****	****	
SIG(1440)	PE	DEAD					
SIG(1480)	PE	*		*	*	*	
SIG(1620)	S11	**		**	*	*	
SIG(1620)	P11	**		**	*	**	
SIG(1620)	PE	**		*	**		LAM 2-PI
SIG(1670)	D13	****	**	***	****	****	SEVERAL OTHERS
SIG(1670)	PE	**		**	**	**	SEVERAL OTHERS
SIG(1690)	PE	**	*	*	**	*	LAM 2-PI
SIG(1750)	S11	***		**	**	*	SIG ETA
SIG(1765)	D15	****	****	****	****	***	SEVERAL OTHERS
SIG(1840)	P13	*		*	**	*	
SIG(1880)	P11	**		**	**		
SIG(1915)	F15	****	***	***	****	***	
SIG(1940)	D13	***		*	***	**	
SIG(2000)	S11	*			*		
SIG(2030)	F17	****	****	****	****	**	XI K
SIG(2070)	F15	*				*	
SIG(2080)	P13	**			**		
SIG(2100)	G17	**			**	**	
SIG(2250)		****	****	*	*	*	
SIG(2455)		***	***	*			
SIG(2620)		***	***	*			
SIG(3000)		**		*	*		

**** GOOD, CLEAR, AND UNMISTAKABLE.
*** GOOD, BUT IN NEED OF CLARIFICATION OR NOT ABSOLUTELY CERTAIN.
** NEEDS CONFIRMATION.
* WEAK.

≠ ATTRIBUTED TO THE STATE CLOSEST TO WHERE THE CROSS SECTION PEAKS.

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18 LAMBDA (1115,JP=1/2+) I=0

SEE STABLE PARTICLE DATA CARD LISTINGS

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Λ(1330) BUMPS →

87 Y*0(1330, JP=) I=0 PRODUCTION EXPERIMENTS

SEE THE MINI-REVUE AT THE START OF THE Y* LISTINGS.

A PEAK IS SEEN NEAR 1330 MEV IN THE LAMBDA GAMMA SPECTRUM IN THREE PI- PROPANE EXPERIMENTS (YUNG-CHANG 64, BUBELEV 67, AND BOZOKI 68). IN THE FIRST TWO, THIS WAS TAKEN AS INDIRECT EVIDENCE FOR THE Y*0(1670) DECAYING TO LAMBDA ETA, WITH THE ETA DECAYING TO TWO GAMMAS. IN THE THIRD EXPERIMENT THIS INTERPRETATION HAS BEEN RULED OUT. BOZOKI 68 MENTION THE POSSIBILITY OF THERE BEING A Y*0(1330) WITH A NARROW WIDTH (<25 MEV), BUT DEFER SERIOUS CONSIDERATION OF IT UNTIL THERE IS MORE DATA.

SHOULD SUCH A RESONANCE EXIST, IT SHOULD BE SEEN IN PI- P TO K0 + (MISSING MASS). DAHL 67 FOUND NO EVIDENCE FOR IT.

A SEARCH FOR A NEW Y*0 NEAR THE LAMBDA OR SIGMA MASS WAS MADE BY TAN 69. NONE WAS FOUND.

ANOTHER SEARCH BY MAYEUR 70 REVEALED NO EVIDENCE FOR THIS STATE.

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REFERENCES FOR Y*0(1330) (PROD. EXP.)

Y-CHANG	64 DUBNA CONF I 615	YUNG-CHANG, IN, KLADNITSKAYA, +	(DUBNA)
BUBELEV	67 PL 24B 246	+CHADRAA, CHUVILO, +	(JINR,BUCHAREST,CERN)
DAHL	67 PR 163 1377	DAHL, HARDY, HESS, KIRZ, MILLER	(LRL)
BOZOKI	68 PL 28B 360	+FENYVES, GEMESY, +	(BUDAPEST,DUBNA)
TAN	69 PRL 23 101	T H TAN	(SLAC)
MAYEUR	70 PL 33B 441	+VAN BINST,WILQUET+++	(BRUX,CERN,TUFT)

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Baryons
Λ(1405), Λ(1520)

Data Card Listings
For notation, see key at front of Listings.

Λ(1405) BUMPS

37 Y*0(1405, JP=1/2-) I=0 PRODUCTION EXPERIMENTS

THIS RESONANCE CAN BE IDENTIFIED WITH THE VIRTUAL BOUND STATE IN THE KBAR-N SYSTEM FOUND IN THE ANALYSIS OF LOW ENERGY K-P INTERACTION. WE LIST SUCH EXPERIMENTS SEPARATELY BELOW. WE USE ONLY PRODUCTION EXPERIMENTS FOR AVERAGING OF MASSES AND WIDTHS.

37 Y*0(1405) MASS (MEV) (PROD. EXP.)

M		(1405.0)		ALSTON	61	HBC	K-P 1.15 BEV/C	
M		(1410.0)		ALEXANDER	62	HBC	PI-P 2.1 BEV/C	
M		(1405.0)		ALSTON	62	HBC	K-P 1.2-.5 BEV/C	
M		(1382.0)	(8.0)	ENGLER	65	HDBC	PI-P, PI+D 1.68	7/66
M		1400.0	24.0	MUSGRAVE	65	HBC	PBAR P 3-4 BEV/C	7/66
M	67	1400.0	5.0	BIRMINGHA	66	HBC	K-P 3.5	9/67
M	120	1405.0	5.0	GALTIERI	68	DBC	K-D 2.1-2.78EV/C	6/68
M		. . . .						
M	AVG	1402.4	3.5	AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)				

37 Y*0(1405) WIDTH (MEV) (PROD. EXP.)

W		(20.0)		ALSTON	61	HBC		7/66
W		35.0	5.0	ALEXANDER	62	HBC		
W		(50.0)		ALSTON	62	HBC		
W		(89.0)	(20.0)	ENGLER	65	HDBC		7/66
W		60.0	20.0	MUSGRAVE	65	HBC		7/66
W	67	50.0	10.0	BIRMINGHA	66	HBC	K-P 3.5	9/67
W	120	35.0	8.0	GALTIERI	68	DBC	K-D 2.1-2.78EV/C	6/68
W		. . . .						
W	AVG	38.1	3.9	AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)				

37 Y*0(1405) PARTIAL DECAY MODES (PROD. EXP.)

		DECAY MASSES
P1	Y*0(1405) INTO SIGMA PI	1197+ 139

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REFERENCES FOR Y*0(1405) (PROD. EXP.)

ALSTON 61 PRL 6 698 +ALVAREZ,EBERHARD,GOOD,GRAZIANO, + (LRL) I
ALEXANDE 62 PRL 8 447 ALEXANDER,KALBFLEISCH,MILLER,SMITH (LRL) I
ALSTON 62 CERN CONF 311 +ALVAREZ,FERRO-LUZZI,ROSENFELD, + (LRL) I
ENGLER 65 PRL 15 224 +FISK,KRAEMER,MELTZER,WESTGARD,+ (CARN,BNL) IJ
MUSGRAVE 65 NC 35 735 +PETMEZAS,+ (BIRM,CERN,EPOL,LOIC,SACLAY)

BIRMINGH 66 PR 152 1148 BIRMINGHAM,GLASGOW,LOIC, OXFORD,RUTHERFORD
GALTIERI 68 PRL 21 573 BARBARO-GALTIERI,CHADWICK + (LRL,SLAC)

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Λ(1405) EXTRAP. S'_{01}

24 Y*0(1405, JP=1/2-) I=0
EXTRAPOLATION BELOW THRESHOLD

SEE NOTE IN Y*0(1405) PRODUCTION EXPERIMENTS -THE DIFFICULTIES IN EXTRAPOLATING FROM THE PHYSICAL REGION TO THE RESONANCE LOCATION ARE DISCUSSED BY DALITZ 67.

THE QUESTION ON WHETHER Y*(1405) IS A KBAR-N BOUND STATE OR A CDD POLE (DALITZ 70) HAS BEEN INVESTIGATED BY CLINE 71, MARTIN 71, GALTIERI 72, AND DOBSON 72. THE LAST TWO PAPERS CONCLUDE THAT THE DATA CANNOT TELL THE DIFFERENCE.

24 Y*0(1405) MASS (MEV)

M	1410.7	(1.0)	KIM	65	HBC	0-EFF-RANGE FIT	7/66
M	1409.6	(1.7)	SAKITT	65	HBC	0-EFF-RANGE FIT	7/66
M	DATA OF SAKITT ARE USED IN FIT BY KITTEL.						
M	1407.5	(1.2)	KITTEL	66	HBC	0-EFF-RANGE FIT	7/66
M	1403.0	(3.0)	KIM	67	HBC	K MATRIX FIT(KP)	8/67
M	1416.0	(4.0)	MARTIN	69	HBC	CONST. K MATRIX	10/69
M	(1421.0)		MARTIN	70	RVUE	CONST. K MATRIX	6/70

24 Y*0(1405) WIDTH (MEV)

W	37.0	(3.2)	KIM	65	HBC		7/66
W	28.2	(4.1)	SAKITT	65	HBC		7/66
W	34.1	(4.1)	KITTEL	66	HBC		7/66
W	50.0	(5.0)	KIM	67	HBC	K MATRIX FIT(KP)	8/67
W	29.0	(6.0)	MARTIN	69	HBC	CONST. K MATRIX	10/69
W	(20.0)		MARTIN	70	RVUE	CONST. K MATRIX	6/70

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REFERENCES FOR Y*0(1405) (FROM EXTRAPOLATIONS)

KIM 65 PRL 14 29 J K KIM (COLUMBIA)IJP
SAKITT 65 PR 139 B719 +DAY,GLASSER,SEEMAN,FRIEDMAN, + (UMD,LRL)IJP
KITTEL 66 PL 21 349 W KITTEL, G OTTER, I WACEK (VIENNA)IJP
KIM 67 PRL 19 1074 J KIM (YALE)IJP
MARTIN 69 PR 183 1352 B R MARTIN, M SAKITT (LOUC+BNL)
MARTIN 70 NP B16 479 A D MARTIN, G G ROSS (DURHAM)IJP

PAPERS NOT REFERRED TO IN DATA CARDS

ABRAMS 65 PR 139 B454 G S ABRAMS, B SECHI-ZORN (UMD)IJP
DONALD 66 PL 22 711 + EDWARDS, LYS, NISAR, MOORE (LIVERPOOL)
KADYK 66 PRL 17 599 +OREN, G+S GOLDHABER, TRILLING (LRL)IJP
FIT SOLUTIONS GIVING AN I≠0 S1 (2 RESONANCE.)
ABRAMS 65, KADYK 66, AND DONALD 66 SUPPORT THOSE EFFECTIVE-RANGE-
DALITZ 67 PR 153 1617 DALITZ, WONG, RAJASEKARAN (OXFORD,BOMBAY)
DALITZ 70 DUKE-HR 70 03 R D DALITZ (OXF)
CLINE 71 PRL 26 1194 D CLINE,R LAUMANN,J MAPP (WISC)
MARTIN 71 PL 35B 62 A D MARTIN,B R MARTIN,ROSS (DURH+LOUC+RHEL)
DOBSON 72 PR D6 3256 P N DOBSON,R MCELHANEY (HAWA)
GALTIERI 72 LBL 555 A.BARBARO-GALTIERI (LBL)

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Λ(1520) D'_{03}

38 Y*0(1520, JP=3/2-) I=0

PRODUCTION AND FORMATION EXPERIMENTS AGREE QUITE WELL WITH EACH OTHER ,THEREFORE. THEY HAVE NOT BEEN SEPARATE FOR THIS PARTICLE
A POSSIBLE EXCEPTION TO ABOVE IS THE LAM PI PI MODE. BOTH CHAN 72 AND MAST 73 (FORMATION) AGREE THAT IT IS PREDOMINANTLY Y*1(1385) PI. HOWEVER, THEY DISAGREE BY A FACTOR OF 2 AS TO THE CONTRIBUTION OF Y*0(1520) TO THE OVERALL LAM PI PI CROSS SECTION. BURKHARDT 71 (PRODUCTION), WITH MUCH LESS STATISTICS, FIND A MUCH LOWER BRANCHING RATIO.

38 Y*0(1520) MASS (MEV)

M	145	1517.2	3.0	GALTIERI	63	DBC	K-D 1.51 BEV/C	
M		1519.4	2.0	WATSON	63	HBC	K-P ALL CHANNELS	
M	29	1520.0	4.0	ALMEIDA	64	HBC	K-P 1.45 BEV/C	
M		(1511.0)	(15.0)	MUSGRAVE	65	HBC	PBAR P 3-4 BEV/C	7/66
M	30	(1510.0)	(2.0)	BIRMINGHA	66	HBC	K-P 3.5	9/67
M	B	1517.2	1.2	BURKHARDT	69	HBC	K-P .8-1.2 GEV/C	10/69
M	B	QUOTED ERROR INCREASED TO ACCOUNT FOR DISAGREEMENT BETWEEN						
M	B	TWO MEASUREMENTS DONE BY SAME AUTHORS (K-P AND SIGMA PI)						
M		(1519.)		KIM	71	DPWA	K-MATRIX ANAL.	3/71
M		. . . .						
M	AVG	1517.85	0.95	AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)				

38 Y*0(1520) WIDTH (MEV)

W		16.4	2.0	WATSON	63	HBC		
W		(19.0)	(19.0)	MUSGRAVE	65	HBC		7/66
W	30	(50.0)	(10.0)	BIRMINGHA	66	HBC	K-P 3.5	9/67
W		(18.0)	OR LESS	DAHL	67	HBC		9/66
W		14.7	1.8	BURKHARDT	69	HBC	K-P .8-1.2 GEV/C	10/69
W		(16.)		KIM	71	DPWA	K-MATRIX ANAL.	3/71
W		. . . .						
W	AVG	15.5	1.3	AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)				

38 Y*0(1520) PARTIAL DECAY MODES

		DECAY MASSES
P1	Y*0(1520) INTO KBAR N	497+ 939
P2	Y*0(1520) INTO SIGMA PI	1197+ 139
P3	Y*0(1520) INTO LAMBDA PI PI	1115+ 139+ 139
P4	Y*0(1520) INTO LAMBDA GAMMA	1115+ 0
P5	Y*0(1520) INTO SIGMA0 GAMMA	1192+ 0
P6	Y*0(1520) INTO SIGMA PI PI	1197+ 139+ 139
P7	Y*0(1520) INTO (Y*1(1385)+PI)	1384+ 139

FITTED PARTIAL DECAY MODE BRANCHING FRACTIONS

The matrix below is derived from the error matrix for the fitted partial decay mode branching fractions, P_i, as follows: The diagonal elements are $P_i \pm \delta P_i$, where $\delta P_i = \sqrt{(\delta P_i \delta P_i)}$, while the off-diagonal elements are the normalized correlation coefficients $(\delta P_i \delta P_j)/(\delta P_i \cdot \delta P_j)$. For the definitions of the individual P_i, see the listings above; only those P_i appearing in the matrix are assumed in the fit to be nonzero and are thus constrained to add to 1.

	P 1	P 2	P 3	P 4	P 5	P 6
P 1	.4502+-.0089					
P 2	-.7405	.4115+-.0092				
P 3	-.2227	-.3403	.1004+-.0054			
P 4	-.0689	-.0647	-.0324	.0080+-.0014		
P 5	-.1739	-.1633	-.0819	-.0095	.0199+-.0035	
P 6	-.0738	-.0693	-.0347	-.0040	-.0102	.0100+-.0015

38 Y*0(1520) BRANCHING RATIOS

R1	Y*0(1520) INTO (SIGMA PI)/(KBAR N)						(P2)/(P1)	
R1		1.72	.78	MUSGRAVE	65	HBC		8/67
R1		0.96	0.20	DAHL	67	HBC	PI-P 1.6-4 GEV/C	9/66
R1		0.73	0.11	DAUBER	67	HBC	K-P AT 2.GEV/C	8/67
R1		1.06	.14	SCHEUER	68	DBC	0 K-N 3 GEV/C	10/69
R1		0.82	0.08	BURKHARDT	69	HBC	K-P .8-1.2 GEV/C	10/69
R1		. . . .						
R1	AVG	0.851	0.064	AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.1)				
R1	FIT	0.914	0.036	FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)				

Data Card Listings

For notation, see key at front of Listings.

Baryons
Λ(1520), Λ(1670)

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R2       Y*0(1520) INTO (LAMBDA PI PI)/(KBAR N)              (P3)/(P1)
R2              0.17     0.05          DAHL       67 HBC      PI-P 1.6-4 GEV/C  9/66
R2              0.21     0.18          DAUBER     67 HBC      K-P AT 2.GEV/C    8/67
R2               .19      .04          SCHEUER    68 DBC    0 K-N 3 GEV/C      10/69
R2              0.22     0.03          BURKHARDT  69 HBC      K-P .8-1.2 GEV/C 10/69
R2             (0.2)                   KIM        71 DPWA     K-MATRIX ANAL.    3/71
R2              . . . . . . . . .
R2  AVG         0.202    0.021   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R2  FIT         0.223    0.014  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R3       Y*0(1520) INTO (SIGMA PI)/(LAMBDA PI PI)            (P2)/(P3)
R3              4.5      1.0           ARMENTERO  65 HBC                        7/66
R3              3.3      1.1           BIRMINGHA  66 HBC      K-P 3.5           9/67
R3              3.9      1.0           UHLIG      67 HBC      K-P .9-1.0 BEV/C  9/66
R3              . . . . . . . . .
R3  AVG         3.94     0.59    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R3  FIT         4.10     0.27   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R4       Y*0(1520) INTO (LAMBDA GAMMA)/TOTAL (PERCENT)       (P4)
R4        238   0.80     0.14          MAST       68 HBC    0 USING ELAST=.45  11/68
R4              . . . . . . . . .
R4  FIT         0.80     0.14   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R5       Y*0(1520) INTO (SIGMA0 GAMMA)/TOTAL (PERCENT)       (P5)
R5  S           2.0       .35          MAST       68 HBC      SEE NOTE S       10/69
R5  S     RATIOS CALCULATED FROM R4,ASSUMING SU(3). NEEDED TO CONSTRAIN
R5  S     ALL THE Y*0(1520) BRANCHING RATIOS TO BE UNITY.
R5              . . . . . . . . .
R5  FIT         1.99     0.35   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R6       Y*0(1520) INTO (KBAR N)/TOTAL                        (P1)
R6              0.29     0.05          WATSON     63 HBC      K-P ALL CHANNELS 10/71
R6              .447     .018          GALTIERI   69 HBC      K- P .28-.45 G/C 10/69
R6              0.47     0.03          COLLEY     71 DBC      K-N 1.5 GEV PROD 10/71
R6             (0.45)                  KIM        71 DPWA     K-MATRIX ANAL.    3/71
R6              . . . . . . . . .
R6  AVG         0.439    0.033   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 2.3)
R6  FIT         0.4502   0.0089 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)

R7       Y*0(1520) INTO (SIGMA PI)/TOTAL                      (P2)
R7              0.55     0.09          WATSON     63 HBC      K-P ALL CHANNELS 10/71
R7              0.418     .017         GALTIERI   69 HBC    0 K-P .28-.45GEV/C  6/69
R7              0.43     0.03          COLLEY     71 DBC      K-N 1.5 GEV PROD 10/71
R7             (0.46)                  KIM        71 DPWA     K-MATRIX ANAL.    3/71
R7              . . . . . . . . .
R7  AVG         0.424    0.015   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R7  FIT         0.4115   0.0092 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)

R8       Y*0(1520) INTO (SIGMA PI PI)/TOTAL                   (P6)
R8              .010     .0015         GALTIERI   69 HBC    0 K-P .28-.45GEV/C 10/69
R8              . . . . . . . . .
R8  FIT         0.0100   0.0015 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R9       Y*0(1520) INTO (Y*1(1385) PI)/(LAM PI PI)            (P7)/(P3)
R9          MORE THAN    0.10          CLINE      69 DBC      K-D TO 2PI LAM N  9/69
R9  B           0.39     0.10          BURKHARDT  71 HBC      LAM. 3PI PROD.    3/71
R9  C          (1.0)                   CHAN       72 IPWA     K-P TO LAM 2PI    2/73*
R9  M           0.82     0.10          MAST       73 IPWA     K-P TO 2PI LAM   12/72*
R9  B   CENTRAL BIN(1514-1524) GIVES .74+-.10 -- OTHER BINS LOWER BY 2-5SIG
R9  C   ONLY THE Y*(1385)DS03 SEEMS TO CONTRIBUTE
R9  M   BOTH Y*(1385)DS03 AND SIGMA (PI PI)DP03 CONTRIBUTE
R9              . . . . . . . . .
R9  AVERAGE MEANINGLESS (SCALE FACTOR = 3.0)

R10      Y*0(1520) INTO (Y*1(1385) PI)/TOTAL                  (P7)
R10             0.041    0.005         CHAN       72 HBC      K-P TO LAM 2PI    3/71

R11      Y*0(1520) INTO (LAMBDA PI PI)/TOTAL                  (P3)
R11             0.10     0.02          COLLEY     71 DBC      K-N 1.5 GEV PROD 10/71
R11             0.11     0.01          MAST       73 IPWA   0 K-P TO LAM.PIPI   1/73*
R11             . . . . . . . . .
R11 AVG         0.1080   0.0089  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R11 FIT         0.1004   0.0054 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

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REFERENCES FOR Y*0(1520)


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GALTIERI 63 PL 6 296          A BARBARO-GALTIERI,A HUSSAIN,RD TRIPP (LRL)
WATSON   63 PR 131 2248       M B WATSON, M FERRO-LUZZI, R D TRIPP  (LRL)IJP
ALMEIDA  64 PL 9 204          S P ALMEIDA, G R LYNCH               (CERN)
ARMENTER 65 PL 19 338         ARMENTEROS,F-LUZZI, +    (CERN,HEID,SACLAY)
MUSGRAVE 65 NC 35 735         +PETMEZAS,+     (BIRM,CERN,EPOL,LOIC,SACLAY)

BIRMINGH 66 PR  152  1148     BIRMINGHAM,GLASGOW,I.C., OXFORD,RUTHERFORD
DAHL     67 PR 163 1377       DAHL,HARDY,HESS,KIRZ,MILLER           (LRL)
DAUBER   67 PL 24B 525        +MALAMUD,SCHLEIN,SLATER,STORK         (UCLA)
UHLIG    67 PR 155 1448       +CHARLTON,CONDON,GLASSER,YODH,+   (UMD,NRL)
MAST     68 PRL 21 1715       MAST,ALSTON,BANGERTER,GALTIERI+       (LRL)
SCHEUER  68 NP B8 503         SABRE COLLAB.    (SACL+AMST+BGNA+REHO+EPOL)

BURKHARD 69 NP B14 106        +FILTHUTH+KLUGE+..    (HEID+EFI+CERN+SACLAY)
CLINE    69 LNC 2 407         +LAUMANN+MAPP                        (WISC)
GALTIERI 69 LUND 352          BARBARO-GALTIERI,BANGERTER,MAST,TRIPP (LRL)
    ALSO 70 DUKE 95           R D TRIPP                             (LRL)

BURKHARDT71 NP  B27 64        +FILTHUTH,KLUGE,OBERLACK++ (HEID+CERN+SACL)
COLLEY   71 NP  B31 61        +COX,EASTWOOD,FRY+..  (BIRM+EDIN+GLAS+LOIC)
KIM      71 PRL 27 356        J K KIM                             (HARV)IJP
    ALSO 70 DUKE 161          J. K. KIM                           (HARV)IJP

CHAN     72 PRL 28 256        +BUT.-SHAFER,HERTZBACH,KOFLER++ (MASA,YALE)
MAST     73 PR D7 5           +ALSTON-GARNJOST,BANGERTER,+...     (LBL) IJP
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PAPERS NOT REFERRED TO IN DATA CARDS


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BERLEY   70 PR D1 1996        +YAMIN,KOFLER,MANN,MEISNER+ (BNL,MASA,YALE)IJP

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Λ(1670) **S''_{01}**

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40  Y*0(1670, JP=1/2-) I=0

SEE THE MINI-REVUE AT THE START OF THE Y* LISTINGS.

 THIS RESONANCE IS WELL ESTABLISHED.
 (SEE THE NOTE FOR THE Y*0(1330)).

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                  40  Y*0(1670) MASS (MEV)

M   M     (1666.0)OR(1675.0)          BERLEY    65 HBC   0 K-P TO LAM ETA    7/66
M   M   THE FIRST VALUE ASSUMES THE BRANCHING RATIO INTO LAMBDA ETA IS
M     SMALL, THE SECOND THAT IT IS LARGE.  BECAUSE THE RESONANCE IS NEAR
M     THE LAMBDA ETA THRESHOLD, THE BRANCHING RATIO AFFECTS THE MOMENTUM
M     DEPENDENCE OF THE TOTAL WIDTH, AND THUS ALSO THE RESONANCE PARA-
M     METERS OBTAINED BY FITTING TO THE DATA.
M   N    (1663.0)    (3.0)            ARMENT-1  68 HBC   0 ELASTIC, CH EXCH 11/68
M   N    (1678.0)    (2.0)            ARMENT-2  68 HBC   0 K-P TO SIGMA PI  11/68
M   A     1674.0     (5.0)            ARMENT-3  69 HBC   0 MULTICHANNEL      9/69
M   N     1662.0     (3.0)            ARMENT-4  69 HBC   0 ELAST,CH.EXC.ED   9/69
M   N     1680.0     (1.0)            ARMENT-4  69 HBC   0 K-P TO SIG PI.ED  9/69
M         1674.0                      BERLEY    69 HBC   0 K-P TO SIGMA PI   6/70
M         1683.0     (5.0)            GALTIERI  70 HBC   0 SIG PI,EDPWA      7/70
M         1670.                       KIM       71 DPWA    K-MATRIX ANAL.    3/71
M         1640.0    (40.0)            LANGBEIN  72 IPWA    MULTICHANNEL     12/72*
M   A           THE MULTICHANNEL ANALYSIS INCLUDES ELASTIC AND SIGMA PI .   10/69
M   N   THE APPARENT DISCREPANCY BETWEEN THESE RESULTS IS PROBABLY NOT
M     SERIOUS.  THE ERRORS GIVEN ARE JUST STATISTICAL.  THE SYSTEMATIC
M     ERRORS THAT RESULT FROM THE RESTRICTIVE PARAMETRIZATION FORCED ON
M     THE PARTIAL-WAVE AMPLITUDES ARE NOT INCLUDED, AND CAN BE LARGE.

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                  40  Y*0(1670) WIDTH (MEV)

W   M      (22.0)OR(15.0)             BERLEY    65 HBC   0 SEE NOTE M ABOVE  7/66
W   N      (26.0)     (8.0)           ARMENT-1  68 HBC   0 SEE NOTE N ABOVE 11/68
W   N      (26.0)     (5.0)           ARMENT-2  68 HBC   0                  11/68
W   A       23.0      (3.0)           ARMENT-3  69 HBC   0                   9/69
W   N       38.0     (15.0)           ARMENT-4  69 HBC   0 ELAST,CH EXC.ED   9/69
W   N       33.0      (5.0)           ARMENT-4  69 HBC   0 K-P TO SIG PI.ED  9/69
W           31.0                      BERLEY    69 HBC   0 K-P TO SIGMA PI   6/70
W           25.0      (5.0)           GALTIERI  70 HBC   0 SIG PI,EDPWA      7/70
W           35.                       KIM       71 DPWA    K-MATRIX ANAL.    3/71
W           45.0     (20.0)           LANGBEIN  72 IPWA    MULTICHANNEL     12/72*
           SEE THE NOTES ACCOMPANYING THE MASSES QUOTED

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                  40  Y*0(1670) PARTIAL DECAY MODES

                                                           DECAY MASSES
P1      Y*0(1670) INTO KBAR N                              497+ 939
P2      Y*0(1670) INTO LAMBDA ETA                         1115+ 548
P3      Y*0(1670) INTO SIGMA PI                           1189+ 139

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                  40  Y*0(1670) BRANCHING RATIOS

R1      Y*0(1670) INTO (KBAR N)/TOTAL                       (P1)
R1   P       (0.14)    (0.04)         ARMENT-1  68 HBC   0 OLD DATA        11/68
R1            0.17                    ARMENT-3  69 HBC   0                  9/69
R1   P        0.14     (0.04)         ARMENT-4  69 HBC   0 NEW DATA         9/69
R1   A       (0.39)    (0.05)         CONFORTO  71 HBC   0 K-P,ELAST,CEX    6/70
R1            0.28                    KIM       71 DPWA    K-MATRIX ANAL.   3/71
R1            0.35     (0.06)         LANGBEIN  72 IPWA    MULTICHANNEL    12/72*
R1   A     EFFECT BELOW REGION ANALYZED. VALUE OF .18 DOES NOT
R1   A   AFFECT FIT OR VALUES OF OTHER PARAMETERS.
R1   P    THIS IS THE DIAMETER OF THE CIRCLE IN THE ARGAND PLOT.  IT IS
R1       SUPERIMPOSED ON A LARGE BACKGROUND.

R2      Y*0(1670) FROM KBAR N TO LAMBDA ETA                 SQRT(P1*P2)
R2   M       (0.20) OR 0.23           BERLEY    65 HBC   0 SEE NOTE M ABOVE  7/66
R2           (0.26)                   ARMENT-3  69 HBC   0.                  9/69
R2           (0.24)                   KIM       71 DPWA    K-MATRIX ANAL.    3/71
        SEE THE NOTES ACCOMPANYING MASSES QUOTED

R3      Y*0(1670) FROM KBAR N TO SIGMA PI                   SQRT(P1*P3)
R3          (-0.25)    (0.06)         ARMENT-2  68 HBC   0 OLD DATA
R3           -0.27                    ARMENT-3  69 HBC   0                   9/69
R3           -0.30     (0.03)         ARMENT-4  69 HBC   0 NEW DATA          9/69
R3           -0.27                    BERLEY    69 HBC   0 K-P TO SIGMA PI   6/70
R3           -0.29     (0.03)         GALTIERI  70 HBC   0 SIG PI,EDPWA      7/70
R3           -0.38                    KIM       71 DPWA    K-MATRIX ANAL.    3/71

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REFERENCES FOR Y*0(1670)


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BERLEY   65 PRL 15 641        +CONNOLLY, HART, RAUM, STONEHILL, +   (BNL)IJP
ARMENT-1 68 NP B8 195         ARMENTEROS, BAILLON, + (CERN,HEIDEL,SACLAY)IJP
ARMENT-2 68 NP B8 223         ARMENTEROS, BAILLON, + (CERN,HEIDEL,SACLAY)IJP

ARMENT-3 69 LUND PAPER 229    ARMENTEROS, BAILLON, + (CERN,HEIDEL,SACLAY)IJP
   VALUES ARE QUOTED IN LEVI  SETTI 69.
ARMENT-4 69 NP B14 91         ARMENTEROS, BAILLON, + (CERN,HEIDEL,SACLAY)IJP
BERLEY   69 PL 30B 430        + HART, RAHM, WILLIS, YAMAMOTO          (BNL)IJP
GALTIERI 70 DUKE 173          A. BARBARO GALTIERI                     (LRL)IJP
CONFORTO 71 NP  B34  41       +LEVI SETTI,LASINSKI..OBERLACK++ (EFI+HEID)IJP
KIM      71 PRL 27 356        J K KIM                                (HARV)IJP
   ALSO  70 DUKE 161          J. K. KIM                              (HARV)IJP
LANGBEIN 72 NP B47 477        +WAGNER                                (MPIM)IJP
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PAPERS NOT REFERRED TO IN DATA CARDS


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BIRMINGH 66 PR 152 1148         (BIRMINGHAM,GLASGOW,LOIC,OXFORD,RUTHERFD)
LEVISETT 69 LUND 339          R LEVI SETTI  (RAPPORTEUR)          (CHICAGO)

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Baryons
Λ(1690), Λ(1750)

Data Card Listings
For notation, see key at front of Listings.

Λ(1690)

55 Y*0(1690, JP=3/2-) I=0 **D''03**

SEE THE MINI-REVUE AT THE START OF THE Y* LISTINGS.

THIS RESONANCE IS WELL ESTABLISHED.

55 Y*0(1690) MASS (MEV)

M		(1696.0)	(3.0)	ARMENT-1 68	HBC	0 ELASTIC, CH EXCH	11/68
M		(1681.0)	(2.0)	ARMENT-3 68	HBC	0 K-P TO SIGMA PI	11/68
M		1681.	(8.)	BARTLEY 68	DBC	0 K-P AND K-D DATA	11/68
M		1695.0	(4.0)	BUGG 68	CNTR	0 K-P, D TOTAL	7/68
M	M	(1697.0)	(2.0)	CONFORTO 68	HBC	0 ELASTIC, CH EXCH	11/68
M	A	1691.0	(2.0)	ARMENT-4 69	HBC	0 ELAS,CH EXC.ED	9/69
M	A	1688.0	(2.0)	ARMENT-4 69	HBC	0 K-P TO SIG PI.ED	9/69
M		1689.0		BERLEY 69	HBC	0 K-P TO SIGMA PI	6/70
M		1701.0	(4.0)	BERTANZA 69	HBC	0 ELASTIC, CH EXCH	9/69
M		1680.0	(5.0)	GALTIERI 70	HBC	0 SIG PI,EDPWA	7/70
M		1688.0	(3.0)	CONFORTO 71	HBC	0 K-P,ELAST,CEX	6/70
M		1690.		KIM 71	DPWA	K-MATRIX ANAL.	3/71
M		1680.0	(20.0)	LANGBEIN 72	IPWA	MULTICHANNEL	12/72*

M M THE Y*0(1690) IS AT THE EDGE OF THE ENERGY REGION ANALYZED BY
M M CONFORTO. THE SAME DATA AS WELL AS OTHERS EXTENDING TO LOWER
M M ENERGIES ARE INCLUDED IN ARMENTEROS 1.
M A ANALYSIS INCLUDES OLD AND NEW DATA OF CHS COLLAB. .43-.8 GEV/C 10/69
M A THE APPARENT DISCREPANCY BETWEEN THE SIGMA PI AND OTHER RESULTS IS
M A PROBABLY NOT SERIOUS. THE ERRORS GIVEN ARE JUST STATISTICAL. THE
M A SYSTEMATIC ERRORS THAT RESULT FROM THE RESTRICTIVE PARAMETRIZATION
M A OF THE PARTIAL-WAVE AMPLITUDES ARE NOT INCLUDED, AND CAN BE LARGE.

55 Y*0(1690) WIDTH (MEV)

W		(35.0)	(7.0)	ARMENT-1 68	HBC	0 OLD DATA	11/68
W		(85.0)	(7.0)	ARMENT-3 68	HBC	0 OLD DATA	11/68
W		48.	(15.)	BARTLEY 68	DBC	0 K-P AND K-D DATA	11/68
W		40.0	(7.0)	BUGG 68	CNTR	0	7/68
W	M	(27.0)	(5.0)	CONFORTO 68	HBC	0 SEE NOTE M ABOVE	11/68
W	A	31.0	(7.0)	ARMENT-4 69	HBC	0 ELAS,CH EXC.ED	9/69
W	A	72.0	(6.0)	ARMENT-4 69	HBC	0 K-P TO SIG PI ED	9/69
W		57.0		BERLEY 69	HBC	0 K-P TO SIGMA PI	6/70
W		28.0	(8.0)	BERTANZA 69	HBC	0	9/69
W		85.0	(10.0)	GALTIERI 70	HBC	0 SIG PI,EDPWA	7/70
W		64.0	(5.0)	CONFORTO 71	HBC	0 K-P,ELAST,CEX	6/70
W		55.		KIM 71	DPWA	K-MATRIX ANAL.	3/71
W		40.0	(10.0)	LANGBEIN 72	IPWA	MULTICHANNEL	12/72*

SEE THE NOTES ACCOMPANYING THE MASSES QUOTED

55 Y*0(1690) PARTIAL DECAY MODES

		DECAY MASSES
P1	Y*0(1690) INTO KBAR N	497+ 939
P2	Y*0(1690) INTO SIGMA PI	1189+ 139
P3	Y*0(1690) INTO LAMBDA PI PI	1115+ 139+ 139
P4	Y*0(1690) INTO SIGMA PI PI	1189+ 139+ 139
P5	Y*0(1690) INTO Y*1(1385) PI	1384+ 139

55 Y*0(1690) BRANCHING RATIOS

THE SUM OF ALL THE QUOTED BRANCHING RATIOS IS MORE THAN 1.0. THE TWO-BODY RATIOS ARE FROM PARTIAL WAVE ANALYSES, AND THUS PROBABLY ARE MORE RELIABLE THAN THE THREE-BODY RATIOS, WHICH ARE DETERMINED FROM BUMPS IN CROSS SECTIONS. OF THE LATTER, THE SIGMA PI PI BUMP LOOKS MORE SIGNIFICANT (THE ERROR GIVEN FOR THE LAMBDA PI PI RATIO LOOKS UN-REASONABLY SMALL). HARDLY ANY OF THE SIGMA PI PI DECAY CAN BE VIA Y*1(1385), FOR THEN NINE TIMES AS MUCH LAMBDA PI PI DECAY WOULD BE REQUIRED.

R1 Y*0(1690) INTO (KBAR N)/TOTAL (P1)

R1		(0.18)	(0.03)	ARMENT-1 68	HBC	0	11/68
R1		(0.23)		BUGG 68	CNTR	0 ASSUMING J=3/2	7/68
R1	M	(0.22)	(0.03)	CONFORTO 68	HBC	0 SEE NOTE M ABOVE	11/68
R1		0.18	(0.02)	ARMENT-4 69	HBC	0 NEW DATA	9/69
R1		0.28	(0.04)	BERTANZA 69	HBC	0	9/69
R1	N	(0.34)	(0.02)	CONFORTO 71	HBC	0 K-P,ELAST,CEX	6/70
R1		0.22		KIM 71	DPWA	K-MATRIX ANAL.	3/71
R1		0.15	(0.05)	LANGBEIN 72	IPWA	MULTICHANNEL	12/72*

R1 N EFFECT IS AT END OF REGION ANALYZED. THIS COULD AFFECT VALUE OF X1.
R1 FROM ALL ABOVE WE ESTIMATE X=0.20 3/72

R2 Y*0(1690) FROM KBAR N TO SIGMA PI SQRT(P1*P2)

R2		(-0.33)	(0.02)	ARMENT-3 68	HBC	0 OLD DATA	11/68
R2		-0.36	(0.02)	ARMENT-4 69	HBC	0 NEW DATA	9/69
R2		-0.27		BERLEY 69	HBC	0 K-P TO SIGMA PI	6/70
R2		-0.31	(0.03)	GALTIERI 70	HBC	0 SIG PI,EDPWA	7/70
R2		-0.40		KIM 71	DPHA	K-MATRIX ANAL.	3/71
R2		0.26	(0.07)	LANGBEIN 72	IPWA	MULTICHANNEL	12/72*

R3 Y*0(1690) FROM KBAR N TO LAMBDA PI PI SQRT(P1*P3)

R3	B	(0.25)	(0.02)	BARTLEY 68	HDBC	0 LAM.2PI CROS SEC	11/68

R3 B ONLY CROSS-SECTION DATA USED. ENHANCEMENT NOT SEEN BY PREVOST 71. 3/72

R4 Y*0(1690) FROM KBAR N TO SIGMA PI PI SQRT(P1*P4)

R4		(0.21)		ARMENT-2 68	HDBC	0 K-N TO SIG PI PI	11/68

REFERENCES FOR Y*0(1690)

DAVIES 67 PRL 18 62 +DOWELL, + (BIRM,CAVE,RHEL) I
REPLACED BY BUGG 68.
ARMENT-1 68 NP B8 195 ARMENTEROS, BAILLON, + (CERN,HEIDEL,SACLAY)IJP
ARMENT-2 68 NP B8 216 ARMENTEROS, BAILLON, + (CERN,HEIDEL,SACLAY) I
ARMENT-3 68 NP B8 223 ARMENTEROS, BAILLON, + (CERN,HEIDEL,SACLAY)IJP
BARTLEY 68 PRL 21 1111 +CHU,DOWD,GREENE,+ (TUFTS,FSU,BRANDEIS) I
BUGG 68 PR 168 1466 +GILMORE, KNIGHT, + (BIRM,CAVE,RHEL) I
CONFORTO 68 NP B8 265 +HARMSEN, LASINSKI, + (CHICAGO,HEIDEL)IJP
ARMENT-4 69 NP B14 91 ARMENTEROS, BAILLON, + (CERN,HEIDEL,SACLAY)IJP
BERLEY 69 PL 30B 430 + HART, RAHM, WILLIS, YAMAMOTO (BNL)IJP
BERTANZA 69 PR 177 2036 +BIGI,CARRARA,CASALI, + (PISA,BNL,YALE)IJP

GALTIERI 70 DUKE 173 A. BARBARO GALTIERI (LRL)IJP
CONFORTO 71 NP B34 41 +LEVI SETTI,LASINSKI..OBERLACK++ (EFI+HEID)IJP
KIM 71 PRL 27 356 J K KIM (HARV)IJP
ALSO 70 DUKE 161 J. K. KIM (HARV)IJP
LANGBEIN 72 NP B47 477 +WAGNER (MPIM)IJP

PAPERS NOT REFERRED TO IN DATA CARDS

PREVOST 71 AMSTERDAM CONF + CHS COLLABORATION , (CERN+HEID+SACL)

Λ(1750)

77 Y*0(1750, JP=1/2+) I=0 **P01**

→ SEE THE MINI-REVIEW AT THE START OF THE Y* LISTINGS.

THE EVIDENCE FOR THIS STATE IS SOMEWHAT CONFUSED. IT WAS FIRST SUGGESTED IN A PARTIAL WAVE ANALYSIS OF KBAR N DATA BY THE BEHAVIOR OF THE P01 AMPLITUDE WHEN IT WAS PARAMETRIZED AS A TWO-STRAIGHT-LINE BACKGROUND. WHEN IT WAS RE-PARAMETRIZED AS A RESONANCE SUPERIMPOSED ON A ONE-STRAIGHT-LINE BACK-GROUND, A BROAD RESONANCE RESULTED (ARMENTEROS 68). A REANALYSIS OF ESSENTIALLY THE SAME DATA, BUT THIS TIME WITH THE P01 AMPLITUDE UNCON-STRAINED, SUGGESTED A MUCH NARROWER RESONANCE AT HIGHER ENERGY (ARMEN-TEROS 70).

A WIDER AND MORE ELASTIC P01 RESONANCE AT ABOUT THE SAME MASS IS SUGGESTED BY THE ANALYSIS OF BAILEY 69. THIS USES CONSIDERABLY LESS DATA THAN THE ARMENTEROS ANALYSES. FOR THIS REASON WE DO NOT QUOTE ANY PARAMETERS FOR THE OTHER PARTIAL WAVES OBTAINED IN THIS ANALYSIS.

ARMENTEROS 70, GALTIERI 70, AND KIM 71 PRESENT EVIDENCE FOR A P01 STATE IN THE SIGMA PI CHANNEL. IN ADDITION THE ANALYSES OF KIM 71 AND LANGBEIN 72 INDICATE A SECOND POSSIBLE P01 STATE.WE TENTATIVELY LIST THESE EFFECTS TOGETHER.

77 Y*0(1750) MASS (MEV)

M	O	(1745.0)		ARMENTERO 68	HBC	0 ELASTIC, CH EXCH	11/68
M		(1740.0)		BAILEY 69	DPWA	0 ELASTIC, CH EXCH	10/70
M		(1800.0)		ARMENTERO 70	HBC	0 ELASTIC, CH EX	6/70
M		(1750.0)		ARMENTERO 70	HBC	0 SIGMA PI	6/70
M	N	(1690.0)	(10.0)	GALTIERI 70	HBC	0 SIG PI,EDPWA	7/70

M N ERROR STATIST. ONLY- NO ERROR DUE TO PARTICULAR P.W.ANAL. INCLUDED 1/71

M		(1755.)		KIM 71	DPWA	K-MATRIX ANAL.	3/71
M	1	(1570.)		KIM 71	DPWA	K-MATRIX ANAL.	3/71
M	A	1620.0	(10.0)	LANGBEIN 72	IPWA	MULTICHANNEL	12/72*
M	B	1780.0	(20.0)	LANGBEIN 72	IPWA	MULTICHANNEL	12/72*

M A AND B CORRESPOND TO 2 DIFFERENT RESONANCES IN P01
M 1 POSSIBLE EFFECT IN SIGMA PI AND KBAR N CHANNELS.
M O OLD ANALYSIS, USING OLD DATA.

77 Y*0(1750) WIDTH (MEV)

W		(147.0)		ARMENTERO 68	HBC	0	
W		(300.0)		BAILEY 69	DPWA	0 ELASTIC, CH EXCH	10/70
W		(30.0)		ARMENTERO 70	HBC	0 ELASTIC, CH EX	6/70
W		(70.0)		ARMENTERO 70	HBC	0 SIGMA PI	6/70
W	N	(22.0)		GALTIERI 70	HBC	0 SIG PI,EDPWA	7/70
W		(35.)		KIM 71	DPWA	K-MATRIX ANAL.	3/71
W	1	(50.)		KIM 71	DPWA	K-MATRIX ANAL.	3/71
W	A	60.0	(10.0)	LANGBEIN 72	IPWA	MULTICHANNEL	12/72*
W	B	120.0	(10.0)	LANGBEIN 72	IPWA	MULTICHANNEL	12/72*

SEE THE NOTES ACCOMPANYING MASSES QUOTED

77 Y*0(1750) PARTIAL DECAY MODES

		DECAY MASSES
P1	Y*0(1750) INTO KBAR N	497+ 939
P2	Y*0(1750) INTO SIGMA PI	1197+ 139

77 Y*0(1750) BRANCHING RATIOS

R1 Y*0(1750) INTO (KBAR N)/TOTAL (P1)

R1		(0.4)		ARMENTERO 68	DPWA	0 ELASTIC, CH EXCH	11/68
R1		(0.55)		BAILEY 69	DPWA	0 ELASTIC, CH EXCH	10/70
R1		(0.15)		ARMENTERO 70	DPWA	0 ELASTIC, CH EXCH	10/70
R1		(0.30)		KIM 71	DPWA	K-MATRIX ANAL.	3/71
R1	A	0.25	(0.15)	LANGBEIN 72	IPWA	MULTICHANNEL	12/72*
R1	B	0.36	(0.05)	LANGBEIN 72	IPWA	MULTICHANNEL	12/72*

R2 Y*0(1750) FROM KBAR N INTO SIGMA PI SQRT(P1*P2)

R2		(+0.20)		ARMENTERO 70	DPWA	0 K-P TO SIGMA PI	6/70
R2	N	(-0.13)	(0.03)	GALTIERI 70	DPWA	0 K-P TO SIGMA PI	7/70
R2		(0.17)		KIM 71	DPWA	K-MATRIX ANAL.	3/71
R2	A	0.28	(0.09)	LANGBEIN 72	IPWA	MULTICHANNEL	12/72*
R2	B	0.01	OR LESS	LANGBEIN 72	IPWA	MULTICHANNEL	12/72*

SEE THE NOTES ACCOMPANYING MASSES QUOTED

REFERENCES FOR Y*0(1750)

ARMENTER 68 NP B8 195 ARMENTEROS, BAILLON, + (CERN,HEIDEL,SACLAY)IJP
BAILEY 69 THESIS UCRL-50617 DAVID SAAL BAILEY (LRL LIVERMORE)IJP
ARMENTER 70 DUKE CONF 123 ARMENTEROS, BAILLON, + (CERN, HEIDEL)IJP
GALTIERI 70 DUKE CONF 173 A BARBARO-GALTIERI (LRL)IJP
KIM 71 PRL 27 356 J K KIM (HARV)IJP
ALSO 70 DUKE 161 J. K. KIM (HARV)IJP
LANGBEIN 72 NP B47 477 +WAGNER (MPIM)IJP

0 0 0 0 3 6 0 4 0 3 9

Data Card Listings

For notation, see key at front of Listings.

Baryons
Λ(1815), Λ(1830)

Λ(1815) F'₀₅

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39  Y*0(1815, JP=5/2+) I=0

SEE THE MINI-REVIEW AT THE START OF THE Y* LISTINGS.

THIS STATE IS WELL ESTABLISHED. MOST OF THE QUOTED ER-
RORS ARE STATISTICAL ONLY. THE SYSTEMATIC ERRORS DUE TO
THE PARTICULAR PARAMETRIZATION USED IN THE P.W.A. ARE
NOT INCLUDED. FOR THIS REASON WE DO NOT CALCULATE WEIGHTED AVERAGES FOR
MASS AND WIDTH.

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                    39  Y*0(1815) MASS (MEV)

M   N    1813.0    (2.0)          ARMENT-1  67 HBC   0 K-P TO SIGMA PI    8/67
M   N    1816.0    (4.0)          BELL      67 HDBC  0 K-N TO SIGMA PI   11/67
M   N    1817.0    (2.0)          ARMENT-3  68 HBC   0 ELASTIC, CH EXCH 11/68
M   N    1819.0    (4.0)          BUGG      68 CNTR  0 K-P, D TOTAL      6/68
M   N    1825.0    (1.0)          BRICMAN   70 CNTR  0 TOTAL AND CH EX   6/70
M   N    1819.0    (1.0)          BRICMAN1  70 DPWA    SIGTOT,ELAS,CHEX  1/71
M        1830.0   (10.0)          COOL      70 CNTR    K-P, D TOTAL     10/70
M        1820.0   (10.0)          GALTIERI  70 DPWA  0 K-P TO SIGMA PI   7/70
M   N    1818.0    (2.0)          CONFORTO  71 DPWA  0 ELASTIC, CH EXCH  6/70
M        1810.                    KIM       71 DPWA    K-MATRIX ANAL.    3/71
M   N    1823.0    (3.0)          KANE      72 DPWA  0 K-P TO PI SIG    10/71
M   N    1818.0    (3.0)          LANGBEIN  72 IPWA    MULTICHANNEL     12/72*
M   N  ERROR STATIST. ONLY- NO ERROR DUE TO PARTICULAR P.W.ANAL. INCLUDED  1/71

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                    39  Y*0(1815) WIDTH (MEV)

W          87.0   (15.0)          ARMENT-1  67 HBC   0                   8/67
W          64.0   (12.0)          BELL      67 HDBC  0                  11/67
W   N      71.0    (4.0)          ARMENT-3  68 HBC   0 ELASTIC, CH EXCH 11/68
W   N      75.0    (7.0)          BUGG      68 CNTR  0 K-P, D TOTAL      6/68
W   N      80.0    (6.0)          BRICMAN   70 CNTR  0 TOTAL AND CH EX   6/70
W   N      79.0    (3.0)          BRICMAN1  70 DPWA    SIGTOT,ELAS,CHEX  1/71
W         100.0                   COOL      70 CNTR    K-P, D TOTAL     10/70
W         100.0   (20.0)          GALTIERI  70 DPWA  0 K-P TO SIGMA PI   7/70
W   N      90.0    (4.0)          CONFORTO  71 DPWA  0 ELASTIC, CH EXCH  6/70
W          70.                    KIM       71 DPWA    K-MATRIX ANAL.    3/71
W   N     104.0   (16.0)          KANE      72 DPWA  0 K-P TO PI SIG    10/71
W   N      70.0    (5.0)          LANGBEIN  72 IPWA    MULTICHANNEL     12/72*
     SEE THE NOTES ACCOMPANYING MASSES QUOTED

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                    39  Y*0(1815) PARTIAL DECAY MODES

                                                        DECAY MASSES
P1     Y*0(1815) INTO KBAR N                             497+ 939
P2     Y*0(1815) INTO SIGMA PI                          1189+ 139
P3     Y*0(1815) INTO Y*1(1385) PI                      1384+ 139
P4     Y*0(1815) INTO SIGMA PI PI                       1192+ 139+ 139
P5     Y*0(1815) INTO LAMBDA PI PI                      1115+ 139+ 139

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<u>FITTED PARTIAL DECAY MODE BRANCHING FRACTIONS</u>

The matrix below is derived from the error matrix for the fitted partial decay mode branching fractions, P_i, as follows: The diagonal elements are $P_i \pm \delta P_i$, where $\delta P_i = \sqrt{\langle \delta P_i \delta P_i \rangle}$, while the off-diagonal elements are the normalized correlation coefficients $\langle \delta P_i \delta P_j \rangle / (\delta P_i \cdot \delta P_j)$. For the definitions of the individual P_i, see the listings above; only those P_i appearing in the matrix are assumed in the fit to be nonzero and are thus constrained to add to 1.

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      P 1         P 2        P 3        P 4
P 1 .6050+-.0243
P 2   -.5445   .1138+-.0084
P 3   0.         0.        .2000+-.0500
P 4   -.3638     .0892     -.9224   .0812+-.0542

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                    39  Y*0(1815) BRANCHING RATIOS

       ERRORS QUOTED BY EXPERIMENTERS DO NOT INCLUDE UNCERTAINTY DUE
       TO PARAMETRIZATION USED IN THE P.W.A.  THEY SHOULD BE INCREASED.

R1     Y*0(1815) INTO (KBAR N)/TOTAL                       (P1)
R1            0.62       0.02          ARMENT-3  68 HBC   0 ELASTIC, CH EXCH 11/68
R1           (0.72)                    BUGG      68 CNTR  0 K-P, D TOTAL      6/68
R1            0.65       0.02          BRICMAN   70 CNTR  0 TOTAL AND CH EX   6/70
R1            0.58       0.02          BRICMAN1  70 DPWA    SIGTOT,ELAS,CHEX  1/71
R1           (0.8)                     COOL      70 CNTR    K-P, D TOTAL     10/70
R1            0.63       0.01          CONFORTO  71 DPWA  0 ELASTIC, CH EXCH  6/70
R1           (0.52)                    KIM       71 DPWA    K-MATRIX ANAL.    3/71
R1            0.47       0.02          LANGBEIN  72 IPWA    MULTICHANNEL     12/72*
R1           . . . . . . . . .
R1  AVG       0.605      0.027   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 3.8)
R1  FIT       0.605      0.024  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 3.4)

R2     Y*0(1815) FROM KBAR N INTO SIGMA PI                 SQRT(P1*P2)
R2            0.27       0.01          ARMENT-1  67 DPWA  0 K-P TO SIGMA PI   8/67
R2            0.23       0.025         BELL      67 DPWA  0 K-P TO SIGMA PI  11/67
R2           -0.26       0.03          GALTIERI  70 DPWA  0 K-P TO SIGMA PI   7/70
R2           (0.26)                    KIM       71 DPWA    K-MATRIX ANAL.    3/71
R2           -0.268      0.027         KANE      72 DPWA  0 K-P TO PI SIG    10/71
R2            0.25       0.03          LANGBEIN  72 IPWA    MULTICHANNEL     12/72*
R2           . . . . . . . . .
R2  AVG MOD   0.2634     0.0081  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R2  FIT       0.2624     0.0081 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R3     Y*0(1815) FROM KBAR N INTO Y*1(1385) PI             SQRT(P1*P3)
R3  A        (0.3)      (0.05)         ARMENT-2  67 HBC   0 K-P TO LAM P+ P+
R3           . . . . . . . . .
R3  FIT       0.348      0.044  FROM FIT

R4     Y*0(1815) INTO (Y*1(1385) PI)/TOTAL                 (P3)
R4            0.20       0.05          BIRGE     65 HBC   0 K-P TO LAM PI PI  7/66
R4           . . . . . . . . .
R4  FIT       0.200      0.050  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R5     Y*0(1815) INTO (SIGMA PI PI)/TOTAL                  (P4)
R5  P       NO CLEAR SIGNAL              ARMENT-4  68 HDBC  0 K-N TO SIG PI PI 11/68
R5  P   THERE IS A SUGGESTION OF A BUMP, ENOUGH TO BE CONSISTENT WITH
R5      WHAT IS EXPECTED FROM SIGMA PI DECAY OF THE Y*1(1385) -- ABOUT 0.02.
R5           . . . . . . . . .
R5  FIT       0.081      0.054  FROM FIT

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                         REFERENCES FOR Y*0(1815)

BIRGE    65 ATHENS CONF  296   +ELY,KALMUS,KERNAN,LOUIE,SAHOURIA, +  (LRL)IJP
ARMENT-1 67 PL 24B 198         ARMENTEROS, F LUZZI, + (CERN,HEIDEL,SACLAY)IJP
ARMENT-2 67 ZEIT PHYS 202 486  ARMENTEROS, F LUZZI, + (CERN,HEIDEL,SACLAY)IJP
BELL     67 PRL 19 936         R B BELL                              (LRL)IJP
ARMENT-3 68 NP B8 195          ARMENTEROS, BAILLON, + (CERN,HEIDEL,SACLAY)IJP
ARMENT-4 68 NP B8 216          ARMENTEROS, BAILLON, + (CERN,HEIDEL,SACLAY) I
BUGG     68 PR 168 1466        +GILMORE, KNIGHT,    +      (RHEL+BIRM+CAVE) I

BRICMAN  70 PL 31B 152         +FERRO LUZZI, PERREAU,+  (CERN,CAEN,SACLAY)
BRICMAN1 70 PL 33B 511         +FERRO-LUZZI,LAGNAUX                  (CERN)
COOL     70 PR D1 1887         +GIACOMELLI, KYCIA, LEONTIC, LI, +   (BNL) I
GALTIERI 70 DUKE CONF 173      A BARBARO-GALTIERI                    (LRL)IJP

CONFORTO 71 NP  B34  41        +LEVI SETTI,LASINSKI..OBERLACK++ (EFI+HEID)IJP
KIM      71 PRL 27 356         J K KIM                              (HARV)IJP
    ALSO 70 DUKE 161           J. K. KIM                            (HARV)IJP

KANE     72 PR D5 1583         D F KANE                              (LBL)IJP
LANGBEIN 72 NP B47 477         +WAGNER                              (MPIM)IJP

                         PAPERS NOT REFERRED TO IN DATA CARDS

          THE FOLLOWING PAPERS ARE NOW OF ONLY HISTORICAL INTEREST --

CHAMBERL 62 PR 125 1696        CHAMBERLAIN,CROWE,KEEFE,KERTH, +      (LRL) I
GALTIERI 63 PL 6 296           A BARBARO-GALTIERI,A HUSSAIN,RD TRIPP (LRL)IJ
SODICKSO 64 PR 133 B757        SODICKSON,MANNELLI,FRISCH,WAHLIG (MIT(BNL)) J
HOLLEY   65 UCRL-16274 THESIS  W R HOLLEY                            (LRL) J
BIRMINGH 66 PR  152  1148      BIRMINGHAM,GLASGOW,I.C., OXFORD,RUTHERFORD
COOL     66 PRL 16 1228        +GIACOMELLI,KYCIA,LEONTIC,LUNDBY +    (BNL)I
GELFAND  66 PRL 17 1224        +HARMSEN,LEVI-SETTI,PREDAZZI+      (EFI,ANL)
ARMENTER 67 NP B3 592          ARMENTEROS,FERRO-LUZZI+  (CERN,HEID,SACLAY)IJP
CONFORTO 68 NP B8 265          +HARMSEN, LASINSKI, +      (CHICAGO,HEIDEL)IJP
LASINSKI 68 PR 163 1792        LASINSKI, LEVI SETTI, PREDAZZI     (CHICAGO) JP
PREVOST  71  AMSTERDAM CONF.   + CHS COLLABORATION          (CERN+HEID+SACL)
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Λ(1830) D'₀₅

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56  Y*0(1830, JP=5/2-) I=0

SEE THE MINI-REVIEW AT THE START OF THE Y* LISTINGS.

THE BEST EVIDENCE FOR THIS RESONANCE COMES FROM THE
SIGMA PI CHANNEL.  IT APPEARS TO BE WELL ESTABLISHED.

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                    56  Y*0(1830) MASS (MEV)

M   N    1827.0    (3.0)          ARMENTERO 67 HBC   0 K-P TO SIGMA PI    8/67
M   N    1837.0   (11.0)          BELL      67 HBC   0 K-P TO SIGMA PI   11/67
M   N    1807.0   (10.0)          ARMENTERO 68 HBC   0 ELASTIC, CH EXCH 11/68
M        1840.0   (15.0)          GALTIERI  70 DPWA  0 K-P TO SIGMA PI    7/70
M   N    1831.0    (5.0)          CONFORTO  71 DPWA  0 ELASTIC, CH EXCH   6/70
M        1830.                    KIM       71 DPWA    K-MATRIX ANAL.     3/71
M   K   (1720.)                   KIM       71 DPWA    K-MATRIX ANAL.     3/71
M        1832.0    (5.0)          KANE      72 DPWA  0 K-P TO PI SIG     10/71
M        1810.0   (10.0)          LANGBEIN  72 IPWA    MULTICHANNEL      12/72*
M   K POSSIBLE EFFECT MAINLY IN SIGMA PI.  NOT CLEAR IF UNCORRELATED
M   K WITH THE 1830 EFFECT
M   N   ERROR STATIST. ONLY- NO ERROR DUE TO PARTICULAR P.W.ANAL. INCLUDED  1/71

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                    56  Y*0(1830) WIDTH (MEV)

W          75.0    (9.0)          ARMENTERO 67 HBC   0 K-P TO SIGMA PI    8/67
W          74.0   (18.0)          BELL      67 HBC   0 K-P TO SIGMA PI    8/67
W         123.0   (32.0)          ARMENTERO 68 HBC   0 ELASTIC, CH EXCH 11/68
W         150.0   (30.0)          GALTIERI  70 DPWA  0 K-P TO SIGMA PI    7/70
W         104.0   (35.0)          CONFORTO  71 DPWA  0 ELASTIC, CH EXCH   6/70
W          80.                    KIM       71 DPWA    K-MATRIX ANAL.     3/71
W   K     (20.)                   KIM       71 DPWA    K-MATRIX ANAL.     3/71
W          88.0   (10.0)          KANE      72 DPWA  0 K-P TO PI SIG     10/71
W          60.0   (20.0)          LANGBEIN  72 IPWA    MULTICHANNEL      12/72*
     SEE THE NOTES ACCOMPANYING MASSES QUOTED

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                    56  Y*0(1830) PARTIAL DECAY MODES

                                                        DECAY MASSES
P1     Y*0(1830) INTO KBAR N                             497+ 939
P2     Y*0(1830) INTO SIGMA PI                          1189+ 139
P3     Y*0(1830) INTO Y*1(1385) PI                      1384+ 139

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                    56  Y*0(1830) BRANCHING RATIOS

R1     Y*0(1830) INTO (KBAR N)/TOTAL                       (P1)
R1            0.09      (0.01)         ARMENTERO 68 HBC   0 ELASTIC, CH EXCH 11/68
R1            0.03      (0.02)         BRICMAN1  70 DPWA    SIGTOT,ELAS,CHEX  1/71
R1            0.05      (0.02)         CONFORTO  71 DPWA  0 ELASTIC, CH EXCH  6/70
R1           (0.24)                    KIM       71 DPWA    K-MATRIX ANAL.    3/71
R1            0.10      (0.03)         LANGBEIN  72 IPWA    MULTICHANNEL     12/72*

R2     Y*0(1830) FROM KBAR N INTO SIGMA PI                 SQRT(P1*P2)
R2            0.15      (0.02)         ARMENTERO 67 DPWA  0 K-P TO SIGMA PI   8/67
R2            0.19      (0.01)         BELL      67 DPWA  0 K-P TO SIGMA PI  11/67
R2           -0.16      (0.03)         GALTIERI  70 DPWA  0 K-P TO SIGMA PI   7/70
R2            0.15                     KIM       71 DPWA    K-MATRIX ANAL.    3/71
R2           -0.138     (0.018)        KANE      72 DPWA  0 K-P TO PI SIG    10/71
R2            0.27      (0.07)         LANGBEIN  72 IPWA    MULTICHANNEL     12/72*

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Baryons
Λ(1830), Λ(1860), Λ(1870), Λ(2010)

Data Card Listings
For notation, see key at front of Listings.

REFERENCES FOR Y*0(1830)

ARMENTER 67 PL 24B 198 ARMENTEROS, F-LUZZI, + (CERN,HEIDEL,SACLAY)IJP
BELL 67 PRL 19 936 R B BELL (LRL)IJP
ARMENTER 68 NP B8 195 ARMENTEROS, BAILLON, + (CERN,HEIDEL,SACLAY)IJP
CONFORTO 68 NP B8 265 +HARMSEN, LASINSKI, + (CHICAGO,HEIDEL)IJP
IS SUPERSEDED BY CONFORTO 71.
BRICMAN1 70 PL 33B 511 +FERRO-LUZZI,LAGNAUX (CERN)
GALTIERI 70 DUKE CONF 173 A BARBARO-GALTIERI (LRL)IJP

CONFORTO 71 NP B34 41 +LEVI SETTI,LASINSKI..OBERLACK++ (EFI+HEID)IJP
KIM 71 PRL 27 356 J K KIM (HARV)IJP
ALSO 70 DUKE 161 J. K. KIM (HARV)IJP
KANE 72 PR D5 1583 D F KANE (LBL)IJP
LANGBEIN 72 NP B47 477 +WAGNER (MPIM)IJP

PAPERS NOT REFERRED TO IN DATA CARDS

PREVOST 71 AMSTERDAM CONF + CHS COLLABORATION (CERN+HEID+SACL)

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Λ(1860) P_{03}

60 Y*0(1860, JP=3/2+) I=0

THE JP=3/2+ ASSIGNMENT IS CONSISTENT WITH ALL AVAILABLE DATA (INCLUDING POLARIZATION) AND RECENT PARTIAL WAVE ANALYSES. THE DOMINANT INELASTIC MODES REMAIN UNKNOWN.

60 Y*0(1860) MASS (MEV)

M	A	F07	1864.0	2.0	ARMENTERO 68 DWPA	0 ELASTIC, CH EXCH	11/68
M	N		1870.0	5.0	BUGG 68 CNTR	0 K-P TOTAL	7/68
M	A	F07	1877.0	6.0	BRICMAN 70 CNTR	0 TOTAL AND CH EX	6/70
M		P03	1870.0	6.0	BRICMAN1 70 DPWA	0 SIGTOT,ELAS,CHEX	1/71
M	N	P03	1883.0	10.0	CONFORTO 71 DPWA	0 ELASTIC, CH EXCH	6/70
M	1	P03	1710.		KIM 71 DPWA	K-MATRIX ANAL.	3/71
M			1850.0	(20.0)	LANGBEIN 72 IPWA	MULTICHANNEL	12/72*

M A THESE TWO ANALYSES GAVE THE F07 ASSIGNMENT, THEY HAVE TO BE 1/71
M A DISCARDED IN VIEW OF CONFORTO 70 AND BRICMAN1 70.
M N DUE TO PARTICULAR PARAMETERIZATION USED,ERROR CAN BE LARGE 1/71
M 1 POSSIBLE EFFECT MAINLY IN SIGMA PI. WE TENTATIVELY LIST IT HERE.

60 Y*0(1860) WIDTH (MEV)

W	A	F07	39.0	7.0	ARMENTERO 68 DWPA	0 ELASTIC, CH EXCH	11/68
W	N		40.0	10.0	BUGG 68 CNTR	0 K-P TOTAL	7/68
W	A	F07	24.0	15.0	BRICMAN 70 CNTR	0 TOTAL AND CH EX	6/70
W		P03	37.0	10.0	BRICMAN1 70 DPWA	0 SIGTOT,ELAS,CHEX	1/71
W	N	P03	80.0	20.0	CONFORTO 71 DPWA	0 ELASTIC, CH EXCH	6/70
W	1	P03	20.		KIM 71 DPWA	K-MATRIX ANAL.	3/71
W			125.0	(20.0)	LANGBEIN 72 IPWA	MULTICHANNEL	12/72*

SEE THE NOTES ACCOMPANYING MASSES QUOTED

60 Y*0(1860) PARTIAL DECAY MODES

		DECAY MASSES
P1	Y*0(1860) INTO KBAR N	497+ 939
P2	Y*0(1860) INTO SIGMA PI	1189+ 139

60 Y*0(1860) BRANCHING RATIOS

R1 Y*0(1860) INTO (KBAR N)/TOTAL (P1)

R1	A	F07	0.12	0.02	ARMENTERO 68 HBC	0 ELASTIC, CH EXCH	11/68
R1			(J+1/2)P1= 0.40		BUGG 68 CNTR	0	7/68
R1	A	F07	0.07	0.02	BRICMAN 70 CNTR	0 TOTAL AND CH EX	6/70
R1		P03	0.14	0.02	BRICMAN1 70 DPWA	0 SIGTOT,ELAS,CHEX	1/71
R1	N	P03	0.25	0.03	CONFORTO 71 DPWA	0 ELASTIC, CH EXCH	6/70
R1			0.37	(0.05)	LANGBEIN 72 IPWA	MULTICHANNEL	12/72*

SEE THE NOTES ACCOMPANYING MASSES QUOTED

R2 Y*0(1860) INTO SIGMA PI (P2)

R2	P	PROBABLY SEEN	GALTIERI 68 DBC	0 K-N TO SIG PI PI	11/68
R2		0.03 OR LESS	LANGBEIN 72 IPWA	MULTICHANNEL	12/72*

R2 P POSSIBLY THIS BUMP SEEN AT 1840+-10 MEV WITH A WIDTH OF 35+-10 MEV
R2 IS THE Y*0(1830), WHICH DECAYS STRONGLY TO SIGMA PI. HOWEVER THE
R2 NARROW WIDTH HERE ARGUES FOR ITS BEING THE Y*0(1860).

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REFERENCES FOR Y*0(1860)

ARMENTERO68 NP B8 195 ARMENTEROS, BAILLON, + (CERN,HEIDEL,SACLAY)IJP
BUGG 68 PR 168 1466 +GILMORE, KNIGHT, + (RHEL,BIRM,CAVE) I
GALTIERI 68 PRL 21 573 BARBARO-GALTIERI, MATISON, + (LRL,SLAC)

BRICMAN 70 PL 31B 152 +FERRO LUZZI, PERREAU,+ (CERN,CAEN,SACLAY)
BRICMAN1 70 PL 33B 511 +FERRO-LUZZI,LAGNAUX (CERN)
CONFORTO 71 NP B34 41 +LEVI SETTI,LASINSKI..OBERLACK++ (EFI+HEID)IJP
KIM 71 PRL 27 356 J K KIM (HARV)IJP
ALSO 70 DUKE 161 J. K. KIM (HARV)IJP
LANGBEIN 72 NP B47 477 +WAGNER (MPIM)IJP

PAPERS NOT REFERRED TO IN DATA CARDS

ARMENTER 67 NP B3 592 ARMENTEROS, F-LUZZI, + (CERN,HEIDEL,SACLAY)IJP
REPLACED BY ARMENTEROS 68 AND CONFORTO 68.
CONFORTO 68 NP B8 265 +HARMSEN, LASINSKI, + (CHICAGO,HEIDEL)IJP
SUPERSEDED BY CONFORTO 71.
LEVISETT 69 LUND 339 R.LEVI SETTI (RAPPORTEUR) (EFI)
ALBROW 71 NP B29 413 +ANDERSON,BOSNJAKOVIC,DAUM,ERNZ,+ (CERN)

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Λ(1870) $S_{01}^{\prime\prime\prime}$

36 Y*0(1870, JP=1/2-) I=0

THE S01 AMPLITUDE SHOWS A SECOND RESONANCE BEHAVIOR AT ABOUT 1800 MEV IN 3 ANALYSES. THE ELASTICITY OF KIM 71 IS SURPRISINGLY LARGE.

36 Y*0(1870) MASS (MEV)

M	(1872.0)	(10.0)	BRICMAN 70 DPWA	TOT, ELAS, CHEX	1/71
M	(1780.)		KIM 71 DPWA	K-MATRIX ANAL.	3/71
M	1830.0	(20.0)	LANGBEIN 72 IPWA	MULTICHANNEL	12/72*

36 Y*0(1870) WIDTH (MEV)

W	(100.0)	(20.0)	BRICMAN 70 DPWA	TOT, ELAS, CHEX	1/71
W	(40.)		KIM 71 DPWA	K-MATRIX ANAL.	3/71
W	70.0	(15.0)	LANGBEIN 72 IPWA	MULTICHANNEL	12/72*

36 Y*0(1870) PARTIAL DECAY MODES

		DECAY MASSES
P1	Y*0(1870) INTO KBAR N	497+ 939
P2	Y*0(1870) INTO SIGMA PI	1197+ 139

36 Y*0(1870) BRANCHING RATIOS

R1 Y*0(1870) INTO (KBAR N)/TOTAL (P1)

R1	(0.18)	(0.02)	BRICMAN 70 DPWA	TOT, ELAS, CHEX	1/71
R1	(0.80)		KIM 71 DPWA	K-MATRIX ANAL.	3/71
R1	0.35	(0.15)	LANGBEIN 72 IPWA	MULTICHANNEL	12/72*

R2 Y*0(1870) FROM KBAR N TO SIGMA PI SQRT(P1*P2)

R2	(0.24)	KIM 71 DPWA	K-MATRIX ANAL.	3/71

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REFERENCES FOR Y*0(1870)

BRICMAN 70 PL 33B 511 C BRICMAN, M FERRO-LUZZI, J P LAGNAUX(CERN)IJP
KIM 71 PRL 27 356 J K KIM (HARV)IJP
ALSO 70 DUKE 161 J. K. KIM (HARV)IJP
LANGBEIN 72 NP B47 477 +WAGNER (MPIM)IJP

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Λ(2010) $D_{03}^{\prime\prime\prime}$

89 Y*0(2010, JP=3/2-) I=0

SEE THE MINI-REVIEW AT THE START OF THE Y* LISTINGS.

SUCH A RESONANCE IS SUGGESTED BY ONLY TWO PARTIAL-WAVE ANALYSES ACROSS THIS REGION. UNTIL THERE IS MORE EVIDENCE, WE OMIT THIS STATE FROM THE MAIN BARYON TABLE.

89 Y*0(2010) MASS (MEV)

M	(2010.0)	(30.0)	GALTIERI 70 DPWA	0 K-P TO SIGMA PI	7/70
M	(1971.0)		BRANDSTE 72 DPWA	K-P TO LAM.OMEGA	1/73*

89 Y*0(2010) WIDTH (MEV)

W	(130.0)	(50.0)	GALTIERI 70 DPWA	0 K-P TO SIGMA PI	7/70
W	(180.0)		BRANDSTE 72 DPWA	K-P TO LAM.OMEGA	1/73*

89 Y*0(2010) PARTIAL DECAY MODES

		DECAY MASSES
P1	Y*0(2010) INTO KBAR N	497+ 939
P2	Y*0(2010) INTO SIGMA PI	1197+ 139
P3	Y*0(2010) INTO LAMBDA OMEGA	1115+ 783

89 Y*0(2010) BRANCHING RATIOS

R1 Y*0(2010) FROM KBAR N TO SIGMA PI SQRT(P1*P2)

R1	(-0.20)	(0.04)	GALTIERI 70 DPWA	0 K-P TO SIGMA PI	7/70

R2 Y*0(2010) FROM KBAR N INTO LAMBDA OMEGA SQRT(P1*P3)

R2	(0.254)	BRANDSTE 72 DPWA	1/73*

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REFERENCES FOR Y*0(2010)

GALTIERI 70 DUKE CONF 173 A BARBARO-GALTIERI (LRL)IJP
BRANDSTE 72 NP B39 13 BRANDSTETTER,BUTTERWORTH,+ (RHEL+COEF+SACL)

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Data Card Listings

For notation, see key at front of Listings.

Baryons

Λ(2020), Λ(2100), Λ(2110)

Λ(2020)

27 Y*0(2020, JP=7/2+) I=0 **F_{07}**

EFFECTS IN THIS PARTIAL WAVE HAVE OBSERVED AT SOMEWHAT DIFFERENT ENERGIES IN TWO CHANNELS. HOWEVER, LITCHFIELD 71 NOTE THAT THE NEED FOR THIS STATE IN THEIR ANALYSIS RESTS SOLELY ON A POSSIBLY INCONSISTENT POLARIZATION MEASUREMENT AT 1.784 GEV/C.

27 Y*0(2020) MASS (MEV)

M		(2020.0)	(20.0)	GALTIERI	70 DPWA	0 K-P TO SIGMA PI	7/70
M		(2100.)	(30.)	LITCHFIE	71 DPWA	K-P TO KBAR N	10/71

27 Y*0(2020) WIDTH (MEV)

W		(160.0)	(30.0)	GALTIERI	70 DPWA	0 K-P TO SIGMA PI	7/70
W		(120.)	(30.)	LITCHFIE	71 DPWA	K-P TO KBAR N	10/71

27 Y*0(2020) PARTIAL DECAY MODES

		DECAY MASSES
P1	Y*0(2020) INTO KBAR N	497+ 939
P2	Y*0(2020) INTO SIGMA PI	1197+ 139

27 Y*0(2020) BRANCHING RATIOS

R1	Y*0(2020) INTO (KBAR N)/TOTAL					(P1)	
R1		(0.05)	(0.02)	LITCHFIE	71 DPWA	K-P TO KBAR N	10/71
R2	Y*0(2020) FROM KBAR N TO SIGMA PI					SQRT(P1*P2)	
R2		(-0.15)	(0.02)	GALTIERI	70 DPWA	0 K-P TO SIGMA PI	7/70

REFERENCES FOR Y*0(2020)

GALTIERI 70 DUKE CONF 173 A BARBARO-GALTIERI (LRL)IJP
LITCHFIE 71 NP B30 125 LITCHFIELD,...+LESQUOY,+.. (RHEL+CDEF+SACL)IJP

Λ(2100)

41 Y*0(2100, JP=7/2-) I=0 **G_{07}**

SEE THE MINI-REVIEW AT THE START OF THE Y* LISTINGS.

THIS ENTRY ONLY INCLUDES RESULTS FROM PARTIAL-WAVE ANALYSES. PARAMETERS OF PEAKS SEEN IN CROSS-SECTIONS AND INVARIANT-MASS DISTRIBUTIONS AROUND 2100 MEV ARE GIVEN IN THE NEXT ENTRY. EVENTUALLY THE PARTIAL-WAVE ANALYSES SHOULD GIVE THE BEST RESULTS, AS THEY ISOLATE THE G07 WAVE. THIS SUPERIORITY IS, HOWEVER, PROBABLY NOT YET ATTAINED, AND WE RELY ON BOTH ENTRIES FOR PARAMETERS GIVEN IN THE MAIN BARYON TABLE.

41 Y*0(2100) MASS (MEV)

M		(2120.0)		WOHL	66 HBC	K-P CH EX	7/66
M	A	(2080.0)	(10.0)	BURGUN	68 DPWA	0 K-P TO XI K	10/69
M	L	(2130.0)	(20.0)	BERTHON1	70 DPWA	0 K-P TO SIGMA PI	10/70
M		2110.0	(20.0)	GALTIERI	70 DPWA	0 K-P TO SIGMA PI	7/70
M		2100.	(15.)	LITCHFIE	71 DPWA	K-P TO KBAR N	10/71
M	L	2110.0	(30.0)	LITCHFIE	71 DPWA	K-P TO SIG PI	10/71
M		(2113.0)		BRANDSTE	72 DPWA	K-P TO LAM.OMEGA	1/73*
M		2092.0	(12.0)	KANE	72 DPWA	0 K-P TO PI SIG	10/71

M A BURGUN 68 SEE A RESONANCE-LIKE EFFECT IN THIS REGION IN THE
M REACTION K-P TO XI K. HOWEVER, AS THEY POINT OUT, IT IS NOT CLEAR
M WHETHER IT IS MAINLY THE G07 Y*0(2100) OR INSTEAD A SO FAR OTHERWISE
M UNOBSERVED RESONANCE WITH A SPIN LESS THAN 7/2.
M L LITCHFIELD 71 IS AN UPDATE OF BERTHON1 70 3/72

41 Y*0(2100) WIDTH (MEV)

W		(145.0)			WOHL	66 HBC		7/66
W	A	(80.0)	(10.0)		BURGUN	68 DPWA	0 K-P TO XI K	10/69
W		140.0	(15.0)		BERTHON1	70 DPWA	0 K-P TO SIGMA PI	10/70
W		60.0	(25.0)		GALTIERI	70 DPWA	0 K-P TO SIGMA PI	7/70
W	B	(170.) TO 300.			LITCHFIE	71 DPWA	K-P TO KBAR N	10/71
W	B	LARGER VALUE CORRESPONDS TO PURE B.W. LOWER VALUE , TO B.W. + BCKGRD						
W	L	140.0	(50.0)	(30.0)	LITCHFIE	71 DPWA	K-P TO SIG PI	10/71
W		(208.0)			BRANDSTE	72 DPWA	K-P TO LAM.OMEGA	1/73*
W		144.0	(26.0)		KANE	72 DPWA	0 K-P TO PI SIG	10/71

SEE THE NOTES ACCOMPANYING MASSES QUOTED

41 Y*0(2100) PARTIAL DECAY MODES

		DECAY MASSES
P1	Y*0(2100) INTO KBAR N	497+ 939
P2	Y*0(2100) INTO SIGMA PI	1197+ 139
P3	Y*0(2100) INTO XI K	1321+ 497
P4	Y*0(2100) INTO LAMBDA OMEGA	1115+ 783

41 Y*0(2100) BRANCHING RATIOS

R1		Y*0(2100) INTO (KBAR N)/TOTAL				(P1)	
R1		(0.25)		WOHL	66 HBC		7/66
R1	D	(0.33)		DAUM	68 CNTR	K-P ELA,POL,SIGT	7/70
R1		0.30	.03	LITCHFIE	71 DPWA	K-P TO KBAR N	10/71
R1	D	DAUM 68 ASSUMES (J+1/2)*X VALUE SEEN IN TOTAL CROSS SECTION.					
R2		Y*0(2100) FROM KBAR N INTO SIGMA PI				SQRT(P1*P2)	
R2	L	(+0.16)	(0.02)	BERTHON1	70 DPWA	0 K-P TO SIGMA PI	10/70
R2		+0.06	(0.03)	GALTIERI	70 DPWA	0 K-P TO SIGMA PI	7/70
R2	L	0.16	(0.05)	LITCHFIE	71 DPWA	K-P TO SIG PI	10/71
R2		+0.096	(0.037)	KANE	72 DPWA	0 K-P TO PI SIG	10/71
R3		Y*0(2100) FROM KBAR N TO XI K				SQRT(P1*P3)	
R3		(0.05)		TRIPP	67 RVUE	0 K-P TO XI K	8/67
R3	B	(0.09)	(0.01)	BURGUN	68 DPWA	0 K-P TO XI K	10/69
R3		(0.003)		MULLER	69 DPWA	0	7/70
R3		0.035	0.018	LITCHFIE	71 DPWA	K-P TO XI K	3/72
R3	B	BURGUN 68 UPDATED BY LITCHFIELD 71, WHO TAKES SOLUTION C OF BURGUN					3/72
R4		Y*0(2100) FROM KBAR N INTO LAMBDA OMEGA				SQRT(P1*P4)	
R4		(0.053)		BRANDSTE	72 DPWA		1/73*

SEE THE NOTES ACCOMPANYING MASSES QUOTED

REFERENCES FOR Y*0(2100)

WOHL 66 PRL 17 107 C G WOHL, F T SOLMITZ, M L STEVENSON (LRL)IJP
TRIPP 67 NP B3 10 + LEITH, + (LRL,SLAC,CERN,HEIDEL,SACLAY)
BURGUN 68 NP B8 447 +MEYER,PAULI, + (SACLAY,COLFRANCE,RHEL)
DAUM 68 NP B7 19 +ERNE, LAGNAUX, SENS, STEUER, UDO (CERN)JP
CONFIRMS THE SPIN-PARITY ASSIGNMENT.
MULLER 69 THESIS,UCRL 19372 R A MULLER (LRL)

BERTHON1 70 NP B24 417 +VRANA, BUTTERWORTH, + (CDEF, RHEL, SACLAY)IJP
GALTIERI 70 DUKE CONF 173 A BARBARO-GALTIERI (LRL)IJP
LITCHFIE 71 NP B30 125 LITCHFIELD,...+LESQUOY,+.. (RHEL+CDEF+SACL)IJP
BRANDSTE 72 NP B39 13 BRANDSTETTER+...+TALLINI (RHEL,CDEF,SACL) IJP
KANE 72 PR D5 1583 D F KANE (LBL)IJP

Λ(2110)

35 Y*0(2110, JP=5/2) I=0 **F''_{05} or D''_{05}**

BERTHON1 70 FIND EITHER F05 OR D05 POSSIBLE IN THE SIG PI CHANNEL, WITH F05 SLIGHTLY PREFERRED. IN THE KBAR N CHANNEL, LITCHFIELD 71 (SAME GROUP) FIND ONLY D05. AS USUAL, THE STATISTICS ARE MUCH BETTER IN THE ELASTIC CHANNEL.
ALTHOUGH KANE 72 FINDS AN F05 EFFECT, THE UNUSUALLY BROAD WIDTH MAY INVALIDATE A RESONANT INTERPRETATION.

35 Y*0(2110) MASS (MEV)

M		(2110.)	(10.)	BERTHON1	70 DPWA	- K- P TO SIG PI	1/71
M		(2140.)	(40.)	LITCHFIE	71 DPWA	K-P TO KBAR N	10/71
M		F05 2034.0		BRANDSTE	72 DPWA	K-P TO LAM.OMEGA	1/73*
M	A	(2141.0)	(6.0)	KANE	72 DPWA	0 K-P TO PI SIG	10/71
M	A	RESONANCE OUTSIDE RANGE OF DATA.					

35 Y*0(2110) WIDTH (MEV)

W		(185.)	(30.)	BERTHON1	70 DPWA	- K- P TO SIG PI	1/71
W		(120.)	(40.)	LITCHFIE	71 DPWA	K-P TO KBAR N	10/71
W		(154.0)		BRANDSTE	72 DPWA	K-P TO LAM.OMEGA	1/73*
W	A	(504.0)	(10.0)	KANE	72 DPWA	0 K-P TO PI SIG	10/71

35 Y*0(2110) PARTIAL DECAY MODES

		DECAY MASSES
P1	Y*0(2110) INTO KBAR N	497+ 939
P2	Y*0(2110) INTO SIGMA PI	1197+ 139
P3	Y*0(2110) INTO LAMBDA OMEGA	1115+ 783

35 Y*0(2110) BRANCHING RATIOS

R1		Y*0(2110) FROM KBAR N TO SIGMA PI				SQRT(P1*P2)	
R1		(+.17)	(.03)	BERTHON1	70 DPWA	- K- P TO SIG PI	1/71
R1	A	(+0.156)	(0.013)	KANE	72 DPWA	0 K-P TO PI SIG	10/71
R2		Y*0(2110) INTO (KBAR N)/TOTAL				(P1)	
R2		(0.14)	(0.04)	LITCHFIE	71 DPWA	K-P TO KBAR N	10/71
R3		Y*0(2110) FROM KBAR N INTO LAMBDA OMEGA				SQRT(P1*P3)	
R3		(0.152)		BRANDSTE	72 DPWA		1/73*

REFERENCES FOR Y*0(2110)

BERTHON1 70 NP B24 417 +VRANA,BUTTERWORTH,+ (CDEF,RHEL,SACLAY)IJP
LITCHFIE 71 NP B30 125 LITCHFIELD,...+LESQUOY,+.. (RHEL+CDEF+SACL)IJP
BRANDSTE 72 NP B39 13 BRANDSTETTER,BUTTERWORTH,+ (RHEL+CDEF+SACL)
KANE 72 PR D5 1583 D F KANE (LBL)IJP

Λ(2100) BUMPS

25 Y*0(2100, JP=) I=0 PRODUCTION EXPERIMENTS

SEE THE MINI-REVIEW AT THE START OF THE Y* LISTINGS.

SEE THE NOTE TO THE G07 Y*0(2100), WHICH PRECEDES THIS ENTRY. HERE WE LIST ONLY PARAMETERS OF PEAKS IN CROSS SECTIONS AND INVARIANT-MASS DISTRIBUTIONS. THE CROSS-SECTION PEAKS ARE AT LEAST DOMINANTLY ASSOCIATED WITH THE Y*0(2100), BUT MAY CONTAIN A SMALL CONTRIBUTION FROM THE SUGGESTED BUT NOT ESTABLISHED OTHER RESONANCES IN THIS REGION.

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                25  Y*0(2100) MASS (MEV) (PROD. EXP.)

M       (2097.0)   (6.0)              BOCK     65 HBC    PBAR P 5.7 BEV/C  7/66
M        2100.0    (7.0)              BUGG     68 CNTR   K-P, D TOTAL      6/68
M        2121.0    (5.0)              BRICMAN  70 CNTR 0 TOTAL AND CH EX   6/70
M        2107.0   (10.0)              COOL     70 CNTR   K-P, D TOTAL     10/70
M       (2135.0)  (20.0)              LU       70 CNTR 0 GAMMA P TO K+ Y*  1/71
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                25  Y*0(2100) WIDTH (MEV) (PROD. EXP.)

W         (24.0)  (14.0)   (24.0)     BOCK     65 HBC    INTO KBAR N (PI)  7/66
W         140.0   (15.0)              BUGG     68 CNTR                     6/68
W         147.0   (15.0)              BRICMAN  70 CNTR 0 TOTAL AND CH EX   6/70
W         185.0                       COOL     70 CNTR   K-P, D TOTAL     10/70
W         (40.0)                      LU       70 CNTR 0 GAMMA P TO K+ Y*  1/71
------ --------- --------- --------- --------- --------- --------- --------

                25  Y*0(2100) PARTIAL DECAY MODES (PROD. EXP.)

                                                            DECAY MASSES
P1     Y*0(2100) INTO KBAR N                                497+ 939
P2     Y*0(2100) INTO KBAR N PI                             497+ 939+ 139
P3     Y*0(2100) INTO LAMBDA ETA                            1115+ 548
P4     Y*0(2100) INTO LAMBDA OMEGA                          1115+ 783
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                25  Y*0(2100) BRANCHING RATIOS (PROD. EXP.)

R1     Y*0(2100) INTO (KBAR N)/TOTAL                       (P1)
R1        THESE VALUES OF ELASTICITIES ASSUME J=7/2 --
R1        0.305                       BUGG     68 CNTR                     6/68
R1        0.24     (0.02)             BRICMAN  70 CNTR 0 TOTAL AND CH EX   6/70
R1        0.4                         COOL     70 CNTR   K-P, D TOTAL     10/70

R2     Y*0(2100) INTO KBAR N PI                            (P2)
R2          SEEN                      BOCK     65 HBC

R3     Y*0(2100) FROM KBAR N INTO LAMBDA ETA               SQRT(P1*P3)
R3          (0.09) OR LESS            FLATTE 2 67 HBC    0 K-P TO LAM ETA    6/68

R4     Y*0(2100) INTO (LAMBDA OMEGA)/TOTAL                 (P4)
R4          (0.1)  OR LESS            FLATTE 1 67 HBC    0 K-P TO LAM OMEGA  8/67
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REFERENCES FOR Y*0(2100) (PROD. EXP.)


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BOCK       65 PL 17 166       +COOPER,FRENCH,KINSON, +        (CERN,SACLAY)
FLATTE 1 67 PR 155 1517       S M FLATTE                              (LRL)
FLATTE 2 67 PR 163 1441       S M FLATTE, C G WOHL                    (LRL)
BUGG       68 PR 168 1466     +GILMORE,KNIGHT, +          (RHEL,BIRM,CAVE) I

BRICMAN    70 PL 31B 152      +FERRO LUZZI, PERREAU,+  (CERN,CAEN,SACLAY)
COOL       70 PR D1 1887      +GIACOMELLI, KYCIA, LEONTIC, LI, +    (BNL) I
LU         70 PR D2 1846      +GREENBERG, HUGHES, MINEHART, MORI,+ (YALE)

                              PAPERS NOT REFERRED TO IN DATA CARDS

COOL       66 PRL 16 1228     +GIACOMELLI,KYCIA,LEONTIC,LI,LUNDBY,+ (BNL) I
   SUPERSEDED BY COOL 70.
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Λ(2350) BUMPS

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                42  Y*0(2350, JP=     ) I=0         PRODUCTION EXPERIMENTS

                SEE THE MINI-REVIEW AT THE START OF THE Y* LISTINGS.

                DAUM 68 FAVORS JP=7/2- OR 9/2+. BRICMAN 70 FAVORS 9/2+.

                LASINSKI 71 SUGGESTS THREE STATES IN THIS REGION
                USING A POMERON + RESONANCES MODEL.
------ --------- --------- --------- --------- --------- --------- --------

                42  Y*0(2350) MASS (MEV) (PROD. EXP.)

M         2340.0   (7.0)              BUGG     68 CNTR   K-P, D TOTAL      6/68
M         2358.0   (6.0)              BRICMAN  70 CNTR 0 TOTAL AND CH EX   6/70
M         2344.0  (15.0)              COOL     70 CNTR   K-P, D TOTAL     10/70
M        (2360.0) (20.0)              LU       70 CNTR 0 GAMMA P TO K+ Y*  1/71
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                42  Y*0(2350) WIDTH (MEV) (PROD. EXP.)

W          140.0  (20.0)              BUGG     68 CNTR   K-P, D TOTAL      6/68
W          324.0  (30.0)              BRICMAN  70 CNTR 0 TOTAL AND CH EX   6/70
W         (190.0)                     COOL     70 CNTR   K-P, D TOTAL     10/70
W          (55.0)                     LU       70 CNTR 0 GAMMA P TO K+ Y*  1/71
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                42  Y*0(2350) PARTIAL DECAY MODES (PROD. EXP.)

                                                            DECAY MASSES
P1     Y*0(2350) INTO KBAR N                                497+ 939
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                42  Y*0(2350) BRANCHING RATIOS (PROD. EXP.)

R1     Y*0(2350) INTO (KBAR N)/TOTAL                       (P1)
R1        J IS NOT KNOWN.  THE FOLLOWING IS (J+1/2)*P1.
R1        (0.57)                      BUGG     68 CNTR   K-P, D TOTAL      6/68
R1         1.1        0.25            BRICMAN  70 CNTR 0 TOTAL AND CH EX   6/70
R1        (1.0)                       COOL     70 CNTR   K-P, D TOTAL     10/70
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REFERENCES FOR Y*0(2350) (PROD. EXP.)


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BUGG       68 PR 168 1466     +GILMORE,KNIGHT, +          (RHEL,BIRM,CAVE) I
DAUM       68 NP B7 19        +ERNE, LAGNAUX, SENS, STEUER, UDO    (CERN)JP
BRICMAN    70 PL 31B 152      +FERRO LUZZI, PERREAU,+  (CERN,CAEN,SACLAY)
COOL       70 PR D1 1887      +GIACOMELLI, KYCIA, LEONTIC, LI, +    (BNL) I
LU         70 PR D2 1846      +GREENBERG, HUGHES, MINEHART, MORI,+ (YALE)

                              PAPERS NOT REFERRED TO IN DATA CARDS

COOL       66 PRL 16 1228     +GIACOMELLI,KYCIA,LEONTIC,LI,LUNDBY,+ (BNL) I
   SUPERSEDED BY COOL 70.
LASINSKI 71 NP  B29  125      T A LASINSKI                          (EFI)IJP
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Λ(2585) BUMPS

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                7   Y*0(2585, JP=     ) I=0         PRODUCTION EXPERIMENTS

                SEE THE MINI-REVIEW AT THE START OF THE Y* LISTINGS.
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                7   Y*0(2585) MASS (MEV) (PROD. EXP.)

M         2585.0    45.0              ABRAMS   70 CNTR   K-P, D TOTAL     10/70
M        (2530.0)  (25.0)             LU       70 CNTR 0 GAMMA P TO K+ Y*  1/71
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                7   Y*0(2585) WIDTH (MEV) (PROD. EXP.)

W         (300.0)                     ABRAMS   70 CNTR   K-P, D TOTAL     10/70
W         (150.0)                     LU       70 CNTR 0 GAMMA P TO K+ Y*  1/71
------ --------- --------- --------- --------- --------- --------- --------

                7   Y*0(2585) PARTIAL DECAY MODES (PROD. EXP.)

                                                            DECAY MASSES
P1     Y*0(2585) INTO KBAR N                                497+ 939
------ --------- --------- --------- --------- --------- --------- --------

                7   Y*0(2585) BRANCHING RATIOS (PROD. EXP.)

R1     Y*0(2585) INTO (KBAR N)/TOTAL                       (P1)
R1        J IS NOT KNOWN.  THE FOLLOWING IS (J+1/2)*P1.
R1        (1.0)                       ABRAMS   70 CNTR   K-P, D TOTAL     10/70
R1  C     (0.12)   (0.12)             BRICMAN  70 CNTR   TOTAL AND CH EX  10/70
R1  C  RESONANCE AT END OF REGION ANALYZED -- NO CLEAR SIGNAL.
****** ********* ********* ********* ********* ********* ********* ********
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REFERENCES FOR Y*0(2585) (PROD. EXP.)


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ABRAMS     70 PR 1D 1917      +COOL, GIACOMELLI, KYCIA, LEONTIC, +  (BNL) I
BRICMAN    70 PL 31B 152      +FERRO LUZZI, PERREAU,+  (CERN,CAEN,SACLAY)
LU         70 PR D2 1846      +GREENBERG, HUGHES, MINEHART, MORI,+ (YALE)

                              PAPERS NOT REFERRED TO IN DATA CARDS

COOL       66 PRL 16 1228     +GIACOMELLI,KYCIA,LEONTIC,LUNDBY +     (BNL)I
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Σ⁺

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                19  SIGMA+ (1189, JP=1/2+) I=1

                SEE STABLE PARTICLE DATA CARD LISTINGS
****** ********* ********* ********* ********* ********* ********* ********
****** ********* ********* ********* ********* ********* ********* ********
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Σ⁻

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                20  SIGMA- (1198, JP=1/2+) I=1

                SEE STABLE PARTICLE DATA CARD LISTINGS
****** ********* ********* ********* ********* ********* ********* ********
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Σ⁰

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                21  SIGMA0 (1193, JP=1/2+) I=1

                SEE STABLE PARTICLE DATA CARD LISTINGS
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Σ(1385) **P'_{13}**

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                43  Y*1(1385, JP=3/2+) I=1

                FOR DISCUSSION OF INCONSISTENCY OF ERRORS AND OUR
                MODIFICATIONS, SEE NOTE ON K*(892)

                FOR THE TABLES WE USE ONLY THE UNSTARRED DATA, WHICH
                ATTEMPTS TO OBTAIN THE SEPARATE CHARGE-STATE MASSES AN
                WIDTHS.  SEE HOWEVER THE IDEOGRAMS INSERTED IN LISTING
     THESE INDICATE SERIOUS SYSTEMATICS, PERHAPS ARISING FROM INTERFERENCE E
     FECTS THAT CHANGE WITH PRODUCTION MECHANISM AND BEAM MOMENTUM.
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                43  Y*1(1385) MASS (MEV)

M      141(1384.0)                    ALSTON   60 HBC  +- K-P 1.15 BEV/C
M         (1385.0)                    BERGE    61 HBC  +- K-P .4-.85 BEV/C
M       38(1384.0)                    MARTIN   61 HBC  +0 K20 P .98 BEV/C
M         (1392.0)   (7.0)            COLLEY   62 HLBC -0 PI- PRP 2. BEV/C
M         (1389.0)   (3.0)            BALTAY   65 HBC  +- PBAR P 3.7 BEV/C  7/66
M         (1392.0)  (10.0)            MUSGRAVE 65 HBC  +-0PBAR P 3-4 BEV/C  7/66
MO     106(1381.0)   (4.0)            CURTIS   63 OSPK  0 PI-P 1.5 BEV/C
```

0 0 0 0 3 6 0 4 3 4 1

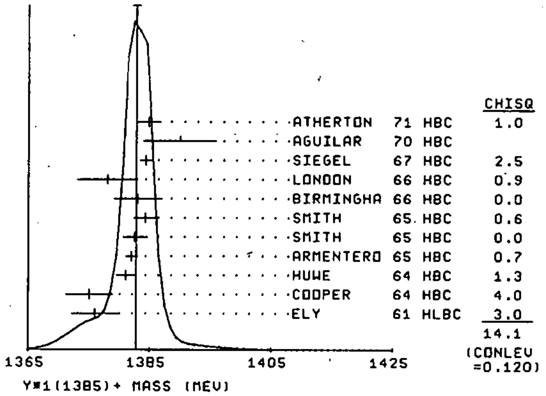
Data Card Listings

For notation, see key at front of Listings.

Baryons
Σ(1385)

```
M+    E 154 1376.0      3.9                ELY        61 HLBC +  K-P 1.11 BEV/C
M+    E           ERROR OF 3.0 ENLARGED TO 3.9 BY US,BECAUSE LT STATIST.ERR. 10/69
M+      170 1375.0      3.9                COOPER     64 HBC  +  K-P 1.45 BEV/C
M+      859 1381.0      1.6                HUWE       64 HBC  +  K-P 1.22 BEV/C
M+      750 1382.0      1.0                ARMENTERO  65 HBC  +  K-P .9-1.2 BEV/C
M+    S 250 1382.6      2.1                SMITH      65 HBC  +  K-P 1.95 BEV/C     9/66
M+    S 250 1384.3      1.9                SMITH      65 HBC  +  K-P 1.8 BEV/C      9/66
M+    S           ERROR OF 1.4 ENLARGED TO 2.1 BY US,BECAUSE <  STATIST.ER.   10/69
M+    S           ERROR OF 1.1 ENLARGED TO 1.9 BY US,BECAUSE <  STATIST.ER.   10/69
M+    B  40 1383.0      4.0                BIRMINGHA  66 HBC  +  K-P 3.5            9/67
M+    B           ERROR OF 2.0 ENLARGED TO 4.0 BY US,BECAUSE <  STATIST.ERR.  10/69
M+          1378.0      5.0                LONDON     66 HBC  +  K-P 2.24 BEV/C     7/66
M+     1260 1384.4      1.0                SIEGEL     67 HBC  +  K-P AT 2.1 GEV/C  10/69
M+          1390.0      6.0                AGUILAR    70 HBC  +  K-P 4 GEV/SIG.PI   5/70
M+          1384.8      2.0                ATHERTON   71 HBC       LAM PI+ + C.C.  10/71
M+          . . . . . . . . . .
M+   AVG    1382.81     0.68    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.3)
                        (SEE IDEOGRAM BELOW )
```

WEIGHTED AVERAGE = 1382.81 ± 0.68
ERROR SCALED BY 1.3

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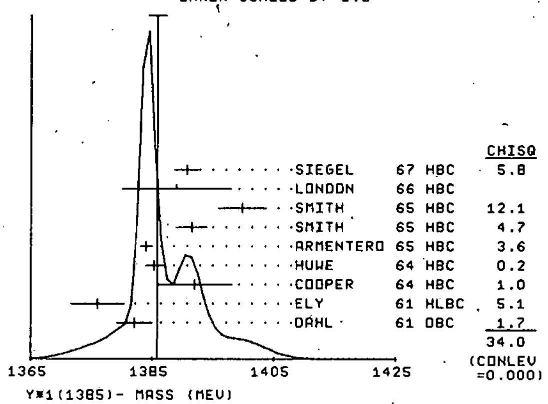
M-       93 1382.0      3.0                DAHL       61 DBC  -  K-D 0.45 BEV/C
M-    E 224 1376.0      4.4                ELY        61 HLBC -
M-    E           ERROR OF 3.0 ENLARGED TO 4.4 BY US,BECAUSE <  STATIST.ERR. 10/69
M-      200 1392.0      6.2                COOPER     64 HBC  -
M-     1086 1385.3      1.5                HUWE       64 HBC  -
M-     1380 1384.0      1.0                ARMENTERO  65 HBC  -
M-    S 120 1391.5      2.6                SMITH      65 HBC  -  K-P 1.8 BEV/C      9/66
M-    S  58 1399.8      4.0                SMITH      65 HBC  -  K-P 1.95 BEV/C     9/66
M-    S           ERROR OF 1.8 ENLARGED TO 2.6 BY US,BECAUSE <  STATIST.ER.   10/69
M-    S           ERROR OF 1.4 ENLARGED TO 4.0 BY US,BECAUSE <  STATIST.ER.   10/69
M-          1389.0      9.0                LONDON     66 HBC  -                     7/66
M-      370 1390.7      2.0                SIEGEL     67 HBC  -  K-P AT 2.1 GEV/C  10/69
M-          . . . . . . . . . .
M-   AVG    1385.9      1.5     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 2.2)
                        (SEE IDEOGRAM BELOW )
```

WEIGHTED AVERAGE = 1385.9 ± 1.5
ERROR SCALED BY 2.2



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43 (Y*-) - (Y*+) MASS DIFFERENCE (MEV)

```
D   R      (0.0)     (4.2)         ELY        61 HLBC +-  K-P 1.11 BEV/C      8/66
D   R     (17.)      (7.)          COOPER     64 HBC                         10/69
D   R      (4.3)     (2.2)         HUWE       64 HBC  +-  K-P 1.22 BEV/C      8/66
D   R      (2.0)     (1.5)         ARMENTERO  65 HBC  +-  K-P .9-1.2 BEV/C    8/66
D   R      (7.2)     (2.1)         SMITH      65 HBC  +-  K-P 1.8 BEV/C       9/66
D   R     (17.2)     (2.0)         SMITH      65 HBC  +-  K-P 1.95 BEV/C      9/66
D   R     (11.0)     (9.0)         LONDON     66 HBC  +-  K-P 2.24 BEV/C      8/66
D           9.0       6.0          LONDON     66 HBC  +-  LAMBDA 3 PI EVTS    7/66
D   R      (6.3)     (2.0)         SIEGEL     67 HBC      K-P AT 2.1 GEV/C   10/69
D   R    REDUNDANT WITH DATA IN MASS LISTING.
```

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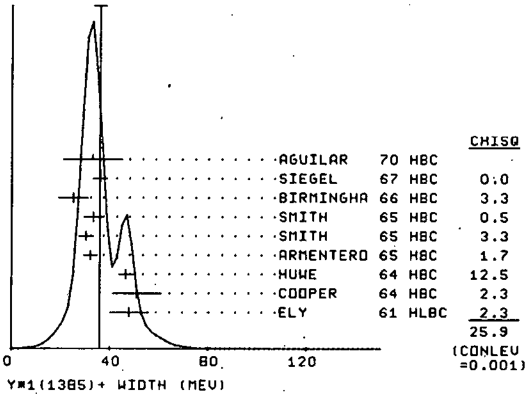
43 Y*1(1385) WIDTH (MEV)

```
W            (64.0)                    ALSTON     60 HBC  +-
W            (40.0)                    BERGE      61 HBC  +-
W            (20.0)  OR LESS           MARTIN     61 HBC  +0
W            (80.0)   (10.0)           COLLEY     62 HLBC -0
W            (30.0)    (9.0)           CURTIS     63 OSPK  0
W            (26.0)    (5.0)           BALTAY     65 HBC  +-                        7/66
W            (38.0)    (9.0)           MUSGRAVE   65 HBC  +-0                       7/66

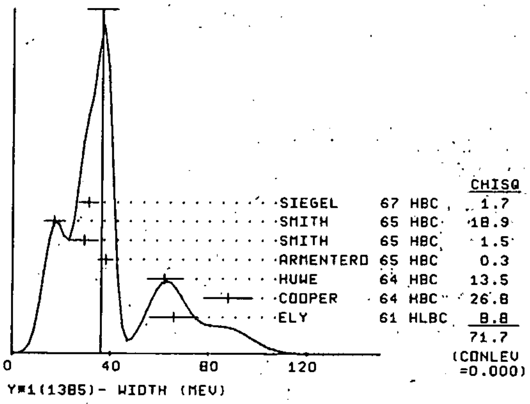
W+            48.0      8.0            ELY        61 HLBC +
W+            51.0     10.0            COOPER     64 HBC  +
W+            46.5      3.0            HUWE       64 HBC  +
W+            32.0      3.0            ARMENTERO  65 HBC  +
W+            30.3      3.1            SMITH      65 HBC  +  K-P 1.8 BEV/C        9/66
W+            33.1      3.8            SMITH      65 HBC  +  K-P 1.95 BEV/C       9/66
W+        40  25.0      6.0            BIRMINGHA  66 HBC  +  K-P 3.5              9/67
W+      1260  36.0      3.0            SIEGEL     67 HBC     K-P AT 2.1 GEV/C    10/69
W+            33.      12.0            AGUILAR    70 HBC  +  K-P 4 GEV/SIG.PI     5/70
W+ T      40  20.       4.             ATHERTON   71 HBC     LAM PI+ + C.C.      10/71
W+ T    FIT B.W. + PHASE SPACE BCKGRD
W+ R      40  35.       5.             ATHERTON   71 HBC     LAM PI+ + C.C.      10/71
W+ R    FIT B.W. AND NO BCKGRD
W+          . . . . . . . . . .
W+  AVG       34.4      2.4     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 2.0)
                        (SEE IDEOGRAM BELOW )
```

WEIGHTED AVERAGE = 35.9 ± 2.6
ERROR SCALED BY 1.9




```
W-            (40.0)                   DAHL       61 DBC  -,
W-             66.0     10.0           ELY        61 HLBC -
W-             88.0     10.0           COOPER     64 HBC  -
W-             62.0      7.0           HUWE       64 HBC  -
W-             38.0      3.0           ARMENTERO  65 HBC  -
W-             29.2      5.7           SMITH      65 HBC  -  K-P 1.80 BEV/C      9/66
W-             17.1      4.4           SMITH      65 HBC  -  K-P 1.95 BEV/C      9/66
W-       370   31.0      4.0           SIEGEL     67 HBC     K-P AT 2.1 GEV/C   10/69
W-           . . . . . . . . . .
W-  AVG        36.3      6.3    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 3.5)
                        (SEE IDEOGRAM BELOW )
```

WEIGHTED AVERAGE = 36.3 ± 6.3
ERROR SCALED BY 3.5



Baryons
Σ(1385), Σ(1440), Σ(1480), Σ(1620)

Data Card Listings
For notation, see key at front of Listings.

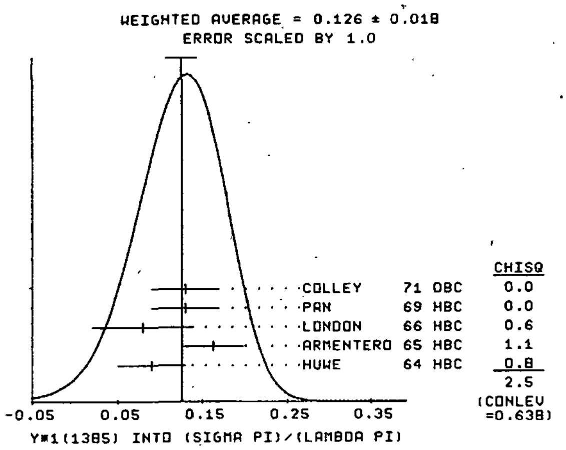
43 Y*1(1385) PARTIAL DECAY MODES

		DECAY MASSES
P1	Y*1(1385) INTO LAMBDA PI	1115+ 139
P2	Y*1(1385) INTO SIGMA PI	1197+ 139
P3	Y*1(1385) INTO LAMBDA GAMMA	1115+ 0

43 Y*1(1385) BRANCHING RATIOS

R1 Y*1(1385) INTO (SIGMA PI)/(LAMBDA PI) (P2)/(P1)

R1		(0.04)	(0.04)	BASTIEN	61 HBC	←		
R1		(0.04) OR LESS		ALSTON	62 HBC	←0		
R1		0.09	0.04	HUWE	64 HBC	←		
R1		0.163	0.035	ARMENTERO	65 HBC	←		7/66
R1		0.08	0.06	LONDON	66 HBC	+		7/66
R1		0.13	0.04	PAN	69 HBC		PI+ P - K Y PI	12/72*
R1		0.13	0.04	COLLEY	71 DBC		K-N 1.5 GEV PROD	10/71
R1		. . . . . .	. . .					
R1	AVG	0.126	0.018	AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0) (SEE IDEOGRAM BELOW)				



R2 Y*1(1385) INTO LAMBDA GAMMA (P3)

R2	1	(0.17)	(0.17)	MEISNER	72 HBC	1 EVENT ONLY	1/73*

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REFERENCES FOR Y*1(1385)

ALSTON 60 PRL 5 520 +ALVAREZ,EBERHARD,GOOD,GRAZIANO, + (LRL) I
BASTIEN 61 PRL 6 702 P BASTIEN,M FERRO-LUZZI,A H ROSENFELD (LRL)
BERGE 61 PRL 6 557 +BASTIEN,DAHL,FERRO-LUZZI,KIRZ, + (LRL)
DAHL 61 PRL 6 142 +HORWITZ,MILLER,MURRAY,WHITE (LRL)
ELY 61 PRL 7 461 +FUNG,GIDAL,PAN,POWELL,WHITE (LRL) J
MARTIN 61 PRL 6 283 +LEIPUNER,CHINOWSKY,SHIVELY, + (BNL,YALE)

ALSTON 62 CERN CONF 311 +ALVAREZ,FERRO-LUZZI,ROSENFELD, + (LRL)
COLLEY 62 PR 128 1930 +GELFAND,NAUENBERG, + (COLUMBIA,RUTGERS) JP
CURTIS 63 PR 132 1771 +COFFIN,MEYER,TERWILLIGER (MICH) J
COOPER 64 PL 8 365 +FILTHUTH,FRIDMAN,MALAMUD, + (CERN,AMST)
HUWE 64 UCRL-11291 THESIS D O HUWE (LRL) JP
ALSO 69 PR 180 1824 D O HUWE (LRL)

ARMENTER 65 PL 19 75 ARMENTEROS, + (CERN,HEIDEL,SACLAY)
BALTAY 65 PR 140 B1027 +SANDWEISS,TAFT,CULWICK,KOPP, + (YALE,BNL)
MUSGRAVE 65 NC 35 735 +PETMEZAS,+ (BIRM,CERN,EPOL,LOIC,SACLAY)
SMITH 65 THESIS (UCLA) L T SMITH (UCLA)

BIRMINGH 66 PR 152 1148 BIRMINGHAM,GLASGOW,I.C., OXFORDYRUTHERFORD
LONDON 66 PR 143 1034 +RAU,SAMIOS,YAMAMOTO,GOLDBERG,+ (BNL,SYRA) J
SIEGEL 67 UCRL 18041 THESIS D M SIEGEL (LRL)
PAN 69 PRL 23 808 +FORMAN (PENN) I
AGUILAR 70 PRL 25 58 +BARNES, BASSANO, CHUNG, EISNER,+(BNL,SYRA)
ATHERTON 71 NP B29 477 +CELNIKIER,CLAYTON,FRENCH,FRISK,+ (CERN)
COLLEY 71 NP B31 61 +COX,EASTWOOD,FRY+.. (BIRM+EDIN+GLAS+LOIC)
MEISNER 72 NC 12A 62 G MEISNER (U NC GREENSBORO+LBL)

QUANTUM NUMBER DETERMINATIONS NOT REFERRED TO IN DATA CARDS.

MALAMUD 64 PL 10 145 E MALAMUD, P E SCHLEIN (CERN,UCLA) JP
SHAFER 64 PR 134 B1372 J B SHAFER, D O HUWE (LRL) JP

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Σ(1440) BUMPS

80 Y*1(1440, JP=) I=1 PRODUCTION EXPERIMENTS

SEE THE MINI-REVUE AT THE START OF THE Y* LISTINGS.

→ CLINE 68 FIND A NARROW PEAK AT 1440 MEV (JUST ABOVE THE KBAR N THRESHOLD) IN THE LAMBDA PI INVARIANT MASS FOR K- D TO LAMBDA PI- P EVENTS. THEY DISCUSS ALTERNATE INTERPRETATIONS -- THAT IT IS A RESONANCE OR A KINEMATIC EFFECT. IN CLINE 68 THE K- BEAM MOMENTUM IS 0.4 GEV/C. IN A STUDY OF THE SAME REACTION WITH A MOMENTUM OF 1.1 GEV/C, ALEXANDER 69 FIND NO PEAK. IN ADDITION, THEY ARE ABLE TO EXPLAIN THE RESULTS OF BOTH EXPERIMENTS WITHOUT INVOKING A NEW RESONANCE. A REANALYSIS OF THE CLINE 68 DATA MADE BY BUNNEL 70 SHOW AGREEMENT OF THE DATA WITH THE ALEXANDER 69 INTERPERTATION.

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REFERENCES FOR Y*1(1440) (PROD. EXP.)

CLINE 68 PRL 21 1372 D CLINE, R LAUMANN, J MAPP (WISCONSIN) I
ALEXANDE 69 PRL 22 483 ALEXANDER, HALL, JEW, + (LRL,RIVERSIDE)
BUNNELL 70 LNC 3 224 +CLINE,LAUMANN,MAPP + (NWES+WISC+ANL)

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Σ(1480) BUMPS

23 Y*1(1480, JP=) I=1 PRODUCTION EXPERIMENTS

SEE THE MINI-REVUE AT THE START OF THE Y* LISTINGS.

→ PEAKS ARE SEEN IN LAMBDA PI AND SIGMA PI SPECTRA IN THE REACTION PI+P TO K+ PI Y AT 1.7 GEV/C. ALSO THE Y POLARIZATION OSCILLATES IN THE SAME REGION.

SEE MILLER 70 FOR A DISCUSSION OF THIS STATE. HE SUGGESTS A POSSIBLE ALTERNATE EXPLANATION IN TERMS OF A REFLECTION OF N*1/2(1670) DECAY TO LAMBDA K. HOWEVER, SUCH AN EXPLANATION FOR THE K+ SIGMA+ PIO CHANNEL SEEMS UNLIKELY (SEE PAN 70) IN TERMS OF KNOWN N*3/2(1690) DECAY INTO SIGMA K. IN ADDITION SUCH REFLECTIONS WOULD ALSO HAVE TO ACCOUNT FOR THE OSCILLATION OF THE Y POLARIZATION IN THE 1480 MASS REGION.
HANSON 71, WITH FEWER DATA THAN PAN 70, CAN NEITHER CONFIRM NOR DENY THE EXISTENCE OF THIS STATE.

23 Y*1(1480) MASS (MEV) (PROD. EXP.)

M	1479.	10.	PAN	70 HBC	+	PI+P TO K PI LAM	3/71
M	1465.	15.	PAN	70 HBC	+	PI+P TO K PI SIG	3/71
M	. . . . . .	. . .					
M	AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)						

23 Y*1(1480) WIDTH (MEV) (PROD. EXP.)

W	31.	15.	PAN	70 HBC	+	PI+P TO K PI LAM	3/71
W	30.	20.	PAN	70 HBC	+	PI+P TO K PI SIG	3/71
W	. . . . . .	. . .					
W	AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)						

23 Y*1(1480) PARTIAL DECAY MODES (PROD. EXP.)

		DECAY MASSES
P1	Y*1(1480) INTO KBAR N	497+ 939
P2	Y*1(1480) INTO LAMBDA PI	1115+ 139
P3	Y*1(1480) INTO SIGMA PI	1189+ 139

23 Y*1(1480) BRANCHING RATIOS (PROD. EXP.)

R1 Y*1(1480) INTO (SIGMA PI)/(LAMBDA PI) (P3)/(P2)

R1	0.82	0.51	PAN	70 HBC	+	3/71

R2 Y*1(1480) INTO (PROTON KOBAR)/(LAMBDA PI) (P1)/(P2)

R2	0.36	0.25	PAN	70 HBC	+	3/71

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REFERENCES FOR Y*1(1480) (PROD. EXP.)

PAN 70 PR D2, 49 +FORMAN,KO,HAGOPIAN,SELOVE (PENN)

PAPERS NOT REFERRED TO IN DATA CARDS

YU-LI PA 69 PRL 23 806 YU-LI PAN, F L FORMAN (PENN) I
YU-LI PA 69 PRL 23 808 YU-LI PAN, F L FORMAN (PENN) I
MILLER 70 DUKE 229 D H MILLER (REVIEW TALK) (PURDUE)
HANSON 71 PR D4 1296 +KALMUS,LOUIE (LBL) I

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Note on Σ(1620)

This state was first suggested by the BNL-CCNY collaboration (CRENNELL 68) who presented evidence for it in the reaction $K^- n \to \Sigma(1620)^{\pm}\pi^{\mp}\pi^-$ with $\Sigma(1620)^{\pm}$ decaying into $\Lambda\pi^{\pm}$. Since then there have been conflicting reports about this state. A good review of the production experiments has been recently given by MILLER 70. We summarize here the situation.

Formation Experiments. Several partial-wave analyses have found evidence for one or two fairly narrow ($\Gamma \sim 50$ MeV) $I = 1$, $J = 1/2$ states within ~ 50 MeV of the effect seen in production. It is not clear at present how many such states really exist. No one has reported a strong coupling of any of these states to $\overline{K}N$, but there is much disagreement about

Data Card Listings

For notation, see key at front of Listings.

Baryons
Σ(1620)

branching ratios into $\Lambda\pi$ and $\Sigma\pi$. We summarize below the results of several recent partial-wave analyses (see the note on Y^*'s for a discussion of the methods of analysis).

S_{11}: Both KIM 71 and LANGBEIN 72 report an S_{11} state near 1620 MeV with $\Gamma \sim 50$ MeV, but KIM 71 finds $\Lambda\pi$ to be the dominant two-body decay mode while LANGBEIN 72 finds the $\Sigma\pi$ mode dominant. ARMENTEROS 70 report no S_{11} state in any channel in this mass region. VAN HORN 72 finds a 66-MeV -wide S_{11} state at 1697 MeV in his energy-dependent fits to the $\Lambda\pi$ channel, and a 50-MeV-wide state at 1655 MeV in five out of seven of his Barrelet ambiguous solutions.

P_{11}: A 50-MeV-wide P_{11} state in the 1500-1600 MeV mass region of the $\Sigma\pi$ channel was reported by ARMENTEROS 70 with no corresponding effect in $\Lambda\pi$ and $\bar{K}N$. KIM 71 claims a P_{11} state at 1670 MeV with Γ = 50 MeV, a dominant $\Sigma\pi$ two-body decay mode, and vanishing coupling to $\Lambda\pi$. LANGBEIN 72 reports no P_{11} resonance. VAN HORN 72 saw a very broad, Γ = 230 MeV, P_{11} resonance at 1668 MeV in his energy-dependent fits to the $\Lambda\pi$ channel, but a fairly narrow, Γ = 60 MeV, resonance at about the same mass in all of his Barrelet ambiguous solutions.

Production experiments. Here the evidence is only in the $\Lambda\pi$ channel. The BNL-CCNY collaboration, with increased data, CRENNELL 69, still claim the effect in the $\Lambda\pi$ channel (no evidence seen in $\bar{K}N$ or $\bar{K}N\pi$). SABRE 70 studied the same reaction at 3.0 GeV/c with comparable statistics and do not see any evidence for it in the $\Lambda\pi$ channel; on the contrary, they believe it to be a spurious peak resulting from misidentified Σ^0 from the production of $\Sigma(1670)$ decaying into $\Sigma^0\pi^+$. CRENNELL 69 give counter arguments to show that this is not the case in their data and the controversy goes on. AMMANN 70 studied the same reaction at 4.5 GeV/c and report a state at 1640 MeV, again decaying only into $\Lambda\pi$ (no evidence seen in $\Sigma\pi$ or $\bar{K}N$ channels). The closeness of this mass to 1670 MeV is suggestive that this effect may be related to what goes on in that region (see discussion below).

In conclusion, for $\Sigma(1620)$ we have to wait for more data and for a complete understanding of the entire mass region 1600 to 1700 MeV. The hope is that the determination of quantum numbers for each of these effects for each decay mode may eventually clarify the situation.

Σ(1620) → **S'_{11}**

```
 32  Y*1(1620, JP=1/2-) I=1

   THE S11 STATE AT 1697 MEV REPORTED BY VANHORN72 IS INTERMEDIATE IN
 MASS BETWEEN THE SIGMA(1620) AND SIGMA(1750).  WE TENTATIVELY LIST IT
 UNDER SIGMA(1750).

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                    32  Y*1(1620) MASS (MEV)

M        (1620.)                      KIM      71 DPWA   K-MATRIX ANAL.   3/71
M         1630.0   (10.0)             LANGBEIN 72 IPWA   MULTICHANNEL    12/72*

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                    32  Y*1(1620) WIDTH (MEV)

W          (40.)                      KIM      71 DPWA   K-MATRIX ANAL.   3/71
W           65.0   (20.0)             LANGBEIN 72 IPWA   MULTICHANNEL    12/72*

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                    32  Y*1(1620) PARTIAL DECAY MODES

                                                         DECAY MASSES
P1      Y*1(1620) INTO KBAR N                          497+ 939
P2      Y*1(1620) INTO SIGMA PI                       1197+ 139
P3      Y*1(1620) INTO LAMBDA PI                      1115+ 134

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                    32  Y*1(1620) BRANCHING RATIOS

R1      Y*1(1620) INTO KBAR N                          (P1)
R1           (0.05)                   KIM      71 DPWA   K-MATRIX ANAL.   3/71
R1 A          0.05   OR LESS          WONG     71 DPWA   K-+P--LAM+PI    10/71
R1            0.22    (0.02)          LANGBEIN 72 IPWA   MULTICHANNEL    12/72*
R1 A     K-MATRIX FIT(NEGLECTS 3-BODY CHANNELS) REQUIRES NO RESONANCE    10/71

R2      Y*1(1620) FROM KBAR N TO SIGMA PI              SQRT(P1*P2)
R2           (0.08)                   KIM      71 DPWA   K-MATRIX ANAL.   3/71
R2            0.40    (0.06)          LANGBEIN 72 IPWA   MULTICHANNEL    12/72*

R3      Y*1(1620) FROM KBAR N TO LAMBDA PI             SQRT(P1*P3)
R3           (0.15)                   KIM      71 DPWA   K-MATRIX ANAL.   3/71

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                        REFERENCES FOR Y*1(1620)

KIM       71 PRL 27 356          J K KIM                              (HARV)IJP
   ALSO   70 DUKE 161            J. K. KIM                            (HARV)IJP
WONG      71 NC 2A 353           N S WONG                             (YALE)IJP
LANGBEIN  72 NP B47 477          +WAGNER                              (MPIM)IJP

                        PAPERS NOT REFERRED TO IN DATA CARDS

VANHORN   72 LBL-1370(THESIS)                                          /LBL IJP

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Σ(1620) → **P'_{11}**

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 79  Y*1(1620, JP=1/2+) I=1

 SEE THE MINI-REVUE AT THE START OF THE Y* LISTINGS.

 THE PARTIAL-WAVE ANALYSIS OF K- N TO SIGMA PI BY
 ARMENTEROS 70 SUGGESTS SUCH A RESONANCE.  KIM 71 FINDS
 A SIGNAL IN BOTH KBAR-N AND SIGMA PI.

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                    79  Y*1(1620) MASS (MEV)

M         1500. -- 1600.              ARMENTERO 70 HDBC -0 K-N TO SIGMA PI   6/70
M        (1670.)                      KIM       71 DPWA    K-MATRIX ANAL.    3/71
M         1668.       (.25)           VANHORN   72 DPWA  0 K- P TO LAM PIO   2/73*

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                    79  Y*1(1620) WIDTH (MEV)

W         .(50.0)                     ARMENTERO 70 HDBC -0 K-N TO SIGMA PI   6/70
W          (50.)                      KIM       71 DPWA    K-MATRIX ANAL.    3/71
W          230.    (165.)    (60.)    VANHORN   72 DPWA  0 K- P TO LAM PIO   2/73*

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                    79  Y*1(1620) PARTIAL DECAY MODES

                                                         DECAY MASSES
P1      Y*1(1620) INTO KBAR N                          497+ 939
P2      Y*1(1620) INTO SIGMA PI                       1197+ 139
P3      Y*1(1620) INTO LAMBDA PI                      1115+ 139

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                    79  Y*1(1620) BRANCHING RATIOS

R1      Y*1(1620) FROM KBAR N TO SIGMA PI              SQRT(P1*P2)
R1          (+0.2)                    ARMENTERO 70 HDBC -0 K-N TO SIGMA PI   6/70
R1           (0.24)                   KIM       71 DPWA    K-MATRIX ANAL.    3/71

R2      Y*1(1620) INTO KBAR N                          (P1)
R2           (0.14)                   KIM       71 DPWA    K-MATRIX ANAL.    3/71
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R3     Y*1(1620) FROM KBAR N TO LAMBDA PI                 SQRT(P1*P3)
R3          (0.0)                    KIM      71 DPWA    K-MATRIX ANAL.    2/73*
R3             .12     (.12)    (.04) VANHORN  72 DPWA  0 K- P TO LAM PIO  2/73*

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                      REFERENCES FOR Y*1(1620)

ARMENTER 70 DUKE 123          ARMENTEROS, BAILLON, +       (CERN,HEIDEL)IJP
KIM      71 PRL 27 356        J K KIM                             (HARV)IJP
   ALSO 70 DUKE 161           J. K. KIM                           (HARV)IJP
VANHORN  72 LBL-1370(THESIS)                                       /LBL IJP

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Σ(1620) BUMPS

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          78  Y*1(1620, JP=    ) I=1       PRODUCTION EXPERIMENTS

          SEE THE MINI-REVUE AT THE START OF THE Y* LISTINGS,

          THIS RESONANCE NEEDS CONFIRMATION.  THE RESULTS OF
          CRENNELL 69 AT 3.9 GEV/C ARE NOT CONFIRMED BY THE SABRE
    COLLABORATION AT 3.0 GEV/C (SABRE 70).  HOWEVER IN AN EXPERIMENT AT
    4.5 GEV/C, AMMANN 70 SEE A PEAK AT 1642 MEV WHICH ON THE BASIS OF
    BRANCHING RATIOS THEY DO NOT ASSOCIATE WITH THE Y*1(1670). SEE MILLER
    70 FOR A REVIEW OF THESE CONFLICTS.
       THERE WAS AN INDICATION OF A Y*1(1610) IN AN EARLY PHASE-SHIFT
    ANALYSIS OF K-P TO LAMBDA PI.  HOWEVER MORE DETAILED ANALYSIS OF
    MORE EXTENSIVE DATA BY THE SAME (CERN, HEIDELBERG, SACLAY) GROUP
    FAILED TO CONFIRM THIS RESULT. THEY NOW SEE IT IN THE SIGMA PI
    CHANNEL (SEE PREVIOUS ENTRY). (OLD LAMBDA PI ANALYSIS LISTED AS
    ARMENTEROS 68, NEW ANALYSIS AS ARMENTEROS 70.)

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                 78  Y*1(1620) MASS (MEV) (PROD. EXP.)

M   N     (1616.0)    (8.0)            CRENNELL  68 DBC  +- K-D 3.9 BEV/C    11/68
M   N    EVENTS OF CRENNELL 68 ARE IN THE LARGER SAMPLE OF CRENNELL 69.
M        20 1618.0     3.0             BLUMENFEL 69 HBC  +  KO LONG + PROTON  9/69
M           1619.0     8.0             CRENNELL  69 DBC  +- K-N TO LAM 3 PI   9/69
M           1642.0    12.0             AMMANN    70 DBC     K-P 4.5 GEV/C     6/70
M           . . . . . . . . . .
M   AVG     1619.4     3.8      AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.4)

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                 78  Y*1(1620) WIDTH (MEV) (PROD. EXP.)

W   N          (66.0)   (16.0)          CRENNELL  68 DBC  +- SEE NOTE N ABOVE 11/68
W        20     30.0     10.0           BLUMENFEL 69 HBC  +                    9/69
W               72.0     22.0     15.0  CRENNELL  69 DBC  +-                   9/69
W               55.0     24.0           AMMANN    70 DBC     K-P 4.5 GEV/C     6/70
W               . . . . . . . . . .
W   AVG         41.3     12.2     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.5)
            SEE THE NOTES ACCOMPANYING THE MASSES QUOTED

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                 78  Y*1(1620) PARTIAL DECAY MODES (PROD. EXP.)

                                                    DECAY MASSES
P1     Y*1(1620) INTO KBAR N                        497+ 939
P2     Y*1(1620) INTO LAMBDA PI                    1115+ 139
P3     Y*1(1620) INTO Y*1(1385) PI                 1384+ 139
P4     Y*1(1620) INTO LAMBDA PI PI                 1115+ 139+ 139
P5     Y*1(1620) INTO SIGMA PI                     1197+ 139
P6     Y*1(1620) INTO Y*0(1405) PI                 1405+ 139

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                 78  Y*1(1620) BRANCHING RATIOS (PROD. EXP.)

R1     Y*1(1620) INTO (LAMBDA PI PI)/(LAMBDA PI)        (P4)/(P3)
R1      14   (2.5)  APPROX            BLUMENFEL 69 HBC  +

R2     Y*1(1620) INTO (KBAR N)/(LAMBDA PI)              (P1)/(P2)
R2          (0.0)     (0.1)           CRENNELL  68 DBC  +
R2           0.4       0.4            AMMANN    70 DBC     K-P 4.5 GEV/C    6/70

R3     Y*1(1620) INTO LAMBDA PI                         (P2)
R3           LARGE                    CRENNELL  68 DBC  +-                  11/68

R4     Y*1(1620) INTO (Y*1(1385) PI)/(LAMBDA PI)        (P3)/(P2)
R4          (0.2)     (0.1)           CRENNELL  68 DBC  +-                  11/68
R4          (0.3)  OR LESS  CL=.95    AMMANN    70 DBC     K-P 4.5 GEV/C    6/70

R5     Y*1(1620) INTO (SIGMA PI)/(LAMBDA PI)            (P5)/(P2)
R5          (1.1)(95 PC UPPER LIMIT) AMMANN     70 DBC     K-P 4.5 GEV/C    6/70

R6     Y*1(1620) INTO (Y*0(1405) PI)/(LAMBDA PI)        (P6)/(P2)
R6           0.7       0.4            AMMANN    70 DBC     K-P 4.5 GEV/C    6/70

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                  REFERENCES FOR Y*1(1620) (PROD. EXP.)

CRENNELL 68 PRL 21 648        +DELANEY, FLAMINIO, KARSHON, +   (BNL,CUNY) I
BLUMENFE 69 PL 29B 58         BLUMENFELD, KALBFLEISCH               (BNL) I
CRENNELL 69 LUND PAPER 183    +KARSHON, LAI, ONEIL, SCARR, +   (BNL,CUNY) I
    RESULTS ARE QUOTED IN LEVI SETTI 69.

AMMANN   70 PRL 24 327        + GARFINKEL, CARMONY, GUTAY,+  (PURDUE,IND)

                  PAPERS NOT REFERRED TO IN DATA CARDS

ARMENTER 68 NP B8 183         ARMENTEROS,BAILLON +       (CERN+HEID+SACL)
LEVISETT 69 LUND CONF         R LEVI SETTI    (RAPPORTEUR)          EFINS
TRIPP    69 UCRL 19361        R D TRIPP                             (LRL)
ARMENTER 70 DUKE 123          ARMENTEROS,BAILLON +       (CERN+HEID+SACL)
MILLER   70 DUKE 229          D H MILLER    (REVIEW TALK)        (PURDUE)
SABRE    70 NP B16 201        SABRE COLLAB.    (SACL,AMST,BGNA,REHO,EPOL)

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Note on Σ(1670)

Formation experiments show the presence of only one I = 1 state in this energy region with major decay modes into $\overline{K}N$ (7-10%), $\Lambda\pi$ (10-15%), $\Sigma\pi$ (30-50%), $\Sigma\pi\pi$ (5-15%), and some $\Lambda\pi\pi$ (the experimental situation here is unclear). Its quantum numbers are $J^P = 3/2^-$.

Production experiments are more confused. When determined, the most likely quantum numbers are also $3/2^-$[for $\Sigma\pi$ and $\Lambda(1405)\pi$]. The measured branching ratio $R = \Sigma\pi/\Sigma\pi\pi$ changes with the momentum transfer to the proton. This was first observed by EBERHARD 69 who suggested the existence of 2 Y_1^* with the same mass and quantum numbers; one object with a large $\Sigma\pi\pi$ [mainly $\Lambda(1405)\pi$] decay mode produced peripherally, and another one with a large $\Sigma\pi$ decay mode produced at larger angles. This observation has now been confirmed by AGUILAR-BENITEZ 70 .

The other difficulty comes from the different $\Lambda\pi/\Sigma\pi$ branching ratios reported by the various experiments. Those experiments done with K^- beams below 2 GeV/c (HUWE 64 and BUTTON-SHAFER 68) report values for the $\Lambda\pi/\Sigma\pi$ ratio in agreement with formation experiments; the others report a higher $\Lambda\pi/\Sigma\pi$ ratio. Therefore, the possibility of a third Y_1^* state, referred to as Σ(1690) in the Data Card Listings, with a large $\Lambda\pi/\Sigma\pi$ branching ratio still exists. This large branching ratio is the main justification for this hypothesis and needs confirmation. It relies on the separation between $K^-p \to \Lambda\pi^+\pi^-$ and $K^-p \to \Sigma^0\pi^+\pi^-$, which is experimentally difficult at high energy. These problems are reviewed by MILLER 70.

Two resonances of the same spin and parity have been hypothesized by EBERHARD 69 as the origin of much of the complexity observed in the 1600 to 1700 MeV region in production experiments. See also the note on Σ(1620).

Σ(1670) **D'_{13}**

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          44  Y*1(1670, JP=3/2-) I=1

          SEE THE MINI-REVUE AT THE START OF THE Y* LISTINGS.

          SEE NOTE ABOVE

          WELL ESTABLISHED RESONANCE.  IT HAS BEEN SEEN IN BOTH
          FORMATION AND PRODUCTION EXPERIMENTS.  HOWEVER THE
          BRANCHING RATIOS OBTAINED BY THESE TWO METHODS SHOW
          LARGE INCONSISTENCIES.

    SEE LISTING OF PRODUCTION EXPERIMENTS BELOW

    AS FOR THE QUANTUM NUMBERS, THE ANALYSES OF LAMBDA PI CHANNEL (IN
    FORMATION EXP.) AS WELL AS THE SIGMA PI CHANNEL AGREE ON JP=3/2-.

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Data Card Listings

For notation, see key at front of Listings.

Baryons
Σ(1670)

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                    44  Y*1(1670) MASS (MEV)

M        1660.0                        BERLEY    64 HBC    0 K-P TO LAM PIO    7/66
M        1668.      (5.)               ARMENTER  68 HBC    0 K-P ELAS.+CH.EX  11/68
M       (1661.0)    (2.0)              ARMENTE2  68 HBC    0 K-P TO SIGMA PI  11/68
M        1680.                         ARMENTE4  69 DBC      K-N TO SIG- PIO  12/68
M        1663.0     (2.0)              ARMENT-5  69 HBC    0 K-P TO SIGMPI ED  9/69
M        1672.0                        BERLEY    69 HBC      K-P TO SIG PI     5/70
M        1660.                         ARMENTER  70 HBC    0 K-P TO LAM.PI EI  5/70
M        1681.0     (3.0)              BRUCKER   70 DBC  -   K-N TO SIG 2PI   10/71
M        1662.0     (5.0)              GALTIERI  70 HBC    0 SIG PI,EDPWA      7/70
M        1665.     (10.)               GALTIERI  70 HBC    0 LAM. PI, EDPWA    7/70
M        1676.      (2.)               BUDGEN    71 DPWA     LAM PIO,CHS DATA 10/71
M        1670.                         KIM       71 DPWA     K-MATRIX ANAL.    3/71
M        1675.0    (15.0)              LANGBEIN  72 IPWA     MULTICHANNEL     12/72*
M        1659.     (12.)       (5.)    VANHORN   72 DPWA   0 K- P TO LAM PIO   2/73*

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                    44  Y*1(1670) WIDTH (MEV)

W          60.0                        BERLEY    64 HBC    0                   7/66
W          56.     (18.)               ARMENTER  68 HBC    0 K-P ELAS.+CH.EX  11/68
W         (44.0)    (4.0)              ARMENTE2  68 HBC    0 K-P TO SIGMA PI  11/68
W          47.0                        ARMENTE4  69 DBC      K-N TO SIG- PIO  12/68
W          49.0     (4.0)              ARMENT-5  69 HBC    0 K-P TO SIGMPI ED  9/69
W          34.0                        BERLEY    69 HBC                        5/70
W          50.                         ARMENTER  70 HBC    0 K-P TO LAMB.PI    5/70
W          30.0    (10.0)              BRUCKER   70 DBC  -   K-N TO SIG 2PI   10/71
W          48.0     (5.0)              GALTIERI  70 HBC    0 SIG PI,EDPWA      7/70
W          50.     (10.)               GALTIERI  70 HBC    0 LAM. PI, EDPWA    7/70
W          59.      (4.5)              BUDGEN    71 DPWA     LAM PIO          10/71
W          40.                         KIM       71 DPWA     K-MATRIX ANAL.    3/71
W          65.0    (20.0)              LANGBEIN  72 IPWA     MULTICHANNEL     12/72*
W          32.     (11.)               VANHORN   72 DPWA   0 K- P TO LAM PIO   2/73*

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                    44  Y*1(1670) PARTIAL DECAY MODES

                                                            DECAY MASSES
P1     Y*1(1670) INTO KBAR N                               497+ 939
P2     Y*1(1670) INTO LAMBDA PI                           1115+ 139
P3     Y*1(1670) INTO SIGMA PI                            1197+ 139
P4     Y*1(1670) INTO LAMBDA PI PI                        1115+ 139+ 139
P5     Y*1(1670) INTO SIGMA PI PI                         1197+ 139+ 139
P6     Y*1(1670) INTO Y*1(1385) PI                        1384+ 139
P7     Y*1(1670) INTO Y*0(1405) PI                        1405+ 139

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                    44  Y*1(1670) BRANCHING RATIOS

R1     Y*1(1670) INTO (KBAR N)/TOTAL                      (P1)
R1          (0.09)    (0.02)           ARMENTER  68 HBC                        9/69
R1           0.08     (0.02)           ARMENT-5  69 HBC    0 ELAS. +CH.EX. ED  9/69
R1           0.07                      KIM       71 DPWA     K-MATRIX ANAL.    3/71
R1           0.10     (0.03)           LANGBEIN  72 IPWA     MULTICHANNEL     12/72*

R2     Y*1(1670) INTO (LAMBDA PI PI)/TOTAL                (P4)
R2          (0.11) OR LESS             ARMENTE3  68 HBC      K-P (P1=.09)      9/69

R3     Y*1(1670) INTO (SIGMA PI PI)/TOTAL                 (P5)
R3   A      (0.14) OR LESS             ARMENTE3  68 HBC      K-P AND D-P1=.09 11/68
R3   A  RATIO ONLY FOR (SIG2PI) SYSTEM IN I=1, WHICH CANNOT BE Y*1(1385)      11/68

R4     Y*1(1670) INTO (Y*0(1405) PI)/TOTAL                (P7)
R4          (0.06) OR LESS             ARMENTE3  68 HBC      K-P AND D-P1=.09 11/68

R5     Y*1(1670) FROM KBAR N TO LAMBDA PI                 SQRT(P1*P2)
R5          +0.1                       ARMENTER  70HBC  .    K-P TO LAMB PI  . 5/70
R5          +0.09     (0.02)           GALTIERI  70 HBC    0 LAM. PI, EDPWA    7/70
R5            .165    (.01)            BUDGEN    71 DPWA   . LAM PIO          10/71
R5           0.08                      KIM       71 DPWA     K-MATRIX ANAL.    3/71
R5           0.13     (0.03)           LANGBEIN  72 IPWA     MULTICHANNEL     12/72*
R5           +.09     (.02)            VANHORN   72 DPWA   0 K- P TO LAM PIO   2/73*

R6     Y*1(1670) FROM KBAR N TO SIGMA PI                  SQRT(P1*P3)
R6         (+0.21)    (0.01)           ARMENTE2  68 HBC    0 OLD DATA         11/68
R6          +0.19                      ARMENTE4  69 DBC                        9/69
R6          +0.20     (0.01)           ARMENT-5  69 HBC    0 NEW DATA          9/69
R6          +0.18                      BERLEY    69 HBC                        5/70
R6          +0.18     (0.06)           GALTIERI  70 HBC    0 SIG PI,EDPWA      7/70
R6           0.15                      KIM       71 DPWA     K-MATRIX ANAL.    3/71
R6           0.23     (0.05)           LANGBEIN  72 IPWA     MULTICHANNEL     12/72*

R7     Y*1(1670) FROM KBAR N TO Y*1(1385) PI              SQRT(P1*P6)
R7   S      (0.17)    (0.02)           SIMS      68 DBC  -   LAM 2PI CROS.SEC 10/71
R7   S  SIMS 68 USES ONLY CROSS-SECT. DATA. RESULT USED AS UPPER LIMIT ONLY   3/72

R8     Y*1(1670) INTO (Y*0(1405)PI)*(KBAR N)/TOTAL**2     (P7*P1)
R8          (0.03) OR LESS             BERLEY    69 HBC    0 K-P .6-.82 BEV/C  5/70
R8   B       0.007    (0.002)          BRUCKER   70 DBC  -   K-N TO SIG 2PI   10/71
R8   B  ASSUMING Y*0(1405) PI CROSS SECTION BUMP DUE SOLEY TO 3/2- RESON.     10/71

R9     Y*1(1670) INTO (Y*0(1405) PI)/(Y*1(1385) PI)       (P7)/(P6)
R9           0.23     (0.08)           BRUCKER   70 DBC  -   K-N TO SIG 2PI   10/71

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REFERENCES FOR Y*1(1670)

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BERLEY   64 DUBNA CONF I 565   +CONNOLLY,HART,RAHM,STONEHILL, +      (BNL)IJP

ARMENTER 68 NP B8 195          ARMENTEROS,BAILLON +     (CERN+HEID+SACLAY)IJP
ARMENTE1 68 NP B8 183          ARMENTEROS,BAILLON +     (CERN+HEID+SACLAY)IJP
ARMENTE2 68 NP B8 223          ARMENTEROS+BAILLON +     (CERN+HEID+SACLAY)IJP
ARMENTE3 68 PL 28B 521         ARMENTEROS,BAILLON +     (CERN+HEID+SACLAY)I
SIMS     68 PRL 21 1413        SIMS,ALBRIGHT,BARTLEY,MEER+ (FSU,TUFT,BRAN)

ARMENTE4 69 NP B10 459         ARMENTEROS,BAILLON,MINTEN +   (CERN+SACLAY) J
ARMENT-5 69 NP B14 91          ARMENTEROS, BAILLON, + (CERN,HEIDEL,SACLAY)IJP
BERLEY   69 PL 30B 430         BERLEY,HART,RAHM,WILLIS,YAMAMOTO      (BNL)

ARMENTER 70 DUKE 123           ARMENTEROS, BAILLON, +           (CERN,HEID)
BRUCKER  70 DUKE 155           +HARRISON,SIMS,ALBRIGHT,CHANDLER++     (FSU)I
GALTIERI 70 DUKE 173           A. BARBARO GALTIERI                  (LRL)IJP
BUDGEN   71 LNC 2  85          D BUDGEN                            (DURH)IJP
KIM      71 PRL 27 356         J K KIM                             (HARV)IJP
    ALSO 70 DUKE 161           J. K. KIM                           (HARV)IJP
LANGBEIN 72 NP B47 477         +WAGNER                             (MPIM)IJP
VANHORN  72 LBL-1370(THESIS)                                        /LBL IJP
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PAPERS NOT REFERRED TO IN DATA CARDS

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BASTIEN1 63 PRL 10 188        P L BASTIEN, J P BERGE          .     (LRL) IJ
    REPLACED BY BASTIEN 2, BUT SIMILAR AND MORE READILY AVAILABLE.
BASTIEN2 63 UCRL-10779 THESIS P L BASTIEN                            (LRL) IJ
T-ZADEH  63 PRL 11 470        TAHER-ZADEH,PROWSE,SCHLEIN,SLATER,+  (UCLA) JP
    SEE NOTE FOLLOWING SCHLEIN 66.
SCHLEIN 66  UCLA-1016         P.E. SCHLEIN, T.G. TRIPPE            (UCLA) JP
    REANALYSES DATA OF TAHER-ZADEH 63 ,   BASTIEN 63 AND ALL PUBLISHED
    LAMBDA PI CROSS SECTION DATA IN THE LIGHT OF THE NOW KNOWN
    Y*1(1765) .  REVERSES THE MODEL-DEPENDENT CONCLUSION OF TAHER-
    ZADEH ON THE PREFERRED JP ASSIGNMENT (FROM 3 2+ TO 3           (2-).)
SMART    66 PRL 17 556        W M SMART,A KERNAN,G E KALMUS,R P ELY (LRL)IJP
ARMENTER 67 NP B3 592         ARMENTEROS,FERRO-LUZZI+  (CERN,HEID,SACLAY)
PREVOST  71  AMSTERDAM CONF   + CHS COLLABORATION         (CERN+HEID+SACL)
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Σ(1670) BUMPS

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          51  Y*1(1670, JP=    ) I=1        PRODUCTION EXPERIMENTS

          SEE NOTE PRECEDING Y*1(1670)
          PROBABLY THERE ARE TWO STATES AT SAME MASS WITH SAME
          QUANTUM NUMBERS, ONE DECAYING INTO SIGMA PI AND LAMBDA
          PI, THE OTHER INTO Y*0(1405) PI.  BRANCHING RATIOS NOT
          DISENTANGLED YET, WE LIST THEM TOGETHER FOR NOW.

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          51  Y*1(1670) MASS (MEV) (PROD. EXP.)

M         (1685.0)                    ALEXANDER 62 HBC  -0 PI-P 2-2.2 BEV/C
M          1660.0      10.0           ALVAREZ   63 HBC  +  K-P 1.51 BEV/C
M         (1665.0)     (5.0)          BUGG      68 CNTR    K-P, D TOTAL C.S
M    P   70(1661.)     (9.)           PRIMER    68 HBC  +  K-P 4.6-5. GEV/C  7/68
M    P       SEE BARNES 69 FOR NEW ANALYSIS OF DATA (3 TIMES MORE DATA)     10/69
M          1670.0       6.0           AGUILAR   70 HBC     SIG.PI K-P 4 GEV  5/70
M          1668.0      10.0           AGUILAR   70 HBC     SIG.2PI K-P 4GEV  5/70
M             . . . . . . . . .
M    AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

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          51  Y*1(1670) MASS (MEV) (PRCD. EXP.)

W          (45.0)                     ALEXANDER 62 HBC  -0
W           40.0       10.0           ALVAREZ   63 HBC  +
W          (30.0)     (15.0)          BUGG      68 CNTR                     11/66
W    P   70 (60.)     (20.)           PRIMER    68 HBC  +  K-P 4.6-5. GEV/C  7/68
W               SEE THE NOTES ACCOMPANYING THE MASSES QUOTED.
W          110.0       12.0           AGUILAR   70 HBC     SIG.PI K-P 4 GEV  5/70
W          135.0       40.0    30.0   AGUILAR   70 HBC     SIG.2PI K-P 4GEV  5/70
W             . . . . . . . . .
W    AVERAGE MEANINGLESS (SCALE FACTOR = 3.4)

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          51  Y*1(1670) PARTIAL DECAY MODES (PROD. EXP.)

                                                            DECAY MASSES
P1     Y*1(1670) INTO KBAR N                               497+ 939
P2     Y*1(1670) INTO LAMBDA PI                           1115+ 139
P3     Y*1(1670) INTO SIGMA PI                            1197+ 139
P4     Y*1(1670) INTO LAMBDA PI PI                        1115+ 139+ 139
P5     Y*1(1670) INTO SIGMA PI PI                         1197+ 139+ 139
P6     Y*1(1670) INTO Y*1(1385) PI                        1384+ 139
P7     Y*1(1670) INTO Y*0(1405) PI                        1405+ 139

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          51  Y*1(1670) BRANCHING RATIOS (PROD. EXP.)

R1     Y*1(1670) INTO (KBAR N)/(SIGMA PI)             (P1)/(P3)
R1      0     (0.19) OR LESS          ALVAREZ   63 HBC  +  K-P 1.15 BEV/C
R1            (0.5)+- .25 OR MORE     SMITH     63 HBC  -0
R1            (0.6)  OR LESS          LONDON    66 HBC  +  K-P 2.25 BEV/C    7/66
R1            (0.025)                 BUGG      68 CNTR  0 ASSUMING J=3/2   11/66
R1      0     (0.24) OR LESS          PRIMER    68 HBC  +  K-P 4.6-5. GEV/C  7/68
R1            (0.26) OR LESS          BARNES    69 HBC  +  K-P 3.9-5 GEV/C  10/69
R1            (0.2)  OR LESS          AGUILAR   70 HBC                       5/70

R2     Y*1(1670) INTO (LAMB.PI)/(SIG PI)              (P2)/(P3)
R2    130     (1.20)                  ALVAREZ   63 HBC  +  K-P 1.15 BEV/C
R2            (1.2)                   SMITH     63 HBC  -0
R2             0.15       0.07        HUWE      64 HBC  +
R2             0.6   OR LESS          LONDON    66 HBC  +  K-P 2.25 BEV/C    7/66
R2     33      0.11       0.06        BUTTON-S  68 HBC  .  K-P AT 1.7 GEV/C 10/69
R2   P  0     (0.)                    PRIMER    68 HBC  +  K-P 3.9-5 GEV/C  10/69
R2   P  PRIMER 68 ASSUMED THIS DECAY TO BE ALL Y*(1690)- SEE BARNES 69 FOR
R2   P  NEW INTERPRATATION OF DATA.(3 TIMES MORE DATA) -
R2            0.45        0.15        BARNES    69 HBC  +  K-P 3.9-5 GEV/C  10/69
R2             . . . . . . . . .
R2   AVERAGE MEANINGLESS (SCALE FACTOR = 1.5)

R3     Y*1(1670) INTO (LAMB. PI PI)/(SIG PI)          (P4)/(P3)
R3     90     (0.56)                  ALVAREZ   63 HBC  +  K-P 1.15 BEV/C
R3            (0.17)                  SMITH     63 HBC  -0
R3            (0.6)  OR LESS          LONDON    66 HBC  +  K-P AT 2.25 BEV/C 7/66

R4     Y*1(1670) INTO (SIGMA PI PI)/(SIG PI)          (P5)/(P3)
R4    180     (0.56)                  ALVAREZ   63 HBC  +  K-P 1.15 BEV/C

R5     Y*1(1670) INTO (Y*0(1405) PI)/(SIG PI)         (P7)/(P3)
R5     50      3.         1.6         LONDON    66 HBC  +  K-P 2.25 BEV/C    7/66
R5   P 17     (0.58)     (0.20)       PRIMER    68 HBC  +  K-P 4.6-5. GEV/C  7/68

R6     Y*1(1670) INTO (SIGMA PI)/(SIGMA PI PI)        (P3)/(P5)
R6             .4    OR LESS          BIRMINGHA 66 HBC  +  K-P AT 3.5 GEV/C 11/67
R6             0.30       0.15        LONDON    66 HBC  +  K-P 2.25 GEV/C    7/66
R6   A     BETWEEN 2.5 AND 0.24       EBERHARD  69 HBC     K-P AT 2.6 GEV/C  9/69
     A     DEPENDING ON THE PRODUCTION ANGLE

R7     Y*1(1670) INTO (Y*0(1405) PI)/(SIGMA PI PI)    (P7)/(P5)
R7             0.90       0.10    0.16 EBERHARD 65 HBC  +  K-P 2.45 BEV/C    7/66

R8     Y*1(1670) INTO (Y*0(1405) PI)/(Y*1(1385) PI)   (P7)/(P6)
R8            (0.8)  OR LESS          EBERHARD  65 HBC  +  K-P 2.45 BEV/C    7/66

R9     Y*1(1670) INTO (LAMBDA PI PI)/(SIGMA PI PI)    (P4)/(P5)
R9             0.35       0.2         BIRMINGHA 66 HBC  +  K-P AT 3.5 GEV/C 11/67
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Baryons
Σ(1670), Σ(1690), Σ(1750)

R10	Y*1(1670) INTO (LAMBDA PI)/(SIGMA PI PI)		(P2)/(P5)	
R10	(.2) OR LESS	BIRMINGHA 66 HBC	+ K-P AT 3.5 GEV/C	11/67
R11	Y*1(1670) INTO (LAMBDA PI)/(LAMBDA PI + SIG PI)		(P2)/(P2+P3)	
R11	(0.6) OR LESS	AGUILAR 70 HBC		5/70

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51 Y*1(1670) QUANTUM NUMBER DETERMINATION (PROD. EXP.)

Q1		JP=3/2+	LEVEQUE 65 HBC	INTO Y*(1405)+PI	11/68
Q3		JP=3/2-	EBERHARD 67 HBC	+ INTO Y*(1405) PI	11/68
Q4	400	JP=3/2-	BUTTON-SH 68 HBC	+- INTO SIGZERO+PI	11/68

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REFERENCES FOR Y*1(1670) (PROD. EXP.)

ALEXANDE 62 CERN CONF 320 — ALEXANDER,JACOBS,KALBFLEISCH,MILLER,+ (LRL) I
ALVAREZ 63 PRL 10 184 — +ALSTON,FERRO-LUZZI,HUWE, + (LRL) I
SMITH 63 ATHENS CONF 67 — G A SMITH (LRL)
HUWE 64 PR 180 1824(1969) — D O HUWE (LRL)
EBERHARD 65 PRL 14 466 — +SHIVELY,ROSS,SIEGAL,FICENEC, + (LRL,ILL) I

BIRMINGH 66 PR 152 1148 — BIRMINGHAM,GLASGOW,I.C.Y OXFORD,RUTHERFORD
LONDON 66 PR 143 1034 — +RAU,SAMIOS,YAMAMOTO,GOLDBERG,+ (BNL,SYRA) IJ
BUGG 68 PR 168 1466 — +GILMORE,KNIGHT,DAVIES+ (BIRM,CAVE,RHEL)I
BUTTON-S 68 PRL 21 1123 — J BUTTON SHAFER (MASA+LRL) JP
PRIMER 68 PRL 20 610 — +GOLDBERG,JAEGER,BARNES,DORNAN + (SYRA,BNL)

BARNES 69 BNL 13823 — +CHUNG,EISNER,FLAMINIO+ (BNL,SYRA)
EBERHARD 69 PRL 22 200 — +FRIEDMAN,PRIPSTEIN,ROSS (LRL)
AGUILAR 70 PRL 25 58 — +BARNES, BASSANO, CHUNG, EISNER,+(BNL,SYRA)

PAPERS NOT REFERRED TO IN DATA CARDS

LEVEQUE 65 PL 18 69 — + (SACLAY,EPOL,GLASGOW,LOIC,OXF,RHEL) JP
LEE 66 PRL 17 45 — Y Y LEE, D O REEDER, R W HARTUNG (WISC) JP
EBERHARD 67 PR 163 1446 — +PRIPSTEIN,SHIVELY,KRUSE,SWANSON (LRL,ILL)IJP

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Σ(1690) BUMPS

58 Y*1(1690, JP=) I=1 PRODUCTION EXPERIMENTS

SEE THE MINI-REVUE AT THE START OF THE Y* LISTINGS.

→ SEE NOTE PRECEDING Y*1(1670) LISTINGS, SEEN IN PRO. EXPERIMENTS ONLY, MAIN DECAY MODE IS LAMBDA PI.

58 Y*1(1690) MASS (MEV) (PROD. EXP.)

M		30(1715.0)	(12.0)	COLLEY 67 HBC	+ K-P 6 GEV/C	8/67
M	P	60(1694.0)	(24.0)	PRIMER 68 HBC	+ K-P 4.6-5 GEV/C	7/68
M	N	(1700.0)	(6.0)	SIMS 68 HBC	- K-N TO LAM PI PI	11/68
M		46(1682.0)	(2.0)	BLUMENFEL 69 HBC	+ KO LONG + PROTON	9/69
M		(1700.0)	(20.0)	MOTT 69 HBC	+ K-P 5.5 GEV/C	9/69

M P SEE Y*1(1670) LISTING-AGUILAR 70 WITH THREE TIMES THE DATA OF
M P PRIMER 68 SHOW THAT THEY HAVE NO EVIDENCE FOR Y*(1690)
M N THIS ANALYSIS, WHICH IS DIFFICULT AND REQUIRES SEVERAL ASSUMPTIONS
M AND SHOWS NO UNAMBIGUOUS Y*1(1690) SIGNAL, SUGGESTS JP=5/2+. SUCH A
M Y* WOULD LEAD ALL PREVIOUSLY KNOWN Y* TRAJECTORIES.

58 Y*1(1690) WIDTH (MEV) (PROD. EXP.)

W		30 (100.0)	(35.0)	COLLEY 67 HBC	+	8/67
W		60 (105.0)	(35.0)	PRIMER 68 HBC	+	7/68
W	N	(62.0)	(14.0)	SIMS 68 HBC	- SEE NOTE N ABOVE	11/68
W		46 (25.0)	(10.0)	BLUMENFEL 69 HBC	+	9/69
W		(130.0)	(25.0)	MOTT 69 HBC	+	9/69

SEE THE NOTES ACCOMPANYING THE MASSES QUOTED

58 Y*1(1690) PARTIAL DECAY MODES (PROD. EXP.)

		DECAY MASSES
P1	Y*1(1690) INTO KBAR N	497+ 939
P2	Y*1(1690) INTO LAMBDA PI	1115+ 139
P3	Y*1(1690) INTO SIGMA PI	1197+ 139
P4	Y*1(1690) INTO Y*1(1385) PI	1384+ 139
P5	Y*1(1690) INTO LAMBDA PI PI (INCLUDING P4)	1115+ 139+ 139

58 Y*1(1690) BRANCHING RATIOS (PROD. EXP.)

R1	Y*1(1690) INTO (KBAR N)/(LAMBDA PI)				(P1)/(P2)	
R1	18 0.4	0.25	COLLEY	67 HBC	+ 6/30 EVENTS	8/67
R1	(0.2) OR LESS		MOTT	69 HBC	+	9/69
R2	Y*1(1690) INTO (SIGMA PI)/(LAMBDA PI)				(P3)/(P2)	
R2	0.3	0.3	COLLEY	67 HBC	+ 4/30 EVENTS	8/67
R2	(0.4) OR LESS	CL=.90	MOTT	69 HBC	+	9/69
R3	Y*1(1690) INTO (Y*1(1385) PI)/(LAMBDA PI)				(P4)/(P2)	
R3	(0.5) OR LESS		MOTT	69 HBC	+	9/69
R4	Y*1(1690) INTO (LAMBDA PI PI)/(LAMBDA PI)				(P5)/(P2)	
R4	0.5	0.25	COLLEY	67 HBC	+ 15/30 EVENTS	8/67
R4	2.0	0.6	BLUMENFEL	69 HBC	+ 31/15 EVENTS	9/69
R4	. . . .					
R4	AVG 0.72	0.53	AVERAGE (ERROR INCLUDES SCALE FACTOR OF 2.3)			
R5	Y*1(1690) INTO (Y*1(1385) PI)/(LAMBDA PI PI)				(P4)/(P5)	
R5	SMALL		COLLEY	67 HBC	+	8/67
R5	LARGE		SIMS	68 HBC	- K-N TO L2PI	11/68

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REFERENCES FOR Y*1(1690) (PROD. EXP.)

COLLEY 67 PL 24B 489 — (BIRM,GLAS,LOIC,MUNICH,OXFORD,RHEL) I
DERRICK 67 PRL 18 266 — +FIELDS, LOKEN, AMMAR, (ARGONNE,NORTHWEST) I
REPLACED BY MOTT 69.
PRIMER 68 PRL 20 610 — +GOLDBERG, JAEGER, BARNES, + (SYRACUSE,BNL) I
SIMS 68 PRL 21 1413 — +ALBRIGHT, + (FSU,TUFTS,BRANDEIS) I

BLUMENFE 69 PL 29B 58 — B J BLUMENFELD, G R KALBFLEISCH (BNL) I
MOTT 69 PR 177 1966 — +AMMAR, DAVIS, KROPAC, +(NORTHWEST,ARGONNE) I

PAPERS NOT REFERRED TO IN DATA CARDS

AGUILAR 70 PRL 25 58 — AGUILAR-BENITEZ,BARNES,BASSANO+ (BNL+SYRA)

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Σ(1750) 57 Y*1(1750, JP=1/2-) I=1 **S''_{11}**

SEE THE MINI-REVIEW AT THE START OF THE Y* LISTINGS.

THERE IS NOW EVIDENCE IN THREE CHANNELS FOR AN S11 RESONANCE NEAR THIS ENERGY. INTERPRETATION OF THE SIGMA ETA THRESHOLD BUMP ON ITS OWN MERITS IS NOT CONCLUSIVE (CLINE 67) -- MORE DATA ARE NEEDED. BUT BY ANALOGY WITH THE SIMILAR N ETA AND LAMBDA ETA THRESHOLD EFFECTS, WHICH ARE ALMOST CERTAINLY RESONANCES, IT SEEMS VERY LIKELY THAT THIS TOO IS A RESONANCE. SEE THE RAPPORTEUR TALKS OF FERRO LUZZI 66 AND MEYER 67 FOR DISCUSSIONS.

IN THE ENERGY-INDEPENDENT PARTIAL WAVE ANALYSIS OF K- N TO LAMBDA PI, THE S11 AMPLITUDE APPEARS TO RESONATE (ARMENTEROS 69). IN 1968 IT APPEARED TO RESONATE NEAR 1650 MEV (ARMENTEROS 68), AND WAS LISTED HEREIN AS A SEPARATE STATE. NOW IT HAS MOVED CLOSE ENOUGH TO THE OTHER EFFECTS TO BE TENTATIVELY LISTED WITH THEM, BUT THE SIZE OF THE CHANGE IN THE MASS SHOULD BE A HEALTHY WARNING THAT THE PARAMETERS GIVEN FOR RESONANCES IN LOWER PARTIAL WAVES FROM SUCH ANALYSES ARE SUBJECT TO LARGE CHANGE. (ARMENTEROS 70, FROM WHICH THE RESONANCE PARAMETERS ARE QUOTED, IS A SLIGHT UPDATING OF ARMENTEROS 69.)

THERE IS WEAKER EVIDENCE FOR THIS RESONANCE IN AN ENERGY-DEPENDENT PARTIAL-WAVE ANALYSIS OF ELASTIC AND CHARGE-EXCHANGE SCATTERING (CONFORTO 71).

KIM 71 IN A MULTICHANNEL ANALYSIS FINDS A SURPRISINGLY LARGE ELASTICITY (.8), AND SMALLER AMPLITUDE IN THE LAMBDA PI CHANNEL.

VANHORN 72 FINDS A STATE SOMEWHAT BELOW THE SIGMA ETA THRESHOLD IN AN ANALYSIS OF THE LAMBDA PI CHANNEL.

IN VIEW OF THESE DISCREPANCIES WE DO NOT QUOTE ANY VALUES FOR THE BRANCHING RATIOS.

57 Y*1(1750) MASS (MEV)

M	NEAR SIGMA ETA THRESHOLD			CLINE	67 DBC	- K-N TO SIGMA ETA	9/66
M	ABOUT 1750.0			MEYER	67 RVUE		9/69
M	ABOUT 1730.0			ARMENTERO	70 HDBC	-0 K-N TO LAMBDA PI	6/70
M	(1757.0)	(10.0)		CONFORTO	71 DPWA	0 ELASTIC, CH EXCH	6/70
M	(1790.)			KIM	71 DPWA	K-MATRIX ANAL.	3/71
M	(1790.0)	(15.0)		LANGBEIN	72 IPWA	MULTICHANNEL	12/72*
M	(1697.)	(20.)	(10.)	VANHORN	72 DPWA	0 K- P TO LAM PIO	2/73*

57 Y*1(1750) WIDTH (MEV)

W	ABOUT 50.0			MEYER	67 RVUE		9/69
W	ABOUT 80.0			ARMENTERO	70 HDBC	-0 K-N TO LAMBDA PI	6/70
W	(55.0)	(10.0)		CONFORTO	71 DPWA	0 ELASTIC, CH EXCH	6/70
W	(50.)			KIM	71 DPWA	K-MATRIX ANAL.	3/71
W	(100.0)	(20.0)		LANGBEIN	72 IPWA	MULTICHANNEL	12/72*
W	(66.)	(14.)	(12.)	VANHORN	72 DPWA	0 K- P TO LAM PIO	2/73*

57 Y*1(1750) PARTIAL DECAY MODES

		DECAY MASSES
P1	Y*1(1750) INTO KBAR N	497+ 939
P2	Y*1(1750) INTO SIGMA ETA	1197+ 548
P3	Y*1(1750) INTO LAMBDA PI	1115+ 134
P4	Y*1(1750) INTO SIGMA PI	1197+ 139

57 Y*1(1750) BRANCHING RATIOS

R1	Y*1(1750) INTO (KBAR N)/TOTAL				(P1)	
R1	(0.12)	(0.05)	CONFORTO	71 DPWA	0 ELASTIC, CH EXCH	6/70
R1	(0.8)		KIM	71 DPWA	K-MATRIX ANAL.	3/71
R1	(0.45)	(0.05)	LANGBEIN	72 IPWA	MULTICHANNEL	12/72*
R2	Y*1(1750) FROM KBAR N INTO SIGMA ETA				SQRT(P1*P2)	
R2	SEEN		CLINE	69 DBC	- THRESHOLD BUMP	9/69
R3	Y*1(1750) FROM KBAR N INTO LAMBDA PI				SQRT(P1*P3)	
R3	(-0.25)		ARMENTERO	70 IPWA	-0 K-N TO LAMBDA PI	6/70
R3	(0.09)		KIM	71 DPWA	K-MATRIX ANAL.	3/71
R3	(0.30)	(0.05)	LANGBEIN	72 IPWA	MULTICHANNEL	12/72*
R3	(-.13)	(.04)	VANHORN	72 DPWA	0 K- P TO LAM PIO	2/73*
R4	Y*1(1750) FROM KBAR N TO SIGMA PI				SQRT(P1*P4)	
R4	(0.16)		KIM	71 DPWA	K-MATRIX ANAL.	3/71
R4	(0.13)	(0.02)	LANGBEIN	72 IPWA	MULTICHANNEL	12/72*

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REFERENCES FOR Y*1(1750)

CLINE 67 PL 25B 41 — CLINE, OLSSON (WISCONSIN)IJP
MEYER 67 HEIDELBERG C 117 — J MEYER (RAPPORTEUR) (SACLAY)IJP
ARMENTER 70 DUKE 123 — ARMENTEROS, BAILLON, + (CERN,HEIDEL)IJP
CONFORTO 71 NP B34 41 — +LEVI SETTI,LASINSKI..OBERLACK++ (EFI+HEID)IJP
KIM 71 PRL 27 356 — J K KIM (HARV)IJP
ALSO 70 DUKE 161 — J. K. KIM (HARV)IJP
LANGBEIN 72 NP B47 477 — +WAGNER (MPIM)IJP
VANHORN 72 LBL-1370(THESIS) — /LBL IJP

0 0 0 0 0 6 0 0 3 4 4

Data Card Listings
For notation, see key at front of Listings.

Baryons
Σ(1750), Σ(1765)

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                    PAPERS NOT REFERRED TO IN DATA CARDS

FERRO-LU 66 BERKELEY CONF 183 M FERRO LUZZI  (RAPPORTEUR)          (CERN)
ARMENTER 68 NP B8 183         ARMENTEROS, BAILLON, + (CERN,HEIDEL,SACLAY)IJP
ARMENTER 69 LUND CONF PAPER   ARMENTEROS, BAILLON, + (CERN,HEIDEL,SACLAY)IJP
HARRISON 70 FSU-HEP 70 3 1    W.C. HARRISON (THESIS)                (FSU)

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Σ(1765) — D_{15}

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45  Y*1(1765, JP=5/2-) I=1

SEE THE MINI-REVIEW AT THE START OF THE Y* LISTINGS.

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              45  Y*1(1765) MASS (MEV)

M         1765.0    10.0          GALTIERI  63 DBC   0 K-D 1.51 BEV/C
M         1755.0    10.0          ARMENTER  65 HBC   0 K-P TO Y*1520 PI  7/66
M         1760.0    10.0          BELL 1    66 DBC   - K-N TO Y*1520 PI  7/66
M    N    1768.0     2.0          ARMENT-1  68 DPWA  0 ELASTIC, CH EXCH 11/68
M    N    1768.0     4.0          BUGG      68 CNTR    K-P, D TOTAL     11/66
M         1775.0     7.0          SMART     68 RVUE -0 K-N TO LAMBDA PI  7/68
M         1770.0    10.0          COOL      70 CNTR    K-P, D TOTAL     10/70
M         1765.0    10.0          GALTIERI  70 DPWA  0 K-P TO LAMBDA PI  7/70
M    N    1770.0     3.0          CONFORTO  71 DPWA  0 ELASTIC, CH EXCH  6/70
M        (1765.)                  KIM       71 DPWA    K-MATRIX ANAL.    3/71
M         1758.7     3.9          BARLETTA  72 DPWA  0 KPPI 0.8-1.2GEV  12/72*
M         1765.0     9.0          KANE      72 DPWA  0 K-P TO PI SIG    10/71
M    N    1770.0     5.0          LANGBEIN  72 IPWA    MULTICHANNEL     12/72*
M         1774.     10.           VANHORN   72 DPWA  0 K- P TO LAM PIO   2/73*
M    N  ERROR STATIST. ONLY- NO ERROR DUE TO PARTICULAR P.W.ANAL. INCLUDED 1/71
M          . . . . . . . . .
M   AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

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              45  Y*1(1765) WIDTH (MEV)

W           60.0    10.0          GALTIERI  63 DBC   0
W           70.0    20.0          BELL 2    66 DBC   -                   7/66
W          128.0     8.0          ARMENT-1  68 DPWA  0 ELASTIC, CH EXCH 11/68
W          110.0     7.0          BUGG      68 CNTR    K-P,D TOTAL       7/68
W          146.0     9.0          SMART     68 RVUE -0                   7/68
W         (100.0)                 COOL      70 CNTR    K-P, D TOTAL     10/70
W          115.0    10.0          GALTIERI  70 DPWA  0 K-P TO LAMBDA PI  7/70
W          132.0    10.0          CONFORTO  71 DPWA  0 ELASTIC, CH EXCH  6/70
W         (100.)                  KIM       71 DPWA    K-MATRIX ANAL.    3/71
W          107.2    10.9          BARLETTA  72 DPWA  0 LAM(1520)PI CH.  12/72*
W          120.0    38.0          KANE      72 DPWA  0 K-P TO PI SIG    10/71
W          123.0    10.0          LANGBEIN  72 IPWA    MULTICHANNEL     12/72*
W          146.     18.           VANHORN   72 DPWA  0 K- P TO LAM PIO   2/73*
W          . . . . . . . . . .
W   AVG    116.0     7.9     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 2.5)
                            (SEE IDEOGRAM BELOW )
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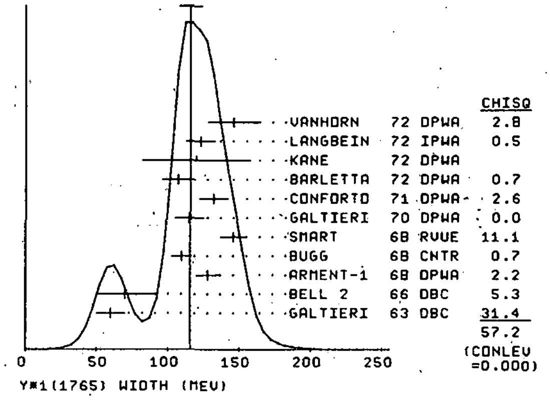
WEIGHTED AVERAGE = 116.0 ± 7.9
ERROR SCALED BY 2.5

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              45  Y*1(1765) PARTIAL DECAY MODES

                                                   DECAY MASSES
P1     Y*1(1765) INTO KBAR N                       497+ 939
P2     Y*1(1765) INTO LAMBDA PI                   1115+ 134
P3     Y*1(1765) INTO Y*0(1520) PI                1518+ 139
P4     Y*1(1765) INTO Y*1(1385) PI                1384+ 139
P5     Y*1(1765) INTO SIGMA PI                    1197+ 139
P6     Y*1(1765) INTO SIGMA ETA                   1197+ 548
P7     Y*1(1765) INTO SIGMA PI PI                 1197+ 139+ 139
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FITTED PARTIAL DECAY MODE BRANCHING FRACTIONS

The matrix below is derived from the error matrix for the fitted partial decay mode branching fractions, P_i, as follows: The diagonal elements are $P_i \pm \delta P_i$, where $\delta P_i = \sqrt{\langle \delta P_i \delta P_i \rangle}$, while the off-diagonal elements are the normalized correlation coefficients $\langle \delta P_i \delta P_j \rangle / (\delta P_i \cdot \delta P_j)$. For the definitions of the individual P_i, see the listings above; only those P_i appearing in the matrix are assumed in the fit to be nonzero and are thus constrained to add to 1.

```
       P 1        P 2        P 3        P 4        P 5        P 6
P 1 .4113+-.0169
P 2   .0885   .1320+-.0168
P 3   .0540     .0048   .1566+-.0328
P 4   .1118     .0099     .0060   .1028+-.0375
P 5  -.1181    -.0104    -.0064    -.0132   .0118+-.0040
P 6  -.4158    -.3284    -.5764    -.6970    -.0210  .1853+-.0585

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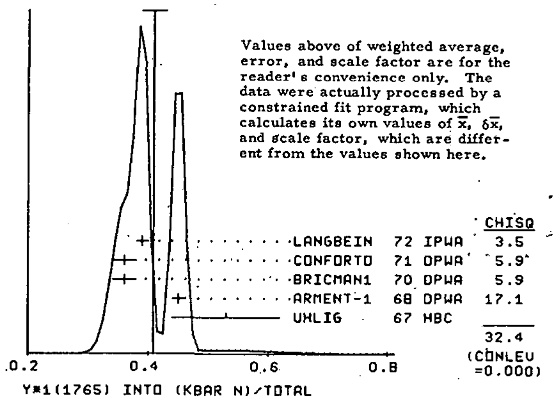
              45  Y*1(1765) BRANCHING RATIOS

      ERRORS QUOTED BY EXPERIMENTERS DO NOT INCLUDE UNCERTAINTY DUE
      TO PARAMETRIZATION USED IN THE P.W.A.  THEY SHOULD BE INCREASED.

R1      Y*1(1765) INTO (KBAR N)/TOTAL                      (P1)
R1           (0.6)                  GALTIERI  63 HBC   0 K-P RVUE
R1            0.53     0.09         UHLIG     67 HBC   0                   9/66
R1            0.45     0.01         ARMENT-1  68 DPWA  0 ELASTIC, CH EXCH 11/68
R1           (0.37)                 BUGG      68 CNTR                     11/66
R1            0.36     0.02         BRICMAN1  70 DPWA    SIGTOT,ELAS,CHEX  1/71
R1           (0.4)                  COOL      70 CNTR    K-P, D TOTAL     10/70
R1            0.36     0.02         CONFORTO  71 DPWA  0 ELASTIC, CH EXCH  6/70
R1           (0.42)                 KIM       71 DPWA    K-MATRIX ANAL.    3/71
R1            0.39     0.01         LANGBEIN  72 IPWA    MULTICHANNEL     12/72*
R1         . . . . . . . . .
R1  AVG       0.409    0.021   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 3.3)
R1  FIT       0.411    0.017  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 2.7)
                             (SEE IDEOGRAM BELOW )
```

WEIGHTED AVERAGE = 0.409 ± 0.021
ERROR SCALED BY 3.3

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R2      Y*1(1765) FROM KBAR N INTO LAMBDA PI               SQRT(P1*P2)
R2           -0.266    0.017        SMART     68 DPWA -0 K-N TO LAMBDA PI  7/68
R2           -0.22     0.03         GALTIERI  70 DPWA  0 K-P TO LAMBDA PI  7/70
R2           (0.30)                 KIM       71 DPWA    K-MATRIX ANAL.    3/71
R2            0.15     0.04         LANGBEIN  72 IPWA    MULTICHANNEL     12/72*
R2            -.28      .04    .05  VANHORN   72 DPWA  0 K- P TO LAM PIO   2/73*
R2         . . . . . . . . .
R2  AVG MOD   0.245    0.022   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.7)
R2  FIT       0.233    0.016  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.5)

R3      Y*1(1765) FROM KBAR N INTO Y*0(1520) PI            SQRT(P1*P3)
R3            0.27     0.03         ARMENTERO 65 HBC   0 K-P TO Y*1520 PI  9/66
R3            0.31     0.02         BARLETTA  72 DPWA  0 K-P TO Y*1520 PI 12/72*
R3         . . . . . . . . .
R3  AVG       0.298    0.018   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.1)
R3  FIT       0.254    0.027  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 2.1)

R4      Y*1(1765) FROM KBAR N INTO Y*1(1385) PI            SQRT(P1*P4)
R4  A        (0.24)   (0.03)        ARMENT-2  67 HBC   0 K-P TO LAM PI PI  8/67
R4  S        (0.32)   (0.06)        SIMS      68 DBC   - K-N TO LAM PI PI 11/68
R4  S   SIMS 68 USES ONLY CROSS-SECT. DATA. RESULT USED AS UPPER LIMIT ONLY 3/72
R4         . . . . . . . . .
R4  FIT       0.206    0.038  FROM FIT

R5      Y*1(1765) FROM KBAR N INTO SIGMA PI                SQRT(P1*P5)
R5            0.07     0.02         ARMENTERO 67 DPWA  0 K-P TO SIGMA PI   8/67
R5           +0.06     0.03         GALTIERI  70 DPWA  0 K-P TO SIGMA PI   7/70
R5           (0.09)                 KIM       71 DPWA    K-MATRIX ANAL.    3/71
R5           +0.074    0.017        KANE      72 DPWA  0 K-P TO PI SIG    10/71
R5            0.09  OR LESS         LANGBEIN  72 IPWA    MULTICHANNEL     12/72*
R5         . . . . . . . . .
R5  AVG       0.070    0.012   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R5  FIT       0.070    0.012  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)
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R6      Y*1(1765) INTO (LAMBDA PI)/(KBAR N)           (P2)/(P1)
R6           0.33      0.05            UHLIG      67 HBC   0 K-P,.9 GEV/C       9/66
R6          . . . . . . . . .
R6  FIT      0.321     0.042  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.4)

R7      Y*1(1765) INTO (Y*0(1520)PI)/(KBAR N)         (P3)/(P1)
R7           0.28      0.05            UHLIG      67 HBC   0 K-P,.9 GEV/C       9/66
R7          . . . . . . . . .
R7  FIT      0.381     0.080  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 2.1)

R8      Y*1(1765) INTO (Y*1(1385)PI)/(KBAR N)         (P4)/(P1)
R8           0.25      0.09            UHLIG      67 HBC   0 K-P,.9 GEV/C       9/66
R8          . . . . . . . . .
R8  FIT      0.250     0.091  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R9      Y*1(1765) INTO (SIGMA PI PI)/TOTAL            (P7)
R9  P       (0.12)                   ARMENT-2  68 HDBC -0 K-N TO SIG PI PI 11/68
R9  P    FOR ABOUT 3/4 OF THIS, THE SIGMA PI SYSTEM HAS I=0 AND IS ALMOST
R9  P ENTIRELY Y*0(1520).  FOR THE OTHER 1/4, THE SIGMA PI HAS I=1.  THIS
R9  P IS ABOUT WHAT IS EXPECTED FROM THE KNOWN RATE Y*1(1765) TO Y*1(1385)
R9  P PI, AS SEEN IN LAMBDA PI PI.

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REFERENCES FOR Y*1(1765)


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GALTIERI 63 PL 6 296            A BARBARO-GALTIERI,A HUSSAIN,RD TRIPP (LRL)IJ
ARMENTER 65 PL 19 338           ARMENTEROS, +         (CERN,HEIDELBERG,SACLAY)IJP
BELL 1   66 PRL 16 203          R B BELL, R W BIRGE, Y-L PAN, R T PU   (LRL)IJP
BELL 2   66 UCRL-16936 THESIS   R B BELL                               (LRL)IJP
ARMENTER 67 PL 24B 198          ARMENTEROS,FERRO-LUZZI+  (CERN,HEID,SACLAY)IJP
ARMENT-2 67 ZEIT.PHYS.202 486   ARMENTEROS,FERRO-LUZZI+  (CERN,HEID,SACLAY)
UHLIG    67 PR 155 1448         +CHARLTON,CONDON,GLASSER,YODH,+    (UMD,NRL)

ARMENT-1 68 NP B8 195           ARMENTEROS, BAILLON, + (CERN,HEIDEL,SACLAY)IJP
ARMENT-2 68 NP B8 216           ARMENTEROS, BAILLON, + (CERN,HEIDEL,SACLAY) I
BUGG     68 PR 168 1466         +GILMORE,KNIGHT,DAVIES+     (BIRM,CAVE,RHEL)I
SIMS     68 PRL 21 1413         SIMS,ALBRIGHT,BARTLEY,MEER+ (FSU,TUFT,BRAN)
SMART    68 PR 169 1330         W M SMART                              (LRL)IJP

BRICMAN1 70 PL 33B 511          +FERRO-LUZZI,LAGNAUX                 (CERN)
COOL     70 PR D1 1887          +GIACOMELLI, KYCIA, LEONTIC, LI, +    (BNL) I
GALTIERI 70 DUKE CONF 173       A BARBARO-GALTIERI                     (LRL)IJP

CONFORTO 71 NP  B34  41         +LEVI SETTI,LASINSKI..OBERLACK++ (EFI+HEID)IJP
KIM      71 PRL 27 356          J K KIM                               (HARV)IJP
   ALSO  70 DUKE 161            J. K. KIM                             (HARV)IJP

BARLETTA 72 NP B40 45           W.A. BARLETTA                          (EFI) IJP
KANE     72 PR D5 1583          D F KANE                               (LBL)IJP
LANGBEIN 72 NP B47 477          +WAGNER                               (MPIM)IJP
VANHORN  72 LBL-1370(THESIS)                                          /LBL IJP
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PAPERS NOT REFERRED TO IN DATA CARDS

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FENSTER  66 PRL 17 841          +GELFAND,HARMSEN,L-SETTI,+ (CHIC,ANL(CERN))IJP
     -- FENSTER 66 IS SUPERSEDED BY BARLETTA 72
CONFORTO 68 NP B8 265           +HARMSEN, LASINSKI, +     (CHICAGO,HEIDEL)IJP
    SUPERSEDED BY CONFORTO 71.
HARRISON 70 FSU-HEP 70 3 1      W.C. HARRISON (THESIS)                (FSU)
PREVOST  71  AMSTERDAM CONF     + CHS COLLABORATION            (CERN+HEID+SACL)
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$\Sigma(1840)$ — P''_{13}

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01  Y*1(1840, JP=3/2+) I=1

SEE THE MINI-REVIEWS PRECEDING THE Y*0*S.

FOR THE TIME BEING, WE LIST THESE TWO CLAIMS
TOGETHER.

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          01  Y*1(1840) MASS (MEV)

M         1840.0     (10.0)            LANGBEIN  72 IPWA   MULTICHANNEL     12/72*
M         1925.     (200.)             VANHORN   72 DPWA  0 K- P TO LAM PIO  2/73*

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          01  Y*1(1840) WIDTH (MEV)

W          120.0     (10.0)            LANGBEIN  72 IPWA   MULTICHANNEL     12/72*
W           65.      (50.)    (20.)    VANHORN   72 DPWA  0 K- P TO LAM PIO  2/73*

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          01  Y*1(1840) PARTIAL DECAY MODES

                                                           DECAY MASSES
P1      Y*1(1840) INTO KBAR N                             497+ 939
P2      Y*1(1840) INTO SIGMA PI                          1197+ 139
P3      Y*1(1840) INTO LAMBDA PI                         1115+ 134

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          01  Y*1(1840) BRANCHING RATIOS

R1      Y*1(1840) INTO (KBAR N)/TOTAL                 (P1)
R1           0.37      (0.13)          LANGBEIN  72 IPWA   MULTICHANNEL     12/72*

R2      Y*1(1840) FROM KBAR N INTO SIGMA PI          SQRT(P1*P2)
R2           0.15      (0.04)          LANGBEIN  72 IPWA   MULTICHANNEL     12/72*

R3      Y*1(1840) FROM KBAR N INTO LAMBDA PI         SQRT(P1*P3)
R3           0.20      (0.04)          LANGBEIN  72 IPWA   MULTICHANNEL     12/72*
R3           +.06      (.04)           VANHORN   72 DPWA  0 K- P TO LAM PIO  2/73*

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REFERENCES FOR Y*1(1840)


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LANGBEIN 72 NP B47 477          +WAGNER                               (MPIM)IJP
VANHORN  72 LBL-1370(THESIS)                                          /LBL IJP
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$\Sigma(1880)$ — P''_{11}

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67  Y*1(1880, JP=1/2+) I=1

SEE THE MINI-REVIEW AT THE START OF THE Y* LISTINGS.

SUCH A RESONANCE IS SUGGESTED BY SOME BUT NOT ALL
PARTIAL-WAVE ANALYSES ACROSS THIS REGION.  UNTIL THERE
IS MORE EVIDENCE, WE OMIT THIS STATE FROM THE MAIN
BARYON TABLE.

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          67  Y*1(1880) MASS (MEV)

M         1882.0     40.0              SMART     68 DPWA -0 K- N TO LAM PI   7/68
M        (1850.0)                      BAILEY    69 DPWA  0 ELASTIC, CH EXCH 10/70
M        ABOUT 1850.0                  ARMENTERO 70 IPWA -0 ELASTIC, CH EXCH  6/70
M         1950.0     50.0              GALTIERI  70 DPWA -0 K- N TO LAM PI   7/70
M         1920.0     30.0              LITCHFIEL 70 DPWA -0 K- N TO LAM PI   6/70
M        (1772.0)                      KANE      72 DPWA    K-P TO SIGMA PI  1/73*
M         1985.      50.               VANHORN   72 DPWA  0 K- P TO LAM PIO  2/73*
M         . . . . . . . . .
M   AVG   1925.6     19.9      AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

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          67  Y*1(1880) WIDTH (MEV)

W          222.0    150.0              SMART     68 DPWA -0 K- N TO LAM PI   7/68
W         (200.0)                      BAILEY    69 DPWA  0 ELASTIC, CH EXCH 10/70
W        ABOUT 30.0                    ARMENTERO 70 IPWA -0 ELASTIC, CH EXCH  6/70
W          200.0     50.0              GALTIERI  70 DPWA -0 K- N TO LAM PI   7/70
W          170.0     40.0              LITCHFIEL 70 DPWA -0 K- N TO LAM PI   6/70
W          (80.0)                      KANE      72 DPWA    K-P TO SIGMA PI  1/73*
W          220.     140.               VANHORN   72 DPWA  0 K- P TO LAM PIO  2/73*
W         . . . . . . . . .
W   AVG    185.0     29.9      AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

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          67  Y*1(1880) PARTIAL DECAY MODES

                                                           DECAY MASSES
P1      Y*1(1880) INTO KBAR N                             497+ 939
P2      Y*1(1880) INTO LAMBDA PI                         1115+ 134

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          67  Y*1(1880) BRANCHING RATIOS

R1      Y*1(1880) INTO (KBAR N)/TOTAL                 (P1)
R1          (0.22)                     BAILEY    69 DPWA  0 ELASTIC, CH EXCH 10/70
R1          (0.20)                     ARMENTERO 70 IPWA -0 ELASTIC, CH EXCH  6/70

R2      Y*1(1880) FROM KBAR N INTO LAMBDA PI         SQRT(P1*P2)
R2          -0.11      0.03            SMART     68 DPWA -0 K- N TO LAM PI   7/68
R2          -0.09      0.04            GALTIERI  70 DPWA -0 K- N TO LAM PI   7/70
R2          -0.14      0.03            LITCHFIEL 70 DPWA -0 K- N TO LAM PI   6/70
R2           +.05       .07     .02    VANHORN   72 DPWA  0 K- P TO LAM PIO  2/73*
R2          . . . . . . . . .
R2  AVG MOD  0.107     0.017   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

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REFERENCES FOR Y*1(1880)


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SMART    68 PR 169 1330         W M SMART                              (LRL)IJP
BAILEY   69 THESIS UCRL-50617 DAVID SAAL BAILEY            (LRL LIVERMORE)IJP
ARMENTER 70 DUKE CONF 123       ARMENTEROS, BAILLON, +        (CERN, HEIDEL)IJP
GALTIERI 70 DUKE CONF 173       A BARBARO-GALTIERI                     (LRL)IJP
LITCHFIE 70 NP B22 269          P J LITCHFIELD                  (RUTHERFORD)IJP
KANE     72 PR D5 1583          D F KANE                               (LBL)
VANHORN  72 LBL-1370(THESIS)                                          /LBL IJP
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$\Sigma(1915)$ — F'_{15}

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46  Y*1(1915, JP=5/2+) I=1

SEE THE MINI-REVIEW AT THE START OF THE Y* LISTINGS.

THIS RESONANCE WAS FIRST SEEN IN THE TOTAL-CROSS-SEC-
TION MEASUREMENTS OF COOL 66.  IN THIS ENTRY, HOWEVER,
WE LIST ONLY THE RESULTS FROM PARTIAL-WAVE ANALYSES.
SEE THE NEXT ENTRY FOR THE PARAMETERS OF PEAKS SEEN AROUND 1900-1950
MEV IN CROSS SECTIONS AND INVARIANT-MASS DISTRIBUTIONS.  WE MAKE THIS
SEPARATION BECAUSE ONLY THE PARTIAL-WAVE ANALYSES ISOLATE THE F15 WAVE
(OR AT LEAST ATTEMPT TO -- THE SIGNAL IS WEAK).  THIS MASS REGION IS
COMPLICATED AND POORLY UNDERSTOOD AND THE PEAKS MAY CONTAIN MORE THAN
JUST THE Y*1(1915).  SEE ALSO THE NOTE TO THE NEXT ENTRY.

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          46  Y*1(1915) MASS (MEV)

M         1902.0     11.0              SMART     68 DPWA -0 K-N TO LAMBDA PI  7/68
M         1910.0     20.0              BERTHON   70 DPWA  0 K-P TO LAMBDA PI  7/70
M         1900.0     15.0              BERTHON1  70 DPWA  0 K-P TO SIGMA PI  10/70
M   N     1936.0     (3.0)             BRICMAN1  70 DPWA    SIGTOT,ELAS,CHEX  1/71
M         1903.0     10.0              COX       70 DPWA -  K-N TO LAMBDA PI  6/70
M         1905.0     30.0              GALTIERI  70 DPWA  0 K-P TO LAMBDA PI  7/70
M         1895.0     10.0              LITCHFIEL 70 DPWA -0 K-N TO LAMBDA PI  6/70
M   B    (1985.0)   (21.0)             ISLAM     71 DPWA    KN--PI-SIG       .12/72*
M   B  DISCREPANCY DUE POSSIBLY TO INSUFFICIENT STATISTICS
M         1910.      15.               LITCHFIE  71 DPWA    K-P TO KBAR N    10/71
M         1925.0      8.0              KANE      72 DPWA  0 K-P TO PI SIG    10/71
M         1920.        .15      .20    VANHORN   72 DPWA  0 K- P TO LAM PIO   2/73*
M   N   ERROR STATIST. ONLY- NO ERROR DUE TO PARTICULAR P.W.ANAL. INCLUDED  1/71
M         . . . . . . . . .
M   AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

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Data Card Listings

For notation, see key at front of Listings.

Baryons
Σ(1915), Σ(1940)

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                    46  Y*1(1915) WIDTH (MEV)

W   A       (50.0)   (20.0)           ARMENTER1 67 DPWA  O ELASTIC, CH EXCH 11/67
W            52.0     25.0            SMART     68 DPWA -O K-N TO LAMBDA PI  7/68
W            60.0     20.0            BERTHON   70 DPWA  O K-P TO LAMBDA PI  7/70
W            75.0     20.0            BERTHON1  70 DPWA  O K-P TO SIGMA PI  10/70
W           135.0     12.0            BRICMAN1  70 DPWA    SIGTOT,ELAS,CHEX  1/71
W            77.0     27.0            COX       70 DPWA -  K-N TO LAMBDA PI  6/70
W            70.0     20.0            GALTIERI  70 DPWA  O K-P TO LAMBDA PI  7/70
W            70.0     15.0            LITCHFIEL 70 DPWA -O K-N TO LAMBDA PI  6/70
W   B      (159.0)   (80.0)           ISLAM     71 DPWA    KN--PI-SIG       12/72*
W            70.      15.             LITCHFIE  71 DPWA    K-P TO KBAR N    10/71
W           146.0     22.0            KANE      72 DPWA  O K-P TO PI SIG    10/71
W           102.      18.             VANHORN   72 DPWA  O K- P TO LAM PIO   2/73*
W   A   LACK OF DATA PREVENTS FROM DETERMINING UNAMB. THIS AMPLITUDE        11/67
W            . . . . . . . . .
W   AVERAGE MEANINGLESS (SCALE FACTOR = 1.9)

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                    46  Y*1(1915) PARTIAL DECAY MODES

                                                             DECAY MASSES
P1      Y*1(1915) INTO KBAR N                                 497+ 939
P2      Y*1(1915) INTO LAMBDA PI                             1115+ 139
P3      Y*1(1915) INTO SIGMA PI                              1197+ 139

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                    46  Y*1(1915) BRANCHING RATIOS

R1      Y*1(1915) INTO (KBAR N)/TOTAL                       (P1)
R1  A         (0.12)   (.01)          ARMENTER1 67 DPWA  O ELASTIC, CH EXCH 11/67
R1             0.18   (0.02)          BRICMAN1  70 DPWA    SIGTOT,ELAS,CHEX  1/71
R1             0.11   (0.03)          CONFORTO  71 DPWA  O ELASTIC, CH EXCH  6/70
R1             0.15   (0.04)          LITCHFIE  71 DPWA    K-P TO KBAR N    10/71

R2      Y*1(1915) FROM KBAR N INTO LAMBDA PI                SQRT(P1*P2)
R2            -0.08   (0.02)          SMART     68 DPWA -O K-N TO LAMBDA PI  7/68
R2            -0.1    (0.02)          BERTHON   70 DPWA  O K-P TO LAMBDA PI  7/70
R2            -0.09   (0.02)          COX       70 DPWA -  K-N TO LAMBDA PI  6/70
R2            -0.11   (0.03)          GALTIERI  70 DPWA  O K-P TO LAMBDA PI  7/70
R2            -0.07   (0.015)         LITCHFIEL 70 DPWA -O K-N TO LAMBDA PI  6/70
R2             -.09     .02           VANHORN   72 DPWA  O K- P TO LAM PIO   2/73*

R3      Y*1(1915) FROM KBAR N INTO SIGMA PI                 SQRT(P1*P3)
R3  A         (0.00)  (0.01)        — ARMENTERO 67 DPWA  O K-P TO SIGMA PI  11/67
R3            -0.13   (0.03)          BERTHON1  70 DPWA  O K-P TO SIGMA PI  10/70
R3            -0.06   (0.03)          GALTIERI  70 DPWA  O K-P TO SIGMA PI   7/70
R3  B         (0.06)  (0.02)          ISLAM     71 DPWA    KN--PI-SIG       12/72*
R3            -0.137  (0.015)         KANE      72 DPWA  O K-P TO PI SIG    10/71

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                         REFERENCES FOR Y*1(1915)

ARMENTER 67 PL 24B 198        ARMENTEROS,FERRO-LUZZI+  (CERN,HEID,SACLAY)
ARMENTE1 67 NP B3 592         ARMENTEROS,FERRO-LUZZI+  (CERN,HEID,SACLAY)
SMART    68 PR 169 1330       W M SMART                             (LRL)IJP

BERTHON  70 NP B20 476        +RANGAN, VRANA, +(COL FRANCE, RHEL, SACLAY)IJP
BERTHON1 70 NP B24 417        +VRANA, BUTTERWORTH, + (CDEF, RHEL, SACLAY)IJ
BRICMAN1 70 PL 33B 511        +FERRO-LUZZI,LAGNAUX                   (CERN)
COX      70 NP B19 61         +ISLAM, COLLEY, +      (BIRM,EDIN,GLAS,LOIC)IJP
GALTIERI 70 DUKE CONF 173     A BARBARO-GALTIERI                    (LRL)IJP
LITCHFIE 70 NP B22 269        P J LITCHFIELD                  (RUTHERFORD)IJP

CONFORTO 71 NP  B34  41       +LEVI SETTI,LASINSKI..OBERLACK++ (EFI+HEID)IJP
ISLAM    71 PJSIR 14 305      +COX,COLLEY,HEATHCOTE                 (BIRM) IJP
   PAKISTAN J. SCI. IND. RES.
LITCHFIE 71 NP  B30 125       LITCHFIELD,...+LESQUOY,+.. (RHEL+CDEF+SACL)IJP
KANE     72 PR D5 1583        D F KANE                              (LBL)IJP
VANHORN  72 LBL-1370(THESIS)                                        /LBL IJP

                         PAPERS NOT REFERRED TO IN DATA CARDS

SMART    66 PRL 17 556        W M SMART,A KERNAN,G E KALMUS,R P ELY (LRL)IJP
    SUPERSEDED BY SMART 68.
CONFORTO 68 NP B8 265         +HARMSEN, LASINSKI, +      (CHICAGO, HEIDEL)
    SUPERSEDED BY CONFORTO 71.
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Σ(1920) BUMPS

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29  Y*1(1920, JP=     ) I=1        PRODUCTION EXPERIMENTS

SEE THE MINI-REVIEW AT THE START OF THE Y* LISTINGS.

SEE THE NOTES TO THE Y*1(1915) AND Y*1(1940), WHICH
IMMEDIATELY PRECEDE AND FOLLOW THIS ENTRY.  HERE WE
LIST ONLY PARAMETERS OF PEAKS SEEN IN CROSS SECTIONS
AND INVARIANT-MASS DISTRIBUTIONS.  THE CROSS-SECTION PEAKS ARE ALMOST
CERTAINLY ASSOCIATED WITH THE F15 Y*1(1915) SEEN IN PARTIAL-WAVE
ANALYSES.  THE INVARIANT-MASS PEAKS SEEM MORE LIKELY TO BE ASSOCIATED
WITH THE NOT-COMPLETELY-ESTABLISHED D13 Y*1(1940).

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                    29  Y*1(1920) MASS (MEV) (PROD. EXP.)

M        CROSS-SECTION PEAKS --
M         1905.0      5.0             BUGG      68 CNTR    K-P, D TOTAL      11/66
M         1906.0      6.0             BRICMAN   70 CNTR  O TOTAL AND CH EX    6/70
M         1912.0     10.0             COOL      70 CNTR    K-P, D TOTAL      10/70
M        INVARIANT-MASS-DISTRIBUTION PEAKS --
M        (1942.0)    (9.0)            BOCK      65 HBC     PBAR P 5.7 BEV/C
M         1940.0     11.0             AGUILAR   70 HBC   + 3.9-4.6 GEV/C K-   5/70
M        ELASTIC DCS --                                                       2/73*
M   1     1931.       9.              DADO      72 HBC   O K-P ELSTC DCS      2/73*
M   1  G7 INDICATED BY LEGENDRE COEFFS.,G9 NOT RULED OUT.                     2/73*
M         . . . . . . . . .
M   AVERAGE MEANINGLESS (SCALE FACTOR = 1.9)

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                    29  Y*1(1920) WIDTH (MEV) (PROD. EXP.)

W        CROSS-SECTION PEAKS --
W          60.0      10.0             BUGG      68 CNTR                      11/66
W          50.0      12.0             BRICMAN   70 CNTR  O TOTAL AND CH EX    6/70
W         (30.0)                      COOL      70 CNTR    K-P, D TOTAL      10/70
W        INVARIANT-MASS-DISTRIBUTION PEAKS --
W         (36.0)    (20.0)   (36.0)   BOCK      65 HBC
W          90.0      20.0             AGUILAR   70 HBC   +  3.9-4.6 GEV/C K-  5/70
W        ELASTIC DCS --                                                       2/73*
W   1      70.       14.              DADO      72 HBC   O K-P ELSTC DCS      2/73*
W          . . . . . . . . . .
W   AVERAGE MEANINGLESS (SCALE FACTOR = 1.1)

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                    29  Y*1(1920) PARTIAL DECAY MODES (PROD. EXP.)

                                                             DECAY MASSES
P1      Y*1(1920) INTO KBAR N                                 497+ 939
P2      Y*1(1920) INTO LAMBDA PI                             1115+ 134
P3      Y*1(1920) INTO SIGMA PI                              1197+ 139

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                    29  Y*1(1920) BRANCHING RATIOS (PROD. EXP.)

R1      Y*1(1920) INTO (KBAR N)/TOTAL                       (P1)
R1          THESE VALUES OF ELASTICITIES ASSUME J=5/2 --
R1             0.06                   BUGG      68 CNTR    ASSUMING J=5/2     6/68
R1             0.07      0.02         BRICMAN   70 CNTR  O TOTAL AND CH EX    6/70
R1             0.07                   COOL      70 CNTR    K-P, D TOTAL      10/70
R1  1   THIS ELASTICITY ASSUMES J=7/2                                         2/73*
R1  1       .62       .08             DADO      72 HBC   O K-P ELSTC DCS      2/73*
R1          . . . . . . . . . .
R1  AVG     0.10      0.13    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 6.7)

R2      Y*1(1920) INTO (KBAR N)/(SIGMA PI)                  (P1)/(P3)
R2           (.37) OR LESS            BARNES    69 HBC   +  1 STAN. DEV.     10/69

R3      Y*1(1920) INTO (LAMBDA PI)/(SIGMA PI)               (P2)/(P3)
R3           (.28) OR LESS            BARNES    69 HBC   +  1 STAN. DEV.     10/69

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                         REFERENCES FOR Y*1(1920) (PROD. EXP.)

BOCK     65 PL 17 166         +COOPER,FRENCH,KINSON, +       (CERN,SACLAY) I
COOL     66 PRL 16 1228       +GIACOMELLI,KYCIA,LEONTIC,LI,LUNDBY,+ (BNL) I
   SUPERSEDED BY COOL 70.
BUGG     68 PR 168 1466       +GILMORE,KNIGHT,DAVIES+     (BIRM,CAVE,RHEL)I
BARNES   69 PRL 22 479        +FLAMINIO,MONTANET,SAMIOS +        (BNL+SYRA)

AGUILAR  70 PRL 25 58         AGUILAR-BENITEZ, BARNES, +          (BNL,SYRA)
BRICMAN  70 PL 31B 152        +FERRO LUZZI, PERREAU,+  (CERN,CAEN,SACLAY)
COOL     70 PR D1 1887        +GIACOMELLI, KYCIA, LEONTIC, LI, +     (BNL) I
DADO     72 PRL 29 1695       +BIRMAN,GOLDBERG,WEISS                 (HAIF)JP

                         PAPERS NOT REFERRED TO IN DATA CARDS

PRIMER   68 PRL 20 610        +GOLDBERG,JAEGER,BARNES,DORNAN + (SYRA,BNL)
    SUPERSEDED BY BARNES 69 AND AGUILAR-BENITEZ 70.
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Σ(1940) **D''_{13}**

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98  Y*1(1940, JP=3/2-) I=1

SEE THE MINI-REVIEW AT THE START OF THE Y* LISTINGS.

SUCH A RESONANCE IS SUGGESTED BY SOME BUT NOT ALL
PARTIAL-WAVE ANALYSES ACROSS THIS REGION.  UNTIL THERE
IS MORE EVIDENCE, WE OMIT THIS STATE FROM THE MAIN
BARYON TABLE.  THIS EFFECT IS PERHAPS ASSOCIATED WITH
THE BUMPS SEEN IN PRODUCTION EXPERIMENTS NEAR THIS
MASS.  SEE THE PRECEDING ENTRY.

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                    98  Y*1(1940) MASS (MEV)

M          1940.0     50.0            GALTIERI  70 DPWA    K- N TO LAM PI     7/70
M          1940.0     40.0            GALTIERI  70 DPWA    K-P TO SIGMA PI    7/70
M          1940.0     30.0            LITCHFIEL 70 DPWA    K- N TO LAM PI     7/70
M          1985.0     (5.0)           KANE      72 DPWA  O K-P TO PI SIG     10/71
M          1949.      40.      60.    VANHORN   72 DPWA  O K- P TO LAM PIO    2/73*
M          . . . . . . . . . . .
M   AVG    1941.4     19.9     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

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                    98  Y*1(1940) WIDTH (MEV)

W           200.0     50.0            GALTIERI  70 DPWA    K- N TO LAM PI     7/70
W           200.0     50.0            GALTIERI  70 DPWA    K-P TO SIGMA PI    7/70
W           280.0     40.0            LITCHFIEL 70 DPWA    K- N TO LAM PI     7/70
W           208.0    (22.0)           KANE      72 DPWA  O K-P TO PI SIG     10/71
W           160.      70.      40.    VANHORN   72 DPWA  O K- P TO LAM PIO    2/73*
W          . . . . . . . . . . .
W   AVG     220.9     26.7     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.1)

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                    98  Y*1(1940) PARTIAL DECAY MODES

                                                             DECAY MASSES
P1      Y*1(1940) INTO KBAR N                                 497+ 939
P2      Y*1(1940) INTO LAMBDA PI                             1115+ 139
P3      Y*1(1940) INTO SIGMA PI                              1197+ 139

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Baryons
Σ(1940), Σ(2000), Σ(2030)

Data Card Listings
For notation, see key at front of Listings.

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              98   Y*1(1940) BRANCHING RATIOS

R1      Y*1(1940) FROM KBAR N INTO LAMBDA PI                SQRT(P1*P2)
R1          -0.12      0.04              GALTIERI  70 DPWA    K- N TO LAM PI     7/70
R1          -0.14      0.03              LITCHFIEL 70 DPWA    K- N TO LAM PI     7/70
R1           -.05       .03       .02    VANHORN   72 DPWA  0 K-P TO LAM PIO     2/73*
R1                   . . . . . . . . .
R1  AVG MOD  0.093     0.030   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.7)

R2      Y*1(1940) FROM KBAR N INTO SIGMA PI                 SQRT(P1*P3)
R2          -0.12      0.03              GALTIERI  70 DPWA    K-P TO SIGMA PI    7/70
R2          -0.093    (0.006)            KANE      72 DPWA  0 K-P TO PI SIG     10/71

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                        REFERENCES FOR Y*1(1940)

GALTIERI 70 DUKE CONF 173        A BARBARO-GALTIERI                        (LRL)IJP
LITCHFIE 70 NP B22 269           P J LITCHFIELD                    (RUTHERFORD)IJP
KANE      72 PR D5 1583          D F KANE                                  (LBL)IJP
VANHORN  72 LBL-1370(THESIS)                                               /LBL IJP

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Σ(2000)   02 Y*1(2000, JP=1/2-) I=1   **S''' 11**

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              02  Y*1(2000) MASS (MEV)

M          2004.      40.              VANHORN   72 DPWA  0 K-P TO LAM PIO     2/73*

              02  Y*1(2000) WIDTH (MEV)

W           116.      40.              VANHORN   72 DPWA  0 K-P TO LAM PIO     2/73*

              02  Y*1(2000) PARTIAL DECAY MODES

                                                              DECAY MASSES
P1      Y*1(2000) INTO KBAR N                                 497+ 939
P2      Y*1(2000) INTO LAMBDA PI                              1115+ 134

              02  Y*1(2000) BRANCHING RATIOS

R1      Y*1(2000) FROM KBAR N INTO LAMBDA PI                SQRT(P1*P2)
R1                .07       .02       .01 VANHORN   72 DPWA  0 K-P TO LAM PIO     2/73*

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                        REFERENCES FOR Y*1(2000)

VANHORN  72 LBL-1370(THESIS)                                               /LBL IJP

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Σ(2030)   47 Y*1(2030, JP=7/2+) I=1   **F 17**

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          SEE THE MINI-REVIEW AT THE START OF THE Y* LISTINGS.

          THIS ENTRY ONLY INCLUDES RESULTS FROM PARTIAL-WAVE
          ANALYSES.  PARAMETERS OF PEAKS SEEN IN CROSS-SECTIONS
          AND INVARIANT-MASS DISTRIBUTIONS AROUND 2030 MEV ARE
    GIVEN IN THE NEXT ENTRY.  EVENTUALLY THE PARTIAL-WAVE ANALYSES SHOULD
    GIVE THE BEST RESULTS, AS THEY ISOLATE THE F17 WAVE.  THIS SUPERIORITY
    IS, HOWEVER, PROBABLY NOT YET ATTAINED, AND WE RELY ON BOTH ENTRIES
    FOR PARAMETERS GIVEN IN THE MAIN BARYON TABLE.

              47  Y*1(2030) MASS (MEV)

M       (2030.0)   (20.0)              WOHL      66 HBC   0 K-P TO LAM PIO     7/66
M        2032.0      6.0               SMART     68 DPWA -  K-N TO LAMBDA PI   6/68
M        2030.0     10.0               BERTHON   70 DPWA  0 K-P TO LAMBDA PI   7/70
M        2035.0     10.0               BERTHON1  70 DPWA  0 K-P TO SIGMA PI   10/70
M        2027.0      6.0               COX       70 DPWA -  K-N TO LAMBDA PI   6/70
M        2010.0     15.0               GALTIERI  70 DPWA  0 K-P TO LAMBDA PI   7/70
M        2000.0     20.0               GALTIERI  70 DPWA  0 K-P TO SIGMA PI    7/70
M        2022.0      4.0               LITCHFIEL 70 DPWA -0 K-N TO LAMBDA PI   6/70
M        2025.      15.                LITCHFIE  71 DPWA    K-P TO KBAR N     10/71
M        2034.0     14.0               KANE      72 DPWA  0 K-P TO PI SIG     10/71
M        2042.      11.                VANHORN   72 DPWA  0 K-P TO LAM PIO     2/73*
M              . . . . . . . . .
M   AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

              47  Y*1(2030) WIDTH (MEV)

W        (170.0)                       WOHL      66 HBC   0                    7/66
W         160.0     16.0               SMART     68 DPWA -  K-N TO LAMBDA PI   6/68
W         165.0     30.0      15.0     BERTHON   70 DPWA  0 K-P TO LAMBDA PI   7/70
W         150.0     20.0               BERTHON1  70 DPWA  0 K-P TO SIGMA PI   10/70
W         158.0     16.0               COX       70 DPWA -  K-N TO LAMBDA PI   6/70
W         115.0     15.0               GALTIERI  70 DPWA  0 K-P TO LAMBDA PI   7/70
W         100.0     40.0               GALTIERI  70 DPWA  0 K-P TO SIGMA PI    7/70
W         170.0     15.0               LITCHFIEL 70 DPWA -0 K-N TO LAMBDA PI   6/70
W         200.      30.                LITCHFIE  71 DPWA    K-P TO KBAR N     10/71
W         118.0     12.0               KANE      72 DPWA  0 K-P TO PI SIG     10/71
W         178.      13.                VANHORN   72 DPWA  0 K-P TO LAM PIO     2/73*
W              . . . . . . . . .
W   AVERAGE MEANINGLESS (SCALE FACTOR = 1.6)

              47  Y*1(2030) PARTIAL DECAY MODES

                                                              DECAY MASSES
P1      Y*1(2030) INTO KBAR N                                 497+ 939
P2      Y*1(2030) INTO LAMBDA PI                              1115+ 134
P3      Y*1(2030) INTO SIGMA PI                               1197+ 139
P4      Y*1(2030) INTO XI K                                   1321+ 497

              47  Y*1(2030) BRANCHING RATIOS

R1      Y*1(2030) INTO (KBAR N)/TOTAL                       (P1)
R1          (0.25)                         WOHL      66 HBC   0 K-P CH EX          7/66
R1   O      (0.11)                         DAUM      68 CNTR    K-P ELA,POL,SIGT   7/70
R1           0.17       0.04               CAMPBELL  71 DBC  -  K- NEUTRON ELAST   1/71
R1           0.18       0.02               LITCHFIE  71 DPWA    K-P TO KBAR N     10/71
R1   D   DAUM 68 ASSUMES (J+1/2)*P1 VALUE SEEN IN TOTAL CROSS SECTION.
R1              . . . . . . . . .
R1   AVG     0.178      0.018    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

R2      Y*1(2030) FROM KBAR N INTO LAMBDA PI                SQRT(P1*P2)
R2          (0.20)                         WOHL      66 HBC   0 K-P TO LAMBDA PI   7/66
R2          +0.21       0.01               SMART     68 DPWA -  K-N TO LAMBDA PI   6/68
R2          +0.2        0.02               BERTHON   70 DPWA  0 K-P TO LAMBDA PI   7/70
R2          +0.19       0.01               COX       70 DPWA -  K-N TO LAMBDA PI   6/70
R2          +0.16       0.03               GALTIERI  70 DPWA  0 K-P TO LAMBDA PI   7/70
R2          +0.20       0.008              LITCHFIEL 70 DPWA -0 K-N TO LAMBDA PI   6/70
R2            .20        .01               VANHORN   72 DPWA  0 K-P TO LAM PIO     2/73*
R2              . . . . . . . . .
R2   AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

R3      Y*1(2030) FROM KBAR N INTO SIGMA PI                 SQRT(P1*P3)
R3   L      (-0.09)    (0.02)              BERTHON1  70 DPWA  0 K-P TO SIGMA PI   10/70
R3          -0.052      0.010              GALTIERI  70 DPWA  0 K-P TO SIGMA PI    7/70
R3          -0.10       0.03               LITCHFIE  71 DPWA    K-P TO SIG PI      3/72
R3   L   LITCHFIELD 71 IS AN UPDATE OF BERTHON1 70                                 3/72
R3          -0.086      0.014              KANE      72 DPWA  0 K-P TO PI SIG     10/71
R3              . . . . . . . . .
R3   AVERAGE MEANINGLESS (SCALE FACTOR = 1.6)

R4      Y*1(2030) FROM KBAR N INTO XI K                     SQRT(P1*P4)
R4          (0.05) OR LESS                 TRIPP     67 RVUE  0 K-P TO XI K        8/67
R4          (0.05) OR LESS                 BURGUN    68 DPWA  0 K-P TO XI K       10/69
R4          (0.023)                        MULLER    69 DPWA  0                    7/70

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                        REFERENCES FOR Y*1(2030)

WOHL      66 PRL 17 107          C G WOHL, F T SOLMITZ, M L STEVENSON  (LRL)IJP
TRIPP     67 NP B3 10            + LEITH, +      (LRL,SLAC,CERN,HEIDEL,SACLAY)
BURGUN    68 NP B8 447           +MEYER,PAULI,TALLINI +        (SACL+CDEF+RHEL)
DAUM      68 NP B7 19            +ERNE,LAGNAUX,SENS,STEUER,UDO           (CERN)JP
     CONFIRMS THE SPIN-PARITY ASSIGNMENT.
SMART     68 PR 169 1336         W M SMART                               (LRL)IJP
MULLER    69 THESIS.UCRL 19372 R A MULLER                                (LRL)

BERTHON   70 NP B20 476          +RANGAN, VRANA, +(COL FRANCE, RHEL, SACLAY)IJP
BERTHON1  70 NP B24 417          +VRANA, BUTTERWORTH, + (CDEF, RHEL, SACLAY)IJP
COX       70 NP B19 61           +ISLAM, COLLEY, +        (BIRM,EDIN,GLAS,LOIC)IJP
GALTIERI  70 DUKE CONF 173       A BARBARO-GALTIERI                        (LRL)IJP
LITCHFIE  70 NP B22 269          P J LITCHFIELD                    (RUTHERFORD)IJP

CAMPBELL  71 NP B25 75           +MORTON, NEGUS, GOYAL, MILLER  (GLAS, LOIC)IJP
LITCHFIE  71 NP B30 125          LITCHFIELD,...+LESQUOY,+.. (RHEL+CDEF+SACL)IJP
KANE      72 PR D5 1583          D F KANE                                  (LBL)IJP
VANHORN   72 LBL-1370(THESIS)                                              /LBL IJP

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Σ(2030) BUMPS   28 Y*1(2030, JP=   ) I=1   PRODUCTION EXPERIMENTS

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          SEE THE MINI-REVIEW AT THE START OF THE Y* LISTINGS.

          SEE THE NOTE TO THE F17 Y*1(2030), WHICH PRECEDES THIS
          ENTRY.  HERE WE LIST ONLY PARAMETERS OF PEAKS IN CROSS
          SECTIONS AND INVARIANT-MASS DISTRIBUTIONS.  THE CROSS-
    SECTION PEAKS ARE AT LEAST DOMINANTLY ASSOCIATED WITH THE Y*1(2030),
    BUT MAY CONTAIN A SMALL CONTRIBUTION FROM THE SUGGESTED BUT NOT ESTAB-
    LISHED OTHER RESONANCES IN THIS REGION.

              28  Y*1(2030) MASS (MEV) (PROD. EXP.)

M        (2022.0)   (20.0)             BLANPIED  65 CNTR  0 GAMMA P TO K+ Y*
M         2020.0      7.0              BUGG      68 CNTR    K-P, D TOTAL       6/68
M         2049.0      4.0              BRICMAN   70 CNTR  0 TOTAL AND CH EX    6/70
M         2025.0     10.0              COOL      70 CNTR    K-P, D TOTAL      10/70
M        (2025.0)   (20.0)             LU        70 CNTR  0 GAMMA P TO K+ Y*   1/71
M              . . . . . . . . .
M   AVERAGE MEANINGLESS (SCALE FACTOR = 2.8)

              28  Y*1(2030) WIDTH (MEV) (PROD. EXP.)

W        (120.0)    (20.0)             BLANPIED  65 CNTR  0
W         130.0     10.0               BUGG      68 CNTR                       6/68
W         126.0     11.0               BRICMAN   70 CNTR  0 TOTAL AND CH EX    6/70
W         165.0                        COOL      70 CNTR    K-P, D TOTAL      10/70
W         (80.0)                       LU        70 CNTR  0 GAMMA P TO K+ Y*   1/71
W              . . . . . . . . .
W   AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

              28  Y*1(2030) PARTIAL DECAY MODES (PROD. EXP.)

                                                              DECAY MASSES
P1      Y*1(2030) INTO KBAR N                                 497+ 939
P2      Y*1(2030) INTO KBAR N PI                              497+ 939+ 139
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                    28  Y*1(2030) BRANCHING RATIOS (PROD. EXP.)

R1      Y*1(2030) INTO (KBAR N)/TOTAL                       (P1)
R1         THESE VALUES OF ELASTICITIES ASSUME J=7/2 --
R1            0.131                   BUGG       68 CNTR                    6/68
R1            0.27     (0.02)         BRICMAN    70 CNTR   0 TOTAL AND CH EX   6/70
R1            0.12                    COOL       70 CNTR     K-P, D TOTAL     10/70

R2      Y*1(2030) INTO KBAR N PI                            (P2)
R2               SEEN                 BOCK       HBC

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                    REFERENCES FOR Y*1(2030) (PROD. EXP.)

BLANPIED 65 PRL 14 741       +GREENBERG,HUGHES,KITCHING,LU,+ (YALE(CEA))
COOL     66 PRL 16 1228      +GIACOMELLI,KYCIA,LEONTIC,LI,LUNDBY,+ (BNL) I
   SUPERSEDED BY COOL 70.
BUGG     68 PR 168 1466      +GILMORE,KNIGHT, +          (RHEL,BIRM,CAVE) I

BRICMAN  70 PL 31B 152       +FERRO LUZZI, PERREAU,+  (CERN,CAEN,SACLAY)
COOL     70 PR D1 1887       +GIACOMELLI, KYCIA, LEONTIC, LI, +    (BNL) I
LU       70 PR D2 1846       +GREENBERG, HUGHES, MINEHART, MORI,+ (YALE)

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Σ(2070) → F''15

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                    34  Y*1(2070, JP=5/2+) I=1

                    THIS STATE HAS BEEN SUGGESTED BY ONLY ONE PARTIAL
                    WAVE ANALYSIS ACROSS THIS REGION. IT NEEDS CONFIRMATION
                    THE RESONANCE PROPOSED BY KANE IS TOO BROAD TO
                    BE USED AS EVIDENCE.

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                    34  Y*1(2070) MASS (MEV)

M          (2070.)    (10.)           BERTHON1   70 DPWA -  K- P TO SIG PI     1/71
M          (2057.0)                   KANE       72 DPWA    K-P TO SIGMA PI    1/73*

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                    34  Y*1(2070) WIDTH (MEV)

W          (140.)     (20.)           BERTHON1   70 DPWA -  K- P TO SIG PI     1/71
W          (906.0)                    KANE       72 DPWA    K-P TO SIGMA PI    1/73*

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                    34  Y*1(2070) PARTIAL DECAY MODES

                                                              DECAY MASSES
P1      Y*1(2070) INTO KBAR N                               497+ 939
P2      Y*1(2070) INTO SIGMA PI                            1197+ 139

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                    34  Y*1(2070) BRANCHING RATIOS

R1      Y*1(2070) FROM KBAR N TO SIGMA                  SQRT(P1*P2)
R1          (+.12)    (.02)           BERTHON1   70 DPWA -  K- P TO SIG PI     1/71
R1          (+0.104)                  KANE       72 DPWA    K-P TO SIGMA PI    1/73*

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                    REFERENCES FOR Y*1(2070)

BERTHON1 70 NP B24 417       +VRANA,BUTTERWORTH,+    (CDEF,RHEL,SACLAY)IJP
KANE     72 PR D5 1583       D F KANE                              (LBL)

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Σ(2080) → P'''13

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                    88  Y*1(2080, JP=3/2+) I=1

                    SEE THE MINI-REVIEW AT THE START OF THE Y* LISTINGS.

                    SUCH A RESONANCE IS SUGGESTED BY SOME BUT NOT ALL
                    PARTIAL-WAVE ANALYSES ACROSS THIS REGION.  UNTIL THERE
                    IS MORE EVIDENCE, WE OMIT THIS STATE FROM THE MAIN
                    BARYON TABLE.

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                    88  Y*1(2080) MASS (MEV)

M          (2082.0)   (4.0)           COX        70 DPWA -  K- N TO LAM PI     6/70
M          (2070.0)   (30.0)          LITCHFIEL  70 DPWA -0 K- N TO LAM PI     6/70

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                    88  Y*1(2080) WIDTH (MEV)

W          (87.0)     (20.0)          COX        70 DPWA -  K- N TO LAM PI     6/70
W          (250.0)    (40.0)          LITCHFIEL  70 DPWA -0 K- N TO LAM PI     6/70

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                    88  Y*1(2080) PARTIAL DECAY MODES

                                                              DECAY MASSES
P1      Y*1(2080) INTO KBAR N                               497+ 939
P2      Y*1(2080) INTO LAMBDA PI                           1115+ 139

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                    88  Y*1(2080) BRANCHING RATIOS

R1      Y*1(2080) FROM KBAR N TO LAMBDA PI              SQRT(P1*P2)
R1          (-0.16)   (0.03)          COX        70 DPWA -  K- N TO LAM PI     6/70
R1          (-0.09)   (0.03)          LITCHFIEL  70 DPWA -0 K- N TO LAM PI     6/70

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                    REFERENCES FOR Y*1(2080)

COX      70 NP B19 61        +ISLAM, COLLEY, +      (BIRM,EDIN,GLAS,LOIC)IJP
LITCHFIE 70 NP B22 269       P J LITCHFIELD                (RUTHERFORD)IJP

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Σ(2100) → G17

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                    26  Y*1(2100, JP=7/2-) I=1

                    SEE THE MINI-REVIEW AT THE START OF THE Y* LISTINGS.

                    SUCH A RESONANCE IS SUGGESTED BY SOME BUT NOT ALL
                    PARTIAL-WAVE ANALYSES ACROSS THIS REGION.  UNTIL THERE
                    IS MORE EVIDENCE, WE OMIT THIS STATE FROM THE MAIN
                    BARYON TABLE.

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                    26  Y*1(2100) MASS (MEV)

M          (2060.0)   (20.0)          GALTIERI   70 DPWA   0 K-P TO LAMBDA PI   7/70
M          (2120.0)   (30.0)          GALTIERI   70 DPWA   0 K-P TO SIGMA PI    7/70

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                    26  Y*1(2100) WIDTH (MEV)

W          (70.0)     (30.0)          GALTIERI   70 DPWA   0 K-P TO LAMBDA PI   7/70
W          (135.0)    (30.0)          GALTIERI   70 DPWA   0 K-P TO SIGMA PI    7/70

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                    26  Y*1(2100) PARTIAL DECAY MODES

                                                              DECAY MASSES
P1      Y*1(2100) INTO KBAR N                               497+ 939
P2      Y*1(2100) INTO LAMBDA PI                           1115+ 134
P3      Y*1(2100) INTO SIGMA PI                            1197+ 139

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                    26  Y*1(2100) BRANCHING RATIOS

R1      Y*1(2100) FROM KBAR N TO LAMBDA PI              SQRT(P1*P2)
R1          (-0.07)   (0.02)          GALTIERI   70 DPWA   0 K-P TO LAMBDA PI   7/70

R2      Y*1(2100) FROM KBAR N TO SIGMA PI               SQRT(P1*P3)
R2          (+0.13)   (0.02)          GALTIERI   70 DPWA   0 K-P TO SIGMA PI    7/70

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                    REFERENCES FOR Y*1(2100)

GALTIERI 70 DUKE CONF 173    A BARBARO-GALTIERI                    (LRL)IJP

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Σ(2250) BUMPS

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                    48  Y*1(2250, JP=    ) I=1        PRODUCTION EXPERIMENTS

                    SEE THE MINI-REVIEW AT THE START OF THE Y* LISTINGS.

                    THE PHASE-SHIFT-ANALYSIS RESULTS ARE TOO WEAK TO
                    WARRANT SEPARATING THEM FROM THE PRODUCTION AND CROSS-
                    SECTION EXPERIMENTS. IN AN ANALYSIS OF ELASTIC AND
                    POLARIZATION DATA, DAUM 68 COULD NOT EXCLUDE ANY
        POSSIBILITY FROM JP= 5/2+- TO JP= 11/2+- FOR THIS STATE. BRICMAN 70
        SUGGESTS 7I2-. VANHORN72 CLAIMS 5/2+.

        LASINSKI 71 SUGGESTS TWO RESONANCES IN THIS REGION USING A POMERON
        + RESONANCES MODEL.

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                    48  Y*1(2250) MASS (MEV) (PROD. EXP.)

M          (2245.0)                   BLANPIED  65 CNTR    GAMMA P TO K+ Y*
M          (2299.0)    (6.0)          BOCK      65 HBC     PBAR P 5.7 BEV/C
M           2250.0      7.0           BUGG      68 CNTR    K-P, D TOTAL      6/68
M           2280.      14.0           AGUILAR   70 HBC  +  K- 3.9-4.6 GEV/C  5/70
M           2237.0     11.0           BRICMAN   70 CNTR  0 TOTAL AND CH EX   6/70
M           2255.0     10.0           COOL      70 CNTR    K-P, D TOTAL     10/70
M          (2250.0)   (20.0)          LU        70 CNTR  0 GAMMA P TO K+ Y*  1/71
M    V      2251.      30.      20.   VANHORN   72 DPWA  0 K-P TO LAM PIO    2/73*
M    V    VANHORN72 VALUE FROM A DPWA THAT FINDS JP=5/2+.
M         . . . . . . . . . .
M    AVERAGE MEANINGLESS (SCALE FACTOR = 1.2)

------ --------- --------- --------- --------- --------- --------- --------

                    48  Y*1(2250) WIDTH (MEV) (PROD. EXP.)

W          (150.0)                    BLANPIED  65 CNTR    GAMMA P TO K+ Y*
W           (21.0)    (17.0)   (21.0) BOCK      65 HBC     PBAR P 5.7 GEV/C
W           230.0      20.0           BUGG      68 CNTR    K-P, D TOTAL      6/68
W           100.0      20.0           AGUILAR   70 HBC  +  K- 3.9-4.6 GEV/C  5/70
W           164.0      50.0           BRICMAN   70 CNTR  0 TOTAL AND CH EX   6/70
W          (170.0)                    COOL      70 CNTR    K-P, D TOTAL     10/70
W          (125.0)                    LU        70 CNTR  0 GAMMA P TO K+ Y*  1/71
W    V      192.       30.            VANHORN   72 DPWA  0 K-P TO LAM PIO    2/73*
W         . . . . . . . . . .
W   AVG     169.5      33.4      AVERAGE (ERROR INCLUDES SCALE FACTOR OF 2.7)
               SEE THE NOTES ACCOMPANYING THE MASSES QUOTED

------ --------- --------- --------- --------- --------- --------- --------

                    48  Y*1(2250) PARTIAL DECAY MODES (PROD. EXP.)

                                                              DECAY MASSES
P1      Y*1(2250) INTO KBAR N                               497+ 939
P2      Y*1(2250) INTO LAMBDA PI                           1115+ 134
P3      Y*1(2250) INTO SIGMA PI                            1197+ 139
P4      Y*1(2250) INTO KBAR N PI                            497+ 939+ 139

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Baryons

Data Card Listings

Σ(2250), Σ(2455), Σ(2620), Σ(3000), EX. HYPE.

For notation, see key at front of Listings.

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                    48  Y*1(2250) BRANCHING RATIOS (PROD. EXP.)

R1     Y*1(2250) INTO (KBAR N)/TOTAL                     (P1)
R1         J IS NOT KNOWN.  THE FOLLOWING IS (J+1/2)*P1.
R1            (0.47)                  BUGG       68 CNTR                       6/68
R1            (0.16),  (0.12)         BRICMAN    70 CNTR   0 TOTAL AND CH EX   6/70
R1            (0.42)                  COOL       70 CNTR     K-P, D TOTAL     10/70

R2     Y*1(2250) FROM KBAR N TO LAMBDA PI               SQRT(P1*P2)
R2         THE FOLLOWING ASSUMES JP=9/2-. DATA INSUF. FOR DETERM. THIS AMP.
R2            (-0.18)                 GALTIERI   70 DPWA     K-P TO LAMBDA PI 10/70
R2   V         -.16        .03        VANHORN    72 DPWA   0 K-P TO LAM PI0    2/73*
             SEE THE NOTES ACCOMPANYING THE MASSES QUOTED

R3     Y*1(2250) FROM KBAR N TO SIGMA PI                SQRT(P1*P3)
R3         THE FOLLOWING ASSUMES JP=9/2-. DATA INSUF. FOR DETERM. THIS AMP.
R3            (+0.07)                 GALTIERI   70 DPWA     K-P TO SIGMA PI  10/70

R4     Y*1(2250) INTO (KBAR N)/(SIGMA PI)               (P1)/(P3)
R4            (0.18) OR LESS          BARNES     69 HBC   +  1 STAN DEV LIMIT 10/69

R5     Y*1(2250) INTO (LAMBDA PI)/(SIGMA PI)            (P2)/(P3)
R5            (0.18) OR LESS          BARNES     69 HBC   +  1 STAN DEV LIMIT 10/69
****** ********* ********* ********* ********* ********* ********* ********
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                     REFERENCES FOR Y*1(2250) (PROD. EXP.)

BLANPIED 65 PRL 14 741        +GREENBERG,HUGHES,KITCHING, +    (YALE(CEA))
BOCK     65 PL  17 166        +COOPER,FRENCH,KINSON, +        (CERN,SACLAY)
BUGG     68 PR 168 1466       +GILMORE,KNIGHT, +           (RHEL,BIRM,CAVE) I
BARNES   69 PRL 22 479        +FLAMINIO,MONTANET,SAMIOS +       (BNL+SYRA)

AGUILAR  70 PRL 25 58         AGUILAR-BENITEZ, BARNES, +        (BNL,SYRA)
BRICMAN  70 PL 31B 152        +FERRO LUZZI, PERREAU,+  (CERN,CAEN,SACLAY)
COOL     70 PR D1 1887        +GIACOMELLI, KYCIA, LEONTIC, LI, +    (BNL) I
GALTIERI 70 DUKE CONF 173     A BARBARO-GALTIERI                    (LRL)IJP
LU       70 PR D2 1846        +GREENBERG, HUGHES, MINEHART, MORI,+ (YALE)
VANHORN  72 LBL-1370(THESIS)                                        /LBL IJP

                     PAPERS NOT REFERRED TO IN DATA CARDS

COOL     66 PRL 16 1228       +GIACOMELLI,KYCIA,LEONTIC,LI,LUNDBY,+ (BNL) I
    SUPEREDED BY COOL 70.
DAUBER   66 PL 23 154         +SCHLEIN, SLATER, STORK, TICHO  (UCLA(LRL)) J
    SUGGESTS J=9/2 RESONANT BEHAVIOR IN SIGMA- PI+, BUT APPEARS
         INCONSISTENT WITH PARAMETERS OF COOL 66.
DAUM     68 NP B7 19          +ERNE, LAGNAUX, SENS, STEUER, UDO    (CERN)JP
LASINSKI 71 NP  B29  125      T A LASINSKI                          (EFI)IJP
****** ********* ********* ********* ********* ********* ********* ********
****** ********* ********* ********* ********* ********* ********* ********
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Σ(2455) BUMPS

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                 53  Y*1(2455, JP=      ) I=1        PRODUCTION EXPERIMENTS

                 SEE THE MINI-REVIEW AT THE START OF THE Y* LISTINGS.
                 THERE IS ALSO SOME SLIGHT EVIDENCE FOR Y* STATES IN
     THIS MASS REGION FROM THE REACTION GAMMA + P TO K+ + MISSING MASS --
     SEE GREENBERG 68.
------ --------- --------- --------- --------- --------- --------- --------

                    53  Y*1(2455) MASS (MEV) (PROD. EXP.)

M            2455.0      7.0          BUGG       68 CNTR     K-P, D TOTAL      6/68
M            2455.0     10.0          ABRAMS     70 CNTR     K-P, D TOTAL     10/70
M            . . . . . . . . .
M    AVG     2455.0      5.7      AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
------ --------- --------- --------- --------- --------- --------- --------

                    53  Y*1(2455) WIDTH (MEV) (PROD. EXP.)

W             100.0     20.0          BUGG       68 CNTR                       6/68
W             140.0                   ABRAMS     70 CNTR     K-P, D TOTAL     10/70
------ --------- --------- --------- --------- --------- --------- --------

                    53  Y*1(2455) PARTIAL DECAY MODES (PROD. EXP.)

                                                               DECAY MASSES
P1     Y*1(2455) INTO KBAR N                                   497+ 939
------ --------- --------- --------- --------- --------- --------- --------

                    53  Y*1(2455) BRANCHING RATIOS (PROD. EXP.)

R1     Y*1(2455) INTO (KBAR N)/TOTAL                     (P1)
R1         J IS NOT KNOWN.  THE FOLLOWING IS (J+1/2)*P1.
R1            (0.3)                   BUGG       68 CNTR                       6/68
R1             0.39                   ABRAMS     70 CNTR     K-P, D TOTAL     10/70
R1   C        (0.05)   (0.05)         BRICMAN    70 CNTR   0 TOTAL AND CH EX   6/70
R1   C     FIT OF TOTAL CROSS SECTION GIVEN BY BRICMAN 70 IS POOR IN
R1   C     THIS REGION.
****** ********* ********* ********* ********* ********* ********* ********
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                     REFERENCES FOR Y*1(2455) (PROD. EXP.)

BUGG     68 PR 168 1466       +GILMORE,KNIGHT, +           (RHEL,BIRM,CAVE) I
ABRAMS   70 PR 1D 1917        +COOL, GIACOMELLI, KYCIA, LEONTIC, +  (BNL) I
BRICMAN  70 PL 31B 152        +FERRO LUZZI, PERREAU,+  (CERN,CAEN,SACLAY)

                     PAPERS NOT REFERRED TO IN DATA CARDS

ABRAMS   67 PRL 19 678        +COOL,GIACOMELLI,KYCIA,LEONTIC,LI, +  (BNL)
    SUPERSEDED BY ABRAMS 70.
GREENBER 68 PRL 20 221        GREENBERG, HUGHES, LU, MINEHART, +    (YALE)
****** ********* ********* ********* ********* ********* ********* ********
****** ********* ********* ********* ********* ********* ********* ********
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Σ(2620) BUMPS

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                 54  Y*1(2620, JP=      ) I=1        PRODUCTION EXPERIMENTS
                 SEE THE MINI-REVIEW AT THE START OF THE Y* LISTINGS.
------ --------- --------- --------- --------- --------- --------- --------

                    54  Y*1(2620) MASS (MEV) (PROD. EXP.)

M            2620.0     15.0          ABRAMS     70 CNTR     K-P, D TOTAL     10/70
------ --------- --------- --------- --------- --------- --------- --------

                    54  Y*1(2620) WIDTH (MEV) (PROD. EXP.)

W            (175.0)                  ABRAMS     70 CNTR     K-P, D TOTAL     10/70
------ --------- --------- --------- --------- --------- --------- --------

                    54  Y*1(2620) PARTIAL DECAY MODES (PROD. EXP.)

                                                               DECAY MASSES
P1     Y*1(2620) INTO KBAR N                                   497+ 939
------ --------- --------- --------- --------- --------- --------- --------

                    54  Y*1(2620) BRANCHING RATIOS (PROD. EXP.)

R1     Y*1(2620) INTO (KBAR N)/TOTAL                     (P1)
R1         J IS NOT KNOWN.  THE FOLLOWING IS (J+1/2)*P1.
R1            (0.32)                  ABRAMS     70 CNTR     K-P, D TOTAL     10/70
R1             0.36     0.12          BRICMAN    70 CNTR   0 TOTAL AND CH EX   6/70
****** ********* ********* ********* ********* ********* ********* ********
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                     REFERENCES FOR Y*1(2620) (PROD. EXP.)

ABRAMS   67 PRL 19 678        +COOL,GIACOMELLI,KYCIA,LEONTIC,LI, +  (BNL)
    SUPERSEDED BY ABRAMS 70.
ABRAMS   70 PR 1D 1917        +COOL, GIACOMELLI, KYCIA, LEONTIC, +  (BNL) I
BRICMAN  70 PL 31B 152        +FERRO LUZZI, PERREAU,+  (CERN,CAEN,SACLAY)
****** ********* ********* ********* ********* ********* ********* ********
****** ********* ********* ********* ********* ********* ********* ********
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Σ(3000) BUMPS →

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                 59  Y*1(3000, JP=      ) I=1        PRODUCTION EXPERIMENTS

                 SEE THE MINI-REVIEW AT THE START OF THE Y* LISTINGS.

                 ENHANCEMENT IN LAMBDA PI AND KBAR N INVARIANT MASS
                 SPECTRA AND IN MISSING MASS OF NEUTRALS RECOILING
                 AGAINST K0.  EVIDENCE NOT CONCLUSIVE.  OMITTED FROM
                 TABLE.
------ --------- --------- --------- --------- --------- --------- --------

                    59  Y*1(3000) MASS (MEV) (PROD. EXP.)

M           (3000.0)                  EHRLICH    66 HBC    0 PI-P 7.91 BEV/C   9/66
------ --------- --------- --------- --------- --------- --------- --------

                    59  Y*1(3000) PARTIAL DECAY MODES (PROD. EXP.)

                                                               DECAY MASSES
P1     Y*1(3000) INTO KBAR N                                   497+ 939
P2     Y*1(3000) INTO LAMBDA PI                               1115+ 139
****** ********* ********* ********* ********* ********* ********* ********
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                     REFERENCES FOR Y*1(3000) (PROD. EXP.)

EHRLICH  66 PR 152 1194       R EHRLICH, W SELOVE, H YUTA     (PENN(BNL)) I
****** ********* ********* ********* ********* ********* ********* ********
****** ********* ********* ********* ********* ********* ********* ********
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EXOTIC HYPERON CROSS SECTION LIMITS

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        THIS IS NOT A COMPLETE LIST. WE WILL TABULATE EXOTICS FROM NOW ON

CS   UNITS MICROBARNS
CS   G         (20.)    OR LESS          GALTIERI  68 DBC     K-N TO SG-PI-PI0  7/70
CS   G   ABOVE LIMIT FOR MASS <  2.15 GEV AND GAMMA  < 60 MEV- (2.1 GEV/C K-)  7/70
CS   A         (40.)    OR LESS          GALTIERI  68 DBC  -- K-N TO SG-PI-PI0  7/70
CS   A   ABOVE LIMIT FOR MASS <  2.3 GEV AND GAMMA  < 120 MEV- (2.7 GEV/C K-)  7/70
****** ********* ********* ********* ********* ********* ********* ********
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                     REFERENCES FOR EXOTIC HYPERONS

GALTIERI 68 PRL 21 573        A.BARBARO-GALTIERI,CHADWICK +     (LRL+SLAC)
****** ********* ********* ********* ********* ********* ********* ********
****** ********* ********* ********* ********* ********* ********* ********
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Data Card Listings

For notation, see key at front of Listings.

Baryons

Ξ⁻, Ξ⁰, Ξ(1530)

Ξ Resonances

The Ξ resonance situation has long been and will probably long remain unsettled. This is because 1) they can only be produced as part of a final state, $K^- + p \rightarrow \Xi^* +$ others, and 2) they are so produced with very small cross sections (<50 μb). Thus the numbers of events available are small, and the analysis is more complicated than if direct formation were possible. Only the Ξ (1530) is really well established. There are at least two Ξ states in the 1800-2000 MeV region and there are indications of several more above 2000 MeV, but the situation is very unclear. We are forced to group together rather disparate observations and await new results. Figures in the listings point out disagreements among various experiments. The table following this note gives our evaluation of the status of the Ξ resonances, based on the meager data available at this time.

STATUS OF XI* RESONANCES

THOSE WITH AN OVERALL STATUS OF *** OR **** ARE INCLUDED IN THE MAIN BARYON TABLE. THE OTHERS AWAIT CONFIRMATION.

PARTICLE	LIJ	OVERALL STATUS	STATUS AS SEEN IN — XI PI	LAM K	SIG K	XI* PI	OTHER CHANNELS
XI(1320)	P11	****					WEAK TO LAM PI
XI(1530)	P13	****	****				
XI(1630)		**	**				
XI(1820)		***	***	***	**	***	
XI(1940)		***	***			***	
XI(2030)		**		**	**		3-BODY DECAYS
XI(2250)		*					3-BODY DECAYS
XI(2500)		**		**	**		3-BODY DECAYS

```
****  GOOD, CLEAR, AND UNMISTAKABLE.
 ***  GOOD, BUT IN NEED OF CLARIFICATION OR NOT ABSOLUTELY CERTAIN.
  **  NEEDS CONFIRMATION.
   *  WEAK.
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****** ********* ********* ********* ********* ********* ********* ********
****** ********* ********* ********* ********* ********* ********* ********
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Ξ⁻

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22  XI- (1321, JP=1/2 ) I=1/2

SEE STABLE PARTICLE DATA CARD LISTINGS
```

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****** ********* ********* ********* ********* ********* ********* ********
****** ********* ********* ********* ********* ********* ********* ********
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Ξ⁰

```
23  XI0 (1314, JP=1/2 ) I=1/2

SEE STABLE PARTICLE DATA CARD LISTINGS
```

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****** ********* ********* ********* ********* ********* ********* ********
****** ********* ********* ********* ********* ********* ********* ********
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Ξ(1530) **P_{13}**

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49  XI*1/2(1530, JP=3/2+) I=1/2

THIS IS THE ONLY REALLY WELL-ESTABLISHED XI*.  THE
QUANTUM NUMBERS 3/2+ ARE FAVORED BY THE DATA.

   WE DO NOT USE  DETERMINATIONS OF THE MASS AND THE WIDTH OF THIS
STATE UNLESS THEY ARE ACCOMPANIED BY SOME DISCUSSION OF SYSTEMATICS
AND RESOLUTION.
```

```
                    49  XI*1/2(1530) MASS (MEV)

M        55(1529.0)    (5.0)            PJERROU   62 HBC  -0 K-P 1.8 GEV/C
M          (1532.0)    (2.0)            BADIER    64 HBC  -0 K-P 3 GEV/C
M-       38 1535.7      3.2             LONDON    66 HBC  -  K-P 2.24 GEV/C     7/66
M-      334 1534.7      1.1             BALTAY    72 HBC  -  K-P 1.75 GEV       1/73*
M-      185 1536.2      1.6             KIRSCH    72 HBC  -  K-P 2.87GEV/C      2/72
M-          . . . . . . . . . . .
M-  AVG     1535.22     0.87    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
M-  FIT     1535.05     0.62   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)
MO       76 1528.7      1.1             LONDON    66 HBC   0 K-P 2.24 GEV/C     7/66
MO       59 1531.4      0.8             BADIER    72 HBC   0 K-P AT 3.95GEV/C 10/71
MO     1262 1532.0      0.4             BALTAY    72 HBC   0 K-P 1.75 GEV       1/73*
MO      324 1531.3      0.6             BORENSTEI 72 HBC   0 K-P 2.2GEV/C       2/72
MO      286 1532.3      0.7             KIRSCH    72 HBC   0 K-P 2.87GEV/C      2/72
MO          . . . . . . . . . . .
MO  AVG     1531.63     0.41    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.5)
MO  FIT     1531.64     0.35   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.3)

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               49  (XI*-) - (XI*0) MASS DIFFERENCE (MEV)

D              5.7      3.0             PJERROU   65 HBC  -0 1.8-1.95 GEV/C     7/66
D   R        (7.0)    (4.0)             LONDON    66 HBC  -0 2.24 GEV/C         7/66
D              2.0      3.2             MERRILL   66 HBC  -0 1.7-2.7 GEV/C      7/66
D              2.7      1.0             BALTAY    72 HBC  -0 K-P 1.75 GEV       1/73*
D              3.9      1.8             KIRSCH    72 HBC  -0 K- P 2.8 GEV/C     2/72
D           . . . . . . . . . . .
D   AVG       3.12      0.81    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
D   FIT       3.41      0.61   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

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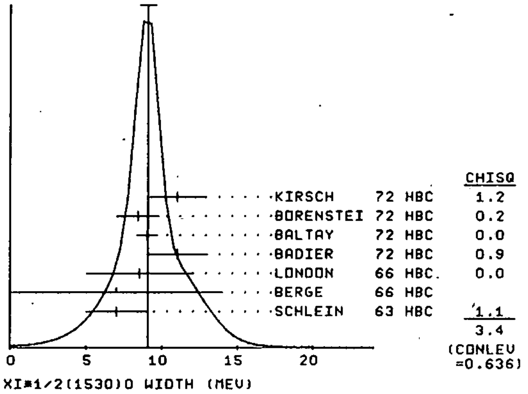
                    49  XI*1/2(1530) WIDTH (MEV)

WO             7.0      2.0             SCHLEIN   63 HBC   0 1.8, 1.95 GEV/C
WO             7.0      7.0             BERGE     66 HBC   0 1.5-1.7 GEV/C      7/66
WO             8.5      3.5             LONDON    66 HBC   0 2.24 GEV/C         7/66
WO            11.0      2.0             BADIER    72 HBC   0 K-P AT 3.95GEV/C 10/71
WO             9.0      0.7             BALTAY    72 HBC   0 K-P 1.75 GEV       1/73*
WO             8.4      1.4             BORENSTEI 72 HBC   0 XI- PI+ MODE       2/72
WO            11.0      1.8             KIRSCH    72 HBC   0 XI- PI+            2/72
WO          . . . . . . . . . . .
WO  AVG       9.07      0.54    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
                        (SEE IDEOGRAM BELOW )
```

WEIGHTED AVERAGE = 9.07 ± 0.54
ERROR SCALED BY 1.0




```
W-             7.8      3.5      7.8    BALTAY    72 HBC  -  K-P 1.75 GEV       1/73*
W-            16.2      4.6             KIRSCH    72 HBC  -  XI- PI0,XI0 PI-    2/72
W-          . . . . . . . . . . .
W-  AVG       12.9      4.1     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.2)

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                 49  XI*1/2(1530) PARTIAL DECAY MODES

                                                             DECAY MASSES
P1     XI*1/2(1530) INTO XI PI                                1321+ 139

     OTHER STRONG DECAYS ARE FORBIDDEN BY ENERGY CONSERVATION.

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                             REFERENCES FOR XI*1/2(1530)

PJERROU  62 PRL 9 114         +PROWSE,SCHLEIN,SLATER,STORK,TICHO   (UCLA) I
SCHLEIN  63 PRL 11 167        +CARMONY,PJERROU,SLATER,STORK,TICHO  (UCLA)IJP
BADIER   64 DUBNA I 593       +DEMOULIN,GOLDBERG, +    (EPOL,SACLAY,AMST) I
PJERROU  65 PRL 14 275        +SCHLEIN,SLATER,SMITH,STORK,TICHO    (UCLA)

BERGE    66 PR 147 945        +EBERHARD,HUBBARD,MERRILL,B-SHAFER,+  (LRL) I
LONDON   66 PR 143 1034       +RAU,SAMIOS,YAMAMOTO,GOLDBERG,+  (BNL,SYRA) IJ
MERRILL  66 UCRL-16455 THESIS D W MERRILL                           (LRL) JP

BADIER   72 NP B37 429        +BARRELET,CHARLTON,VIDEAU            (EPOL)
BALTAY   72 PL 42B 129        +BRIDGEWATER,COOPER,GERSHWIN,+   (COLU+BING)
BORENSTE 72 PR D5 1559        BORENSTEIN,DANBURG,KALBFLEISCH++ (BNL,MICH) I
KIRSCH   72 NP B40 349        SCHMIDT+CHANG,HEMINGWAY(BRAN,UMD,SYRA,TUFT) I

                             PAPERS NOT REFERRED TO IN DATA CARDS

SHAFER   66 PR 142 883        BUTTON-SHAFER,LINDSEY,MURRAY,SMITH    (LRL) JP
    A SPIN-PARITY DETERMINATION.
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****** ********* ********* ********* ********* ********* ********* ********
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Baryons
Ξ(1630), Ξ(1820)

Data Card Listings
For notation, see key at front of Listings.

Ξ(1630)

21 XI*1/2(1630, JP=) I=1/2

THIS EFFECT NEEDS CONFIRMATION.
THIS IS A 3- OR 4-STANDARD-DEVIATION BUMP SEEN IN ONE CHANNEL IN ONE EXPERIMENT. BARTSCH 69 SEE A SMALL,BROAD ENHANCEMENT NEAR 1650 MEV - IT IS NOT CLEAR THAT IT IS THE SAME PHENOMENON AS BMST 70, WHO FIND CS=3.6+-1.6 MICROBARNS AT 2.87 GEV/C INCIDENT K- MOMENTUM.
BORENSTEIN 72 SEE NO EFFECT IN THIS REGION. THEY FIND CR < 2 MUB AT 2.18.
ROSS 72 ARGUE THAT THE EFFECT THEY SEE IS NOT THE SAME AS THAT SEEN BY BMST 70. ROSS 72 FIND CS= 2+-1 MICROBARNS AT 3.3 GEV/C

21 XI*1/2(1630) MASS (MEV)

M		40	1635.	10.	BMST	70 HBC	0 INTO XI- PI+	7/70
M		29	1606.	6.	ROSS	72 HBC	0 K-P AT 3.1-3.7	3/72
M			. . . .					
M	AVG		1613.7	12.8	AVERAGE (ERROR INCLUDES SCALE FACTOR OF 2.5)			

21 XI*1/2(1630) WIDTH (MEV)

W		40	57.	18.	BMST	70 HBC	0 K-P AT 2.87	
W			21.	7.	ROSS	72 HBC	0 XI-PI+ K*0(890)	3/72
W			. . . .					
W	AVG		25.7	12.2	AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.9)			

21 XI*1/2(1630) PARTIAL DECAY MODES

		DECAY MASSES
P1	XI*1/2(1630) INTO XI PI	1321+ 139

SEEN IN K- P TO XI- PI+ K0.

REFERENCES FOR XI*1/2(1630)

BMST 70 DUKE 317 — BRANDEIS+MARYLAND+SYRACUSE+TUFTS COLLABOR.
BORENSTE 72 PR D5 1559 — BORENSTEIN,DANBURG,KALBFLEISCH++ (BNL,MICH) I
ROSS 72 PL 38B 177 — ,BURAN,LLOYD,MULVEY,RADOJICIC (OXF) I

PAPERS NOT REFERRED TO IN DATA CARDS

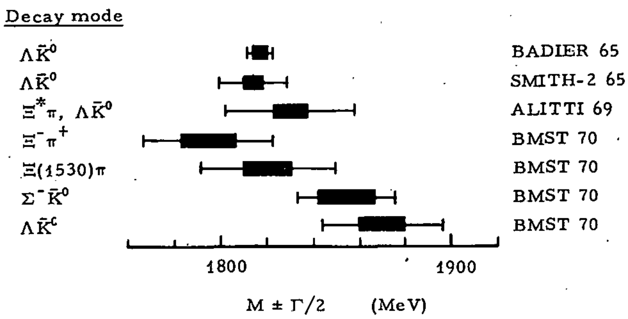
APSELL 69 PRL 23 884 + (BRANDEIS, MARYLAND, SYRACUSE, TUFTS)
SUPERSEDED BY BMST 70.
BARTSCH 69 PL 28B 439 + (AACHEN, BERLIN, CERN, LOIC, VIENNA)
KALBFLEI 70 DUKE CONF 331 G R KALBFLEISCH (BNL) I
SUMMARIZES EVIDENCE FOR ISOSPIN 1 (2.)

Ξ(1820)

50 XI*1/2(1820, JP=) I=1/2

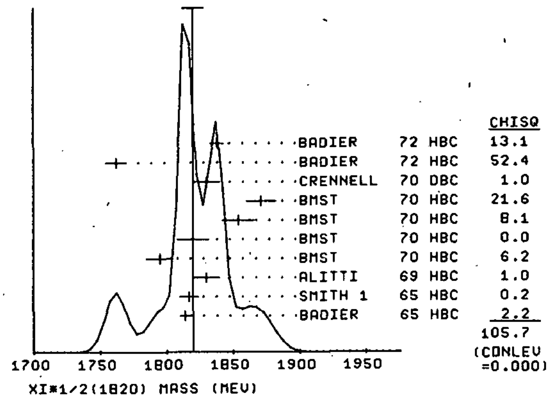
AS THE ACCOMPANYING IDEOGRAMS ILLUSTRATE, THE SITUATION IS CONFUSED. UNTIL SOME FUTURE CLARIFICATION, WE LIST UNDER XI(1820) EVERYTHING REPORTED IN THE MASS RANGE 1750-1875 MEV. WHEN BRANCHING RATIOS ARE REPORTED, WE QUOTE THEM, BUT ONLY THE MOST QUALITATIVE CONCLUSIONS ARE JUSTIFIED.

Ξ(1820)
Masses and widths of reported enhancements in the Ξ(1820) region (solid rectangles indicate error on mass).



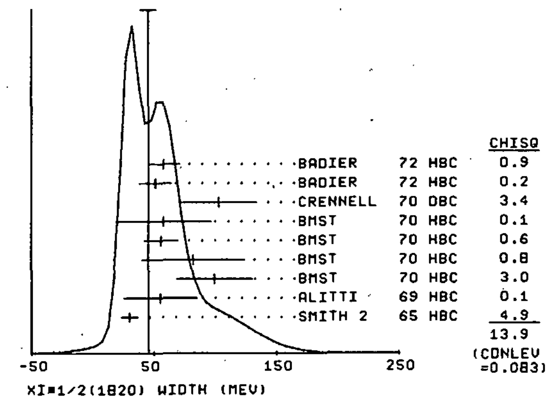
50 XI*1/2(1820) MASS (MEV)

M			(1770.0)		HALSTEINS	63 FBC	-0 K-FR 3.5 GEV/C	
M		30	1814.0	4.0	BADIER	65 HBC	0 LAMBDA KBAR	
M		29	1817.0	7.0	SMITH 1	65 HBC	-0 LAMBDA KBAR	
M		40	1830.0	10.0	ALITTI	69 HBC	- LAM, SIG KBAR	9/69
M		65	1795.	10.	BMST	70 HBC	0 XI-PI+ (2.9 K-P)	7/70
M		55	1820.	12.	BMST	70 HBC	XI(1530) PI	7/70
M		35	1854.	12.	BMST	70 HBC	- SIGMA- K0BAR	7/70
M		65	1871.	11.	BMST	70 HBC	0 LAMBDA K0BAR	7/70
M		25	1830.0	10.0	CRENNELL	70 DBC	-0 3.6, 3.9 GEV/C	10/70
M	B	28	1762.0	8.0	BADIER	72 HBC	XI PI,XI2PI,K Y	10/71
M	B	38	1838.0	5.0	BADIER	72 HBC	XI PI,XI2PI,K Y	10/71
M	B	BADIER 71 ADDS ALL CHANNELS AND DIVIDES PEAK IN LOWER AND HIGHER M						
M			. . . .					
M	AVERAGE MEANINGLESS (SCALE FACTOR = 3.4) (SEE IDEOGRAM BELOW)							



50 XI*1/2(1820) WIDTH (MEV)

W			(80.0)	OR LESS		HALSTEINS	63 FBC	-0 K-FR 3.5 GEV/C	
W			(12.0)	(4.0)		BADIER	65 HBC	0 LAMBDA KBAR	
W			30.0	7.0		SMITH 2	65 HBC	-0	
W			55.0	40.0	20.0	ALITTI	69 HBC	- LAM, SIG KBAR	9/69
W		65	99.	31.		BMST	70 HBC	XI-PI+ (2.9 K-P)	7/70
W		55	82.	42.		BMST	70 HBC	XI(1530) PI	7/70
W		35	56.	14.		BMST	70 HBC	- SIGMA- K0BAR	7/70
W		65	58.	39.		BMST	70 HBC	0 LAMBDA K0BAR	7/70
W			103.0	38.0	24.0	CRENNELL	70 DBC	-0 3.6, 3.9 GEV/C	10/70
W	B		51.0	13.0		BADIER	72 HBC	LOWER MASS	10/71
W	B		58.0	13.0		BADIER	72 HBC	HIGHER MASS	10/71
W		SEE THE NOTES ACCOMPANYING THE MASSES QUOTED							
W			. . . .						
W	AVERAGE MEANINGLESS (SCALE FACTOR = 1.3) (SEE IDEOGRAM BELOW)								



50 XI*1/2(1820) PARTIAL DECAY MODES

		DECAY MASSES
P1	XI*1/2(1820) INTO LAMBDA KBAR	1115+ 497
P2	XI*1/2(1820) INTO XI PI	1321+ 139
P3	XI*1/2(1820) INTO SIGMA KBAR	1197+ 497
P4	XI*1/2(1820) INTO XI*1/2(1530) PI	1533+ 139
P5	XI*1/2(1820) INTO XI PI PI (EXCLUDING P4)	1321+ 139+ 139

0 0 0 0 3 6 0 4 3 4 8

Data Card Listings

For notation, see key at front of Listings.

Baryons

Ξ(1820), Ξ(1940), Ξ(2030)

```
                    50  XI*1/2(1820) BRANCHING RATIOS

R1    XI*1/2(1820) INTO (LAMBDA KBAR)/TOTAL               (P1)
R1          0.3       0.15           ALITTI    69 HBC  -                  9/69

R2    XI*1/2(1820) INTO (XI PI)/TOTAL                     (P2)
R2          0.1       0.1            ALITTI    69 HBC  -                  9/69

R3    XI*1/2(1820) INTO (SIGMA KBAR)/TOTAL                (P3)
R3         (0.02) OR LESS            TRIPP     67 RVUE                    8/67
R3          0.3       0.15           ALITTI    69 HBC  -                  9/69

R4    XI*1/2(1820) INTO (XI*1/2(1530) PI)/TOTAL           (P4)
R4          0.3       0.15           ALITTI    69 HBC  -                  9/69
R4         (0.25) OR LESS            DAUBER    69 HBC     K-P 2.7 BEV/C   9/69

R5    XI*1/2(1820) INTO (XI PI)/(LAMBDA KBAR)             (P2)/(P1)
R5          0.20      0.20           BADIER    65 HBC                     7/66

R6    XI*1/2(1820) INTO (XI*(1530) PI)/(LAM KBAR)         (P4)/(P1)
R6          0.26      0.13           SMITH 1   65 HBC

R7    XI*1/2(1820) INTO (XI PI PI)/(LAMBDA KBAR)          (P5)/(P1)
R7         (0.1)  OR MORE            SMITH 1   65 HBC

R8    XI*1/2(1820) INTO (XI PI)/(XI*1/2(1530) PI)         (P2)/(P4)
R8          1.5       0.6       0.4  APSELL    70 HBC  0                  6/70

R9    XI*1/2(1820) INTO (XI PI PI)/(XI*1/2(1530) PI)      (P5)/(P4)
R9          0.3       0.5            APSELL    70 HBC  0                  6/70

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                               REFERENCES FOR XI*1/2(1820)

HALSTEIN 63 SIENA CONF 173    HALSTEINSLID,+ (BERGEN,CERN,EPOL,RHEL,LOUC) I
BADIER   65 PL 16 171         +DEMOULIN,GOLDBERG, +     (EPOL,SACLAY,AMST) I
SMITH 1  65 PRL 14 25         +LINDSEY,BUTTON-SHAFER,MURRAY           (LRL)IJP
SMITH 2  65 ATHENS CONF 251   G A SMITH, J S LINDSEY                  (LRL)
TRIPP    67 NP B3 10          + LEITH, +    (LRL,SLAC,CERN,HEIDEL,SACLAY)
   USES DATA OF SMITH 1.

ALITTI   69 PRL 22 79         +BARNES,FLAMINIO,METZGER, +  (BNL,SYRACUSE) I
DAUBER   69 PR 179 1262       +BERGE, HUBBARD, MERRILL, MULLER        (LRL)
APSELL   70 PRL 24 777        +      (BRANDEIS, MARYLAND, SYRACUSE, TUFTS) I
BMST     70 DUKE 317          BRANDEIS+MARYLAND+SYRACUSE+TUFTS COLLABOR.
CRENNELL 70 PR 1D 847         +KARSHON, LAI, ONEALL, SCARR, SCHUMANN(BNL)
BADIER   72 NP B37 429        +BARRELET,CHARLTON,VIDEAU              (EPOL)

                              PAPERS NOT REFERRED TO IN DATA CARDS

MERRILL  68 PR 167 1202       D W MERRILL, J BUTTON-SHAFER            (LRL)
   WEAK EVIDENCE CONCERNING JP.
APSELL   69 PRL 23 884        +      (BRANDEIS, MARYLAND, SYRACUSE, TUFTS)
   SUPERSEDED BY BMST  70.
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Ξ(1940)

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52  XI*1/2(1940, JP=    ) I=1/2

WE LIST UNDER XI(1940) EVERYTHING REPORTED IN THE MASS
RANGE 1875-2000 MEV.  THE SITUATION IS PERHAPS NOT
QUITE SO UNCLEAR AS IS THE CASE FOR THE XI(1820).

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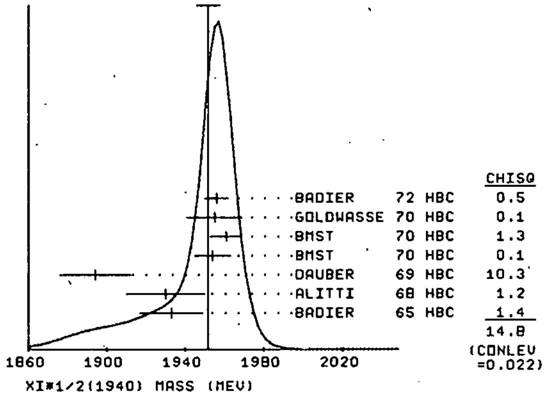
                    52  XI*1/2(1940) MASS (MEV)

M      35 1933.0    16.0            BADIER    65 HBC  0 XI- PI+
M      27 1930.0    20.0            ALITTI    68 HBC  0 XI- PI+            11/68
M      66 1894.0    18.0            DAUBER    69 HBC  -  XI PI             11/68
M     110 1954.      9.             BMST      70 HBC  0 XI-PI+ (2.9 K-P)    7/70
M      40 1961.      8.             BMST      70 HBC    XI(1530) PI         7/70
M      21 1955.0    14.0            GOLDWASSE 70 HBC  -  XI PI             10/70
M      29 1956.0     6.0            BADIER    72 HBC    XI PI,XI2PI,K Y    10/71
M          . . . . . . . . . .
M   AVERAGE MEANINGLESS (SCALE FACTOR = 1.6)
                  (SEE IDEOGRAM BELOW )
```

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                    52  XI*1/2(1940) WIDTH (MEV)

W      35  140.0    35.0            BADIER    65 HBC  0 XI- PI+
W      27   80.0    40.0            ALITTI    68 HBC  0 XI- PI+            11/68
W      66   98.0    23.0            DAUBER    69 HBC  -  XI PI             11/68
W     110  129.     30.             BMST      70 HBC  0 XI-PI+ (2.9 K-P)    7/70
W      40   42.     35.             BMST      70 HBC    XI(1530) PI         7/70
W      21   56.0    26.0            GOLDWASSE 70 HBC  -  XI PI             10/70
W      29   35.0    11.0            BADIER    72 HBC    XI PI,XI2PI,K Y    10/71
W          . . . . . . . . . .
W   AVERAGE MEANINGLESS (SCALE FACTOR = 1.8)
                  (SEE IDEOGRAM BELOW )
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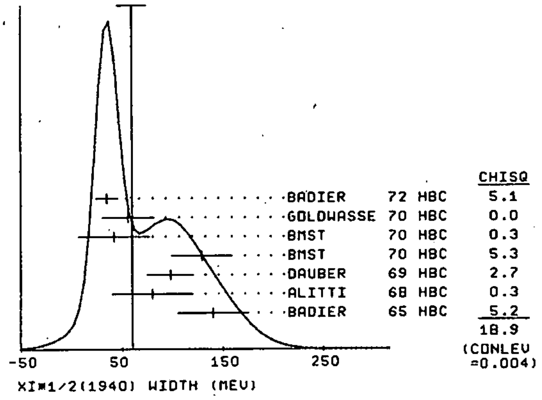


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                    52  XI*1/2(1940) PARTIAL DECAY MODES

                                                          DECAY MASSES
P1    XI*1/2(1940) INTO XI PI                             1321+ 139
P2    XI*1/2(1940) INTO XI*(1530) PI                      1533+ 139
P3    XI*1/2(1940) INTO XI PI PI (EXCLUDING P2)           1321+ 139+ 139

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                    52  XI*1/2(1940) BRANCHING RATIOS

   THE XI(1940) IS SEEN MAINLY IN XI PI AND SOME IN XI(1530) PI.  IT
HAS BEEN LOOKED FOR IN OTHER CHANNELS BUT NOT SEEN.

R1    XI*1/2(1940) INTO (XI PI)/(XI*1/2(1530) PI)         (P1)/(P2)
R1          2.8       0.7       0.6  APSELL    70 HBC  0                  6/70

R2    XI*1/2(1940) INTO (XI PI PI)/(XI*1/2(1530) PI)      (P3)/(P2)
R2          0.0       0.3            APSELL    70 HBC  0                  6/70

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                               REFERENCES FOR XI*1/2(1940)

BADIER   65 PL 16 171         +DEMOULIN,GOLDBERG, +     (EPOL,SACLAY,AMST) I
ALITTI   68 PRL 21 1119       +FLAMINIO,METZGER,RADOJICIC,+(BNL,SYRACUSE) I
DAUBER   69 PR 179 1262       +BERGE, HUBBARD, MERRILL, MULLER      (LRL) I
APSELL   70 PRL 24 777        +      (BRANDEIS, MARYLAND, SYRACUSE, TUFTS) I
BMST     70 DUKE 317          BRANDEIS+MARYLAND+SYRACUSE+TUFTS COLLABOR.
GOLDWASS 70 PR 1D 1960        E L GOLDWASSER, P F SCHULTZ      (ILLINOIS)
BADIER   72 NP B37,429        +BARRELET,CHARLTON,VIDEAU              (EPOL)

                              PAPERS NOT REFERRED TO IN DATA CARDS

APSELL   69 PRL 23 884        +      (BRANDEIS, MARYLAND, SYRACUSE, TUFTS)
   SUPERSEDED BY BMST  70.
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Ξ(2030)

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68  XI*1/2(2030, JP=    ) I=1/2

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                    68  XI*1/2(2030) MASS (MEV)

M      42 2030.0    10.0            ALITTI    69 HBC  -  K-P 3.9-5 BEV/C    9/69
M      40 2058.0    17.0            BARTSCH   69 HBC     K-P 10GEV/C        9/69
M          . . . . . . . . . .
M   AVERAGE MEANINGLESS (SCALE FACTOR = 1.4)

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                    68  XI*1/2(2030) WIDTH (MEV)

W          45.0     40.0    20.0    ALITTI    69 HBC  -                     9/69
W          57.0     30.0            BARTSCH   69 HBC                        9/69
W          . . . . . . . . . .
W   AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

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Baryons

Ξ(2030), Ξ(2250), Ξ(2500), Ω⁻

Data Card Listings

For notation, see key at front of Listings.

```
                    68  XI*1/2(2030) PARTIAL DECAY MODES

                                                              DECAY MASSES
P1     XI*1/2(2030) INTO XI PI                                1321+ 139
P2     XI*1/2(2030) INTO LAMBDA KBAR                          1115+ 497
P3     XI*1/2(2030) INTO SIGMA KBAR                           1197+ 497
P4     XI*1/2(2030) INTO XI*1/2(1530) PI                      1533+ 139
P5     XI*1/2(2030) INTO LAMBDA (OR SIGMA) KBAR PI            1115+ 497+ 139
------ --------- --------- --------- --------- --------- --------- --------

                    68  XI*1/2(2030) BRANCHING RATIOS

R1     XI*1/2(2030) INTO (XI PI)/(MODES P1 TO P4)        (P1)/(P1+P2+P3+P4)
R1          (0.30) OR LESS           ALITTI     69 HBC   - 1 STD DEV LIMIT   9/69

R2     XI*1/2(2030) INTO (LAM KBAR)/(MODES P1 TO P4)     (P2)/(P1+P2+P3+P4)
R2          0.25     0.15            ALITTI     69 HBC   -                   9/69

R3     XI*1/2(2030) INTO (SIG KBAR)/(MODES P1 TO P4)     (P3)/(P1+P2+P3+P4)
R3          0.75     0.20            ALITTI     69 HBC   -                   9/69

R4     XI*1/2(2030) INTO (XI* PI)/(MODES P1 THRU P4)     (P4)/(P1+P2+P3+P4)
R4          (0.15) OR LESS           ALITTI     69 HBC   - 1 STD DEV LIMIT   9/69

R5     XI*1/2(2030) INTO LAMBDA (OR SIGMA) KBAR PI       (P5)
R5          SEEN                     BARTSCH    69 HBC                       9/69
****** ********* ********* ********* ********* ********* ********* ********

                    REFERENCES FOR XI*1/2(2030)

ALITTI   69 PRL 22 79         +BARNES,FLAMINIO,METZGER, +  (BNL,SYRACUSE) I
BARTSCH  69 PL 28B 439        +      (AACHEN, BERLIN, CERN, LOIC, VIENNA)
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Ξ(2250)

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22  XI*1/2(2250, JP=    )
THE EVIDENCE FOR THIS STATE IS WEAK.  BARTSCH 69 SEE
A BUMP OF NOT MUCH STATISTICAL SIGNIFICANCE IN LAMBDA-
KBAR-PI, SIGMA-KBAR-PI, AND XI-PI-PI MASS SPECTRA.
GOLDWASSER 70 SEE A NARROWER BUMP IN XI-PI-PI AT A
HIGHER MASS.  PERHAPS THEY ARE THE SAME STATE, PERHAPS
THEY ARE NOT.
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                    22  XI*1/2(2250) MASS (MEV)

M        35 2244.0     52.0            BARTSCH   69 HBC       K-P 10 GEV/C      9/69
M        18 2295.0     15.0            GOLDWASSE 70 HBC   -   K-P 5.5 GEV/C    10/70.
M         . . . . . . . . .
M      AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)
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                    22  XI*1/2(2250) WIDTH (MEV)

W          130.0      80.0             BARTSCH   69 HBC                         9/69
W        LESS THAN    30.0             GOLDWASSE 70 HBC   -   K-P 5.5 GEV/C    10/70
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                    22  XI*1/2(2250) PARTIAL DECAY MODES

                                                              DECAY MASSES
P1     XI*1/2(2250) INTO XI PI PI                             1321+ 139+ 139
P2     XI*1/2(2250) INTO LAMBDA KBAR PI                       1115+ 497+ 139
P3     XI*1/2(2250) INTO SIGMA KBAR PI                        1197+ 497+ 139
****** ********* ********* ********* ********* ********* ********* ********

                    REFERENCES FOR XI*1/2(2250)

BARTSCH  69 PL 28B 439          +      (AACHEN, BERLIN, CERN, LOIC, VIENNA)
GOLDWASS 70 PR 1D 1960          E L GOLDWASSER, P F SCHULTZ     (ILLINOIS)
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Ξ(2500)

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99  XI*1/2(2500, JP=    ) I=1/2
IT IS QUITE POSSIBLE THAT THE REASON THE EXPERIMENTS
DISAGREE ABOUT THE MASS AND WIDTH IS THAT THEY ARE
SEEING DIFFERENT XI*S.  FOR NOW, HOWEVER, WE GROUP
THEM TOGETHER.
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                    99  XI*1/2(2500) MASS (MEV)

M        30 2430.0     20.0            ALITTI    69 HBC   -  K-P 4.6-5 GEV/C    9/69
M        45 2500.0     10.0            BARTSCH   69 HBC   -0 K-P 10 GEV/C       9/69
M         . . . . . . . . .
M      AVERAGE MEANINGLESS (SCALE FACTOR = 3.1)
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                    99  XI*1/2(2500) WIDTH (MEV)

W          150.0      60.0      40.0   ALITTI    69 HBC   -                     9/69
W           59.0      27.0             BARTSCH   69 HBC   -0                    9/69
W         . . . . . . . . .
W      AVERAGE MEANINGLESS (SCALE FACTOR = 1.6)
------ --------- --------- --------- --------- --------- --------- --------

                    99  XI*1/2(2500) PARTIAL DECAY MODES

                                                              DECAY MASSES
P1     XI*1/2(2500) INTO XI PI                                1321+ 139
P2     XI*1/2(2500) INTO LAMBDA KBAR                          1115+ 497
P3     XI*1/2(2500) INTO SIGMA KBAR                           1197+ 497
P4     XI*1/2(2500) INTO XI*1/2(1530) PI                      1533+ 139
P5     XI*1/2(2500) INTO LAMBDA (OR SIGMA) KBAR PI            1115+ 497+ 139
P6     XI*1/2(2500) INTO XI PI PI                             1321+ 139+ 139
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                    99  XI*1/2(2500) BRANCHING RATIOS

R1     XI*1/2(2500) INTO (XI PI)/(MODES P1 THRU P4)      (P1)/(P1+P2+P3+P4)
R1          (0.5) OR LESS            ALITTI     69 HBC     1 STD DEV LIMIT   9/69

R2     XI*1/2(2500) INTO (LAM KBAR)/(MODES P1 THRU P4)   (P2)/(P1+P2+P3+P4)
R2          0.5      0.2             ALITTI     69 HBC   -                   9/69

R3     XI*1/2(2500) INTO (SIG KBAR)/(MODES P1 THRU P4)   (P3)/(P1+P2+P3+P4)
R3          0.5      0.2             ALITTI     69 HBC   -                   9/69

R4     XI*1/2(2500) INTO (XI* PI)/(MODES P1 THRU P4)     (P4)/(P1+P2+P3+P4)
R4          (0.2) OR LESS            ALITTI     69 HBC     1 STD DEV LIMIT   9/69

R5     XI*1/2(2500) INTO (LAMBDA (OR SIGMA) KBAR PI)/TOTAL
R5                                                       (P5)
R5          SEEN                     BARTSCH    69 HBC   -0                  9/69

R6     XI*1/2(2500) INTO (XI PI PI)/TOTAL                (P6)
R6          SEEN                     BARTSCH    69 HBC   -0                  9/69
****** ********* ********* ********* ********* ********* ********* ********

                    REFERENCES FOR XI*1/2(2500)

ALITTI   69 PRL 22 79         +BARNES,FLAMINIO,METZGER, +  (BNL,SYRACUSE) I
BARTSCH  69 PL 28B 439        +      (AACHEN, BERLIN, CERN, LOIC, VIENNA)
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Ω⁻

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24  OMEGA-(1675, JP=3/2+) I=0
SEE STABLE PARTICLE DATA CARD LISTINGS
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Appendix I

TEST OF $\Delta I=1/2$ RULE FOR K DECAYS

The quantities of interest for making tests of theoretical predictions regarding the $\Delta I=1/2$ rule for K decay are usually partial decay rates for single channels or special sums of channels. It is not possible to compute the errors on sums, differences, and ratios of partial decay rates from the information given in the Table of Stable Particles because of the presence of off-diagonal terms in the error matrix. For this reason we give some of these quantities in Table I. Throughout this Appendix, italics are used to indicate that a quantity has changed by more than one (old) standard deviation since our previous edition, and S gives the scale factor included in the quoted error because of inconsistencies in the data (see footnote at end of Stable Particle Table for definition of S).

Table I. (000) or (+-0) refer to the sign of the pions into which the K_L decays.

$\Gamma_{K^+_{\ell 3}} = \Gamma_{K^+_{e3}} + \Gamma_{K^+_{\mu 3}}$	$= (6.542\pm.083)\times 10^6\ \mathrm{sec}^{-1}$	
$\Gamma_{K^+_{\mu 3}} / \Gamma_{K^+_{e3}}$	$= 0.668\pm.024$	S=2.2
$\Gamma_{K^+_{\tau}} / \Gamma_{K^+_{\tau'}}$	= *3.223 ± .090*	
$\Gamma_{K^0_{\ell 3}} = \Gamma_{K^0_{e3}} + \Gamma_{K^0_{\mu 3}}$	$= (12.68\pm.16)\times 10^6\ \mathrm{sec}^{-1}$	S=1.1
$\Gamma_{K^0_{\mu 3}} / \Gamma_{K^0_{e3}}$	$= 0.694\pm.022$	
$\Gamma_{K^0(000)} / \Gamma_{K^0(+-0)}$	$= 1.711\pm.081$	S=1.3

1. Leptonic decay rates

The $\Gamma_{K_{\ell 3}}$ rates are useful in testing the leptonic $\Delta I = 1/2$ rule in the way suggested by Trilling.[1] The predictions are

$\Gamma_{K^0_{\ell 3}} / 2\Gamma_{K^+_{\ell 3}} = 1.012$, a phase-space factor,[2] and

$$\Gamma_{K^0_{\mu 3}} / \Gamma_{K^0_{e3}} = \Gamma_{K^+_{\mu 3}} / \Gamma_{K^+_{e3}}\ .$$

From Table I,

$$\Gamma_{K^0_{\ell 3}} / 2\Gamma_{K^+_{\ell 3}} = 0.969\pm.017$$

and

$$\frac{\Gamma_{K^0_{\mu 3}}}{\Gamma_{K^0_{e3}}}\left[\frac{\Gamma_{K^+_{\mu 3}}}{\Gamma_{K^+_{e3}}}\right]^{-1} = 1.039\pm.050\ .$$

These results seem to show a less than 2σ disagreement with the predictions, but the errors should be regarded with caution in view of the internal disagreements in the data. (Note the ideograms in the data listing for the charged K meson.)

2. Three-pion decays

We follow here the tests done by Mast et al.,[3] based on the general analysis of K decays suggested by Zemach.[4] Both decay rates (Γ) and slopes (g, the energy dependence of the Dalitz plot distributions) are used. The $\Delta I = 1/2$ rule predicts that the following test quantities are all equal to zero:

$$\text{Test 1} = \frac{2}{3}\,\frac{\Gamma_{K^0(000)}}{\phi_1}\left[\frac{\Gamma_{K^0(+-0)}}{\phi_2}\right]^{-1} - 1\ ,$$

$$\text{Test 2} = \frac{1}{4}\,\frac{\Gamma_{K^+_\tau}}{\phi_3}\left[\frac{\Gamma_{K^+_{\tau'}}}{\phi_4}\right]^{-1} - 1\ ,$$

$$\text{Test 3} = \frac{1}{2}\,\frac{\Gamma_{K^+_\tau}}{\phi_3}\left[\frac{\Gamma_{K^0(+-0)}}{\phi_2}\right]^{-1} - 1\ ,$$

$$\text{Test 4} = \frac{1}{2}\,g_{K^+_{\tau'}} + g_{K^+_\tau}\ ,$$

$$\text{Test 5} = g_{K^0(+-0)} + g_{K^+_\tau} - \frac{1}{2}\,g_{K^+_{\tau'}}\ .$$

The ϕ_i are phase-space factors which have been calculated as described in Mast et al.[3] by use of a relativistic formulation and the masses and slopes from this compilation. The factors labeled UDP are the relative areas of the Dalitz plots, assuming a uniform distribution. The NUDP include the observed slopes (see below). The CNUDP have been calculated by including the final-state Coulomb interaction. The values are:

	Method		
	UDP	NUDP	CNUDP
$\phi_1(000)$ =	1.489	1.489	1.444
$\phi_2(+-0)$ =	1.221	1.294	1.279
$\phi_3(++-)$ =	1.000	1.000	1.000
$\phi_4(+00)$ =	1.247	1.183	1.147

For convenience, we repeat the slope parameters tabulated in the Stable Particle Table. They are as follows:

$g_{K_\tau^+} = -0.214 \pm 0.005$ S=1.7

$g_{K_\tau^-} = -0.214 \pm 0.007$ S=2.7

$\bar{g}_{K_\tau^\pm} = -0.214 \pm 0.004$

$g_{K_{\tau'}^+} = 0.523 \pm 0.023$ S=1.4

$g_{K^0 (+-0)} = 0.604 \pm 0.023$ S=2.7

A difference in the τ^+ and τ^- slopes would be an indication of CP violation in this decay. Since no difference is observed at this time, we average the two and use this value in Test 4.

We use the CNUDP factors and the rates and slopes reported here to compute the five test quantities which the $\Delta I=1/2$ rule predicts to be zero. The results are:

Test 1 = 0.010 ± 0.048
Test 2 = -0.076 ± 0.026
Test 3 = 0.190 ± 0.025
Test 4 = 0.048 ± 0.012
Test 5 = 0.128 ± 0.026

The three-pion final state can be in isospin states I = 1, 2, 3. Tests 1 and 2 test the existence of isospin I = 3 in the final state. Since the rate tests (Tests 1, 2, and 3) could differ from zero by as much as 0.1 owing to the mass differences and the occurrence of big slopes[5], no evidence for I=3 is found. Test 4 is related to the I=2 amplitude in the final state and indicates the presence of I=2. Tests 3 and 5 give information on the $\Delta I = 3/2$ part of the I=1 amplitude relative to the $\Delta I = 1/2$ part. Both tests indicate the presence of $\Delta I = 3/2$.

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Appendix II

A. SU(3) CLASSIFICATION OF BARYON RESONANCES

There are a few multiplets that have been studied and we report here the results.

Exact SU(3) symmetry predicts that all the members of a multiplet should have the same mass and the same couplings for decays into other multiplets. It has been found, however, that the members of the octet of Stable Baryons lie within 20% of their mean mass; therefore a symmetry breaking interaction has been introduced by GELL-MANN 62 and OKUBO 62 independently. In addition, for the isospin-0 vector mesons (ω and ϕ) an additional symmetry-breaking interaction had to be introduced (SAKURAI 62) to take care of octet-singlet mixing. The relevant formulae for masses and decay rates are given below.

Mass Formulae

Broken SU(3) gives:

Decuplet	$\Delta - \Sigma = \Sigma - \Xi^* = \Xi^* - \Omega$	GMO	(1)
Octet	$2(N + \Xi) = 3\Lambda + \Sigma$	GMO	(2)
Octet-Singlet mixing	$\sin^2\theta = \dfrac{\Lambda - M_8}{\Lambda - \Lambda'}$	Mixing angle†	(3)
	$M_8 = \dfrac{2(N+\Xi) - \Sigma}{3}$	GMO	(4)

Here GMO stands for the Gell-Mann-Okubo formula; the particle symbol indicates its mass. The formulae would be the same if squared masses were used. For the nonet case, Λ is the "mostly-octet" particle, Λ' is the "mostly-singlet" particle.

Decay Rates

In terms of a relativistically invariant matrix element T, the decay rate for two-body decay of a resonance of mass M_R is

$$\Gamma \propto \frac{|T|^2 R_2}{M_R}, \qquad (5)$$

where $R_2 = k/M_R$ is the two-body phase space factor. Since the numerator is an invariant, and since Γ must transform as 1/E, we introduce the denominator $1/M_R$ (see FEYNMAN 62).

For meson decays (see below) the rates are calculated according to Eq. (5); for baryon resonance decays into $1/2^+$ baryons and 0^- mesons, one next takes into account the fact that spin sums in $|T|^2$ introduce another factor M_R, cancelling the $1/M_R$. We are then left with

$$\Gamma = \frac{|T|^2 k}{M_R} M_N, \quad \text{for baryons} \qquad (5')$$

$$= \frac{|T|^2 k}{M_R^2} M_N^2, \quad \text{for mesons} \qquad (5'')$$

The powers of the nucleon mass M_N or M_N^2 have been introduced so that we can treat $|T|$ as dimensionless.

$|T|^2$ contains centrifugal barrier factors, which we call B_ℓ. We then have

$$\left.\begin{array}{l}\text{Decuplet}\\ \text{Singlet}\end{array}\right\} \Gamma = (cg)^2 B_\ell(k) \frac{M_N}{M_R} k \qquad (6)$$

$$\text{Octet} \quad \Gamma = (c_D g_D + c_F g_F)^2 B_\ell(k) \frac{M_N}{M_R} k \qquad (7)$$

$$\begin{array}{l}\text{Octet-}\\ \text{Singlet}\\ \text{mixing}\end{array} \left\{ \begin{array}{l} G_8 = \Lambda \cos\theta - \Lambda' \sin\theta \\ G_1 = \Lambda \sin\theta + \Lambda' \cos\theta \end{array}\right. \qquad (8)$$

$$\text{with} \quad \begin{array}{l} G_8 = c_D g_D + c_F g_F \\ G_1 = c_1 g_1. \end{array} \qquad (9)$$

Here c_i are the SU(3) coefficients with the sign convention adopted in this article [see note preceding the table of SU(3) isoscalar factors and Fig. 2 in the text]. M_N is the nucleon mass, M_R is the resonance mass for which Γ is calculated, k is the center-of-mass momentum for the channel being considered, g_i are the relevant couplings. For the case of singlet-octet mixing, formula (8) has to be used in conjunction with (6) and (7). G_8 and G_1 represent the couplings for the multiplet, and Λ and Λ' represent the couplings for the physical states.

The relation between g_D, g_F, and the parameter α is

$$\alpha = \left[1 + \frac{\sqrt{5}}{3} \frac{g_F}{g_D}\right]^{-1}. \qquad (10)$$

Exact SU(3) predicts that the couplings g_i for all the members of a multiplet are the same; however, since the symmetry is broken for the masses, it is probably broken for the widths. In the case of the $3/2^+$ decuplet, for broken SU(3) a sum rule has been derived by BECCHI 64 and by GUPTA 64 independently. It relates the g_i for the members of the decuplet by the relation

$$2(\Delta + \Xi) = 3\Sigma^*(\Lambda\pi) + \Sigma^*(\Sigma\pi), \qquad (11)$$

where $\Sigma^*(\Lambda\pi)$ is the coupling for the $\Sigma(1385) \to \Lambda\pi$ decay and $\Sigma^*(\Sigma\pi)$ is the coupling for the decay $\Sigma(1385) \to \Sigma\pi$.

As mentioned in the text (Sec. IV D) the determination of the relative signs of resonant amplitudes can be useful in making an SU(3) assignment of resonances. In fact the resonant amplitude $T \propto \sqrt{x_e x_i} \propto G_e G_i$ where the subscript e refers to the elastic channel and the G_e, G_i are the couplings of Eqs. (6) through (9). Assuming that all g_i are positive, the sign of the G_i are dependent upon the sign of the Clebsh-Gordon coefficients c_i. Once a sign convention is adopted (we use the LEVI-SETTI 69 convention, see Fig. 2 in the text) and the sign for a Σ state (I = 1) and a Λ state (I = 0) of known SU(3) assignment have been chosen for reference, the signs of all the other amplitudes can be useful in determining multiplet assignments. For exact SU(3) all the decays of members of a decuplet have the same sign. For octets the relative sign depends upon the value of g_D/g_F and the mixing angle, as seen from Eqs. (7) through (9).

Fits to the Data

Fits of baryon decay rates within SU(3) can be found, among others, in TRIPP 68 and 69, LEVI SETTI 69, SAMIOS 70 and PLANE 70. The most recent fits were made by BARBARO-GALTIERI 72.

In fitting the data a choice for B_ℓ has to be made. PLANE 70 tried two forms for B_ℓ:

(a) The form $B_\ell = (kr)^{2\ell} D_\ell(kr)$, r being the radius of interaction and D_ℓ the polynomials in kr given by BLATT-WEISSKOPF 52. Usually r is taken to be 1 fermi (TRIPP 68).

(b) The form $B_\ell = k^{2\ell}$.

However, for their final results they used form (b). A discussion of the differences among these two forms can be found in BARBARO-GALTIERI 71. It turns out that not only the values of the couplings, g_i, depend upon the form used for B_ℓ, but also the value obtained for the mixing angle. For the $3/2^-$ singlet, $\Lambda(1520)$, and isospin-0 member of the octet, $\Lambda(1690)$, the mixing angles obtained in the two cases are

$$\theta_a = (-16.1 {}^{+1.4}_{-1.3})^\circ, \quad \theta_b = (-27.5 {}^{+3.6}_{-3.4})^\circ,$$

in disagreement by a few standard deviations. It turns out that if a radius of interaction of r = 0.15 fermi is used for form (a), the two values of θ agree. This value of r does not fit resonance shapes when used in the Breit-Wigner resonant form.

Table I is a summary of the fits made by BARBARO-GALTIERI 72 using the barrier factor form (b) and exact SU(3). A few comments follow.

$\frac{1}{2}^-$ - Nonet (Baryon - Eta Resonances)

For this nonet Eq. (7) was multiplied by the factor

$$\left[\frac{M_R - M_B}{\bar{M}_R - \bar{M}_B}\right]^2 ,$$

where M_B is the decay baryon and $\bar{M}_R - \bar{M}_B$ = 564 MeV is the difference of the mean $1/2^-$ and $1/2^+$ baryon octet masses. This kinematic factor comes from PCAC arguments (i.e., the assumption that axial vector current remains an octet in presence of symmetry breaking) and it was advocated by Graham et al. (GRAHAM 67). For the $1/2^-$ nonet it has been used in this form first by Gell-Mann et al. (GELL-MANN 68).

$\frac{3}{2}^+$ Decuplet

The agreement among the coupling constants obtained for the four rates in this decuplet is very bad. The fit made using form (b) for B_ℓ has χ^2=50 for 3 Degrees of Freedom; the one made with form (a) for B_ℓ has χ^2=24/3DF. The broken SU(3) relation (11), however, is very well satisfied.

B. SU(3) CLASSIFICATION OF MESON RESONANCES

All of the discussion above applies, except that for Bosons the GMO formula is usually applied to the square of the masses, as opposed to the first power for fermions. Thus for example, Eq. (2) becomes

$$4\hat{K} = 3\hat{\eta} + \hat{\pi}. \qquad (2')$$

The symbol $\hat{K}$ was introduced by Glashow and Socolow[†] for the square of the K mass, etc.

Because of the difference between Eqs. (5') and (5''), there is also an extra factor of (M_N/M_R) in Eqs. (6) and (7). The three established nonets (0^-, 1^-, 2^+) and their mixing angles are listed at the bottom of the Meson table.

Footnotes and References

[†]The formula has been calculated from analogy with the formula for mixing of meson states, first put in this form by S. L. Glashow and R. H. Socolow, Phys. Rev. Letters 15, 329 (1966). For the baryon formula see A. Barbaro-Galtieri, Phenomenology of Resonances and Particle Supermultiplets. UCRL-17054 (1966).

[‡]This is an updated version of the fits by Flaminio et al., BNL report 14572.

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Table I. SU(3) baryon multiplets with two or more known members. Values of θ and α [defined by Eqs. (8) and (10)] are the results of fits made by BARBARO-GALTIERI 72 to all the measured two-body decay rates of each multiplet.

J^P	Octet members[a]				Singlet	θ(deg)[b]	α
$1/2^-$	N'(1535)	Λ(1670)	Σ(1750)	[Ξ(1825)]	Λ(1405)	8±3	1.2±.1
$3/2^-$	N(1520)	Λ(1690)	Σ(1670)	[Ξ(1815)]	Λ(1520)	-23±4	.34±.09
$5/2^-$	N(1670)	Λ(1830)	Σ(1765)				1.13±.05
$5/2^+$	N(1688)	Λ(1815)	Σ(1915)				.62±.04
	Decuplet members				g_{10}		
$3/2^+$	Δ(1236)	Σ(1385)	Ξ(1530)	Ω^-		1.78 - 2.29	χ^2=50/3DF
$7/2^+$	Δ(1950)	Σ(2030)					

[a]Masses in parentheses are the nominal masses used in the Baryon Table. The Ξ members have masses as calculated by using formulae (1) and (2) with the mixing angle θ derived from the decay widths.
[b]See text for a discussion of the 3/2⁻ mixing angle.

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Appendix III
TEST OF $\Delta I=1/2$ RULE FOR HYPERON DECAYS

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1. Nonleptonic Decay Amplitudes

In this edition we are adopting a new convention for the amplitudes A and B. Some theorists have suggested that dimensionless amplitudes are more useful to them than the ones appearing in the literature. Berge (1966) used a convention, which we adopted last year, with A and B in units of $sec^{-1/2}$. Samios (1965) used a convention which gave A and B in units of $(MeV\text{-}sec)^{-1/2}$. Following is the convention suggested by Jackson (1973), which gives dimensionless A and B, which we will adopt in this edition.

The effective Lagrangian density for nonleptonic hyperon decays ($B_1 \to B_2 + \pi$) can be written

$$\mathcal{L}_{eff} = G\mu_c^2 [\bar{\psi}_2 (A+B\gamma_5) \psi_1] \phi_\pi ,$$

where $G = 10^{-5} m_p^{-2}$ is a coupling constant characteristic of first-order weak decays, μ_c is the charged pion mass, and A and B are dimensionless complex numbers giving the relative amplitudes of the parity-violating and parity-conserving decays, respectively. The matrix γ_5 is to be taken in the Pauli form, $\gamma_5 = \begin{pmatrix} 0 & -I \\ -I & 0 \end{pmatrix}$. The invariant amplitude for the decay is

$$\mathcal{M} = G\mu_c^2 [\bar{u}(p)(A+B\gamma_5) u(P)] ,$$

where P is the 4-momentum of the decaying hyperon of mass M, and p is the 4-momentum of the baryon decay product of mass m. With the normalization convention, $\bar{u}_i u_i = 2m_i$, the Pauli form of the matrix element in the rest frame of the decaying hyperon is

$$\mathcal{M} = G\mu_c^2 \langle \chi_2 | \sqrt{2M(E+m)}\, A + \sqrt{2M(E-m)}\, B \vec{\sigma}\cdot\hat{q} | \chi_1 \rangle ,$$

where E is the total energy of the final baryon and $\hat{q}$ is a unit vector in the direction of motion of the final baryon. Comparison with Section IV H shows that the amplitudes s and p defined there are proportional to A and B:

$$\frac{p}{s} = \left(\frac{E-m}{E+m}\right)\frac{B}{A} = \sqrt{\frac{(M-m)^2 - \mu^2}{(M+m)^2 - \mu^2}}\ \frac{B}{A} .$$

Here μ is the mass of the pion entering the decay. The parameters α, β, γ can therefore be expressed in terms of A and B, rather than s and p, if desired.

The decay rate for $B_1 \to B_2 + \pi$ is

$$\Gamma = \frac{G^2 \mu_c^4}{8\pi} q \left\{ \left[\frac{(M+m)^2 - \mu^2}{M^2} \right] |A|^2 + \left[\frac{(M-m)^2 - \mu^2}{M^2} \right] |B|^2 \right\},$$

where q is the c.m.s. momentum of the decay products. For reference, the dimensionless constant in this expression has the value $(G^2 \mu_c^4/8\pi) = 1.9488 \times 10^{-15}$.

To convert numbers for A and B of Table I, Appendix III, April 1972 edition to the new dimensionless numbers, multiply old values by $0.98124 \times 10^{-5} \sec^{1/2}$. This is the value of

$$\frac{\sqrt{\hbar}\, 10^5}{G\mu_c^2 \sqrt{\mu_c}} = \sqrt{\frac{65.822}{0.13958}} \left(\frac{0.93826}{0.13958} \right)^2 \times 10^{-13} \times 10^5 \times 10^5 \sec^{1/2}.$$

$$A_{new} = 0.98124\, A_{old} \times 10^{-5} \sec^{1/2}$$

$$B_{new} = 0.98124\, B_{old} \times 10^{-5} \sec^{1/2}.$$

Table I summarizes the amplitudes A and B for the nonleptonic decays of the Λ, Σ, and Ξ hyperons. These amplitudes have been calculated by using the experimental data for mean lives, branching ratios, and the decay asymmetry α given in the Stable Particle Table of this review. Time-reversal invariance is assumed and final-state interactions are neglected, so A and B are taken to be relatively real and $\beta = 0$. The subscript on the hyperon refers to the sign of the decaying pion. The statistical correlation coefficient

$$C_{AB} = \frac{\langle \Delta A \Delta B \rangle}{\sqrt{\langle \Delta A^2 \rangle \langle \Delta B^2 \rangle}}$$

is also given. The absolute signs of A and B have been assigned, using the following convention. Taking $A(\Lambda^0_-)$ as positive, the other S-wave decay amplitudes are chosen to give an approximate fit to the triangular relationships

$$\sqrt{2}A(\Sigma_0^+) + A(\Sigma_+^+) = A(\Sigma_-^-) \text{ and } \sqrt{3}A(\Sigma_0^+) + A(\Lambda_-^0) = 2A(\Xi_-^-).$$

The signs of the B amplitudes relative to those of the corresponding A amplitudes are determined by the sign of the appropriate α decay parameter.

Table I

M $\to$ m + μ	A	B	C_{AB}
$\Lambda^0_- \to p + \pi^-$	1.50±0.01	10.28±0.25	-0.264
$\Sigma^+_+ \to n + \pi^+$	0.06±0.02	19.04±0.16	0.003
$\Sigma^+_0 \to p + \pi^0$	1.46±0.06	-12.22±0.70	0.945
$\Sigma^-_- \to n + \pi^-$	1.93±0.01	-0.65±0.08	-0.030
$\Xi^0_0 \to \Lambda + \pi^0$	1.54±0.03	-5.12±1.24	0.362
$\Xi^0_0 \to \Lambda + \pi^-$	2.03±0.02	-6.86±0.52	0.207

2. Tests of the $\Delta I=1/2$ Rule

(a) Λ Decay

For Λ decay the $\Delta I = 1/2$ rule predicts that $\Gamma_0/\Gamma_- = 0.50$ and $\alpha_0 = \alpha_-$. In order to determine the magnitude of possible $\Delta I = 3/2$ amplitudes present we write the linear expressions [Overseth and Pakvasa (1969)] for the $\Delta I = 3/2$ S- and P-wave amplitudes in terms of $\Delta\alpha$, where $\Delta\alpha$ is the measured value of α_0/α_- minus the predicted value, and in terms of $\Delta\Gamma$ similarly defined. Evaluating these we find

$$\Delta\alpha = -1.54(S_3/S_1) + 1.61(P_3/P_1),$$
$$\Delta\Gamma = 1.84(S_3/S_1) + 0.26(P_3/P_1).$$

Here the $\Delta I = 3/2$ amplitudes are expressed relative to the $\Delta I = 1/2$ amplitudes. The numerical values of the coefficients depend on the ratio P/S. The uncertainties in the coefficients are small compared to the uncertainties in $\Delta\alpha$ and $\Delta\Gamma$. Final-state π-N interactions have been included in these relations but have a very small effect. From the Stable Particle Table,

$$\Delta\alpha = 0.006 \pm 0.066, \quad \Delta\Gamma = 0.058 \pm 0.012,$$

and hence

$$(S_3/S_1) = 0.027 \pm 0.008$$

and

$$(P_3/P_1) = 0.030 \pm 0.037.$$

The possible 3% $\Delta I = 3/2$ S-wave amplitude is due to the disagreement of decay rates with prediction. At this level the results are sensitive to electromagnetic corrections. However, in Λ decay the phase space correction and the other radiative corrections appear to be about equal in magnitude and have opposite signs [Belavin and Narodetsky (1968); and Intemann (1973)], and hence cancel each other in the correction to the decay rates.

(b) Ξ Decay

The analysis for Ξ decay is very similar to that for Λ decay. If the $\Delta I = 1/2$ rule is valid, $\Gamma_0(\Xi^0)/\Gamma_-(\Xi^-) = 0.50$ and $\alpha_0 = \alpha_-$. For this case the expressions linear in $\Delta I=3/2$ S- and P-wave amplitudes are [Overseth and Pakvasa (1969)]

$$\Delta\alpha = 1.37(S_3/S_1) - 1.37(P_3/P_1),$$
$$\Delta\Gamma = -1.44(S_3/S_1) - 0.06(P_3/P_1).$$

From the Stable Particle Table,

$$\Delta\alpha = -0.040 \pm 0.234, \quad \Delta\Gamma = 0.061 \pm 0.025,$$

and we find

$$(S_3/S_1) = -0.042 \pm 0.018$$

and

$$(P_3/P_1) = -0.013 \pm 0.164.$$

U U U U U 6 U 4 U 5 2

(c) Σ Decay

The traditional test of the $\Delta I = 1/2$ rule in Σ decay is that the amplitudes satisfy the relationship $\sqrt{2}\,\Sigma_0^+ + \Sigma_+^+ - \Sigma_-^- = 0$. Graphically this is equivalent to closing the Σ triangle when the amplitudes are plotted on A, B axes. Including $\Delta I \geq 3/2$ amplitudes in Σ decay analysis, the "Σ triangle" relationship becomes

$$\sqrt{2}\,A_0 + A_+ - A_- = -3\sqrt{\frac{2}{5}}\,A_3 + \frac{2}{\sqrt{15}}\,A_5,$$

where A_3, A_5 are $\Delta I = 3/2$, $5/2$ amplitudes, respectively. There is a similar equation for the B amplitudes. From Table I,

$$\sqrt{2}\,A_0 + A_+ - A_- = 0.19 \pm 0.11$$

$$\text{and } \sqrt{2}\,B_0 + B_+ - B_- = 2.41 \pm 1.23.$$

If we neglect the $\Delta I = 5/2$ amplitudes and assume all amplitudes to be real we can solve for possible $\Delta I = 3/2$ amplitudes. The result is

$$\frac{A_3}{A_-} = -0.052 \pm 0.029$$

and

$$\frac{B_3}{B_+} = -0.067 \pm 0.033.$$

Thus for hyperon decay, present experimental data limit $\Delta I = 3/2$ amplitudes to less than about 5%.

3. The Lee-Sugawara Relation

From Table I the Lee-Sugawara [Lee (1964) and Sugawara (1964)] relation $\sqrt{3}\,\Sigma_0^+ + \Lambda_- - 2\,\Xi_-^- = 0$ is satisfied to -0.03 ± 0.15 for the A amplitudes, and to 2.83 ± 2.50 for the B amplitudes.

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$$\frac{\Gamma^0}{\Gamma^-} \approx \frac{1}{2}\left\{1 + 3\sqrt{2} \times \left(\frac{[S_{11}S_{33}\cos(\delta_1 - \delta_3) + P_{11}P_{33}\cos(\delta_{11} - \delta_{31})]}{S_{11}^2 + P_{11}^2}\right)\right\}.$$

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