Title

EVIDENCE CONCERNING p -EXCHANGE IN THE REACTIONS n+p -> n| A++ AND n+p u> wo A++

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Sun Yiu Fung, Warren Jackson, and Robert Pu

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July 1968

The Regge pole model is most easily tested in reactions where only a single trajectory can be exchanged in the t-channel. The success of the single ρ trajectory model in describing the $\pi^- p$ charge exchange reaction[1] has prompted us to extend the available data on two other reactions expected to be dominated by ρ exchange;

1) $\pi^+ p \to \pi^\circ \Delta^{++}$

2) $\pi^+ p \to \omega^\circ \Delta^{++}$

The results for reaction 2) have already been published[2] and we shall only make a few further remarks. Preliminary results based on 538 events of reaction 1) are presented.

The dip observed near t = -0.5 in the differential cross section for the $\pi^- p$ charge exchange reaction has been interpreted as evidence for the ρ-trajectory passing through zero at this point. That we did not observe such a dip in reaction 2) has been interpreted as evidence for the dominance of the B meson trajectory in that reaction. However, in reaction 1) only the ρ trajectory can be exchanged, providing a better test of the model. The low production cross section and rapid fall-off of $d\sigma/dt$ require the increased statistics of this experiment to discern such a dip. The detailed behavior of $d\sigma/dt$ at very small momentum transfer is also of interest in this regard.[3]

We present only a brief discussion of the experimental techniques to allow the reader a better evaluation and for comparison with previous experiments.[4]

96 000 two prong and 40 000 four prong events distributed among the five incident π^+ momenta 2.95, 3.20, 3.53, 3.74, and 4.08 GeV/c were measured on the FSD machine. Extensive use was made of the automatic

ionization measurements available from the FSD. The details of the exposure and reaction 2) have been described elsewhere.[5] The major problems in the analysis of reaction 1) are: (i) Proton contamination in the beam; this contamination varied from 3-20% in our momentum range and is a particularly severe problem in the small momentum transfer region. Here the process $pp \rightarrow \pi^+ p\ n$ is difficult to distinguish from the process $\pi^+ p \rightarrow \pi^+ p\ \pi^\circ$ with the usual constraint and ionization methods. It is important to make this distinction since the former has a cross section approximately 15 times the latter in our energy range, making even a small beam proton contamination manifest. However, the π, p mass difference produces a small upward shift in the missing mass when a real proton event is treated as a pion event. We have measured small samples of film with incident protons at 2.95, 3.65, and 4.0 GeV/c and have verified that a cut on the missing mass squared of 0.04 removes all proton events at all but the highest incident energy. This asymmetric cut certainly distorts the mass spectra but this distortion is minimal when we restrict ourselves to the Δ^{++} band $(1.12 < M(\pi^+,p) < 1.32)$. (ii) The process $\pi^+ p \rightarrow \rho^+ p$ overlaps reaction 1) in a region lying entirely in the forward hemisphere of the decay distribution of the Δ^{++} with respect to its direction of motion. This allows us to use the method of Eberhard and Pripstein[6] to remove the overlap events and repopulate the sample with events in the corresponding part of the backward decay hemisphere. These "repopulated events" represent 15% of our sample with a ρ band cut $.64 < M(\pi^+, \pi^\circ) < .90$. Again the highly peripheral nature of the ρ^+ production process reflects itself as very small momentum transfers to the Δ^{++} so that the removal of these overlap events is essential for studying the low t region of reaction 1).

Figure 1. Shows $d\sigma/dt$ for all momenta combined. The insert shows the small momentum transfer region with the 4.08 GeV/c data removed to eliminate residual proton contamination. The dip near $t = -0.5$ is clearly established. (Absolute normalization should be taken as tentative at this time).

Figure 2. Shows the t-dependence of the density matrix elements for the Δ^{++} decay. The only sign of a dip near $t = -0.5$ is seen in ρ_{33}. The 4.08 GeV c data have been removed below $t = -0.2$. The insert shows the behavior of ρ_{33} at very small momentum transfer. We remark that removing the ρ-overlap is especially important in this region since not to do so significantly reduces ρ_{33}. Note that ρ_{33} must go to zero at $t = 0$.

Figure 3. Shows the cross section for reaction 1) as a function of the incident momentum; it decreases roughly as $p^{-1.5}$.

Several attempts have been made to extract the ρ exchange contribution for reaction 2).[7] In particular, the asymptotic relation $\rho_{1-1} = -\rho_{11}$ should be satisfied at the value of t where the ρ exchange contribution vanishes or, more practically, the combination $\sigma_1^+ \equiv \rho_{11} + \rho_{1-1}$ should exhibit a minimum. In Figure 4 we show $d\sigma/dt(t)$ and $\sigma_1^+(t)$ for our data. While no dip is observed at $t = -0.5$, we note a suggestion of a dip at $t = -0.8$ in both distributions. Such a dip also seems to occur in the data of Alff-Steinberger, et al.[8] between 2.3 and 2.9 GeV c incident momentum. In no single distribution is the dip statistically significant, but its recurrence suggests further experiments.

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REFERENCES

* Work done under the auspices of the U.S. Atomic Energy Commission.

1. G. Höhler, J. Baacke, H. Schlaile, P. Sondereggar, Phys. Letters 20, 79 (1966); F. Arbab and C. B. Chiu, Phys. Rev. 147, 1045 (1966).
2. D. Brown, G. Gidal, R. W. Birge, R. Bacastow, S. Y. Fung, W. Jackson, R. Pu, Phys. Rev. Letters 19, 664 (1967).
3. M. Krammer and U. Maor, Nuovo Cimento 50A, 963 (1967); R. Thews Phys. Rev. 155, 1624 (1967); R. Mathews, private communication.
4. M. Abolins, D. Carmomy, D. Hoa, R. Lander, C. Rindfleisch, N. Xuong, Phys. Rev. 136B, 195 (1964); Aachen et al., Phys. Letters 10, 229 (1964) and Phys. Rev. 138B, 897 (1965); Saclay-Orsay-Bari-Bologna Coll. Phys. Letters 13, 341 (1964); M. Deutschmann, et al., Phys. Letters 18, 351 (1965).
5. D. Brown (Thesis), UCRL-18254, (May 1968).
6. P. Eberhard and M. Pripstein, Phys. Rev. Letters 10, 351 (1963).
7. H. Högaasen and H. J. Lubatti, Phys. Letters 26B, 166 (1968); J. P. Ader, M. Capdeville, G. Cohen-Tannoudji, Ph. Salin, CERN Th. 886 (March 1968).
8. C. Alff-Steinberger et al., Phys. Rev. 145, 1072 (1966); N. Gelfand (Thesis), NEVIS 137 (1965).

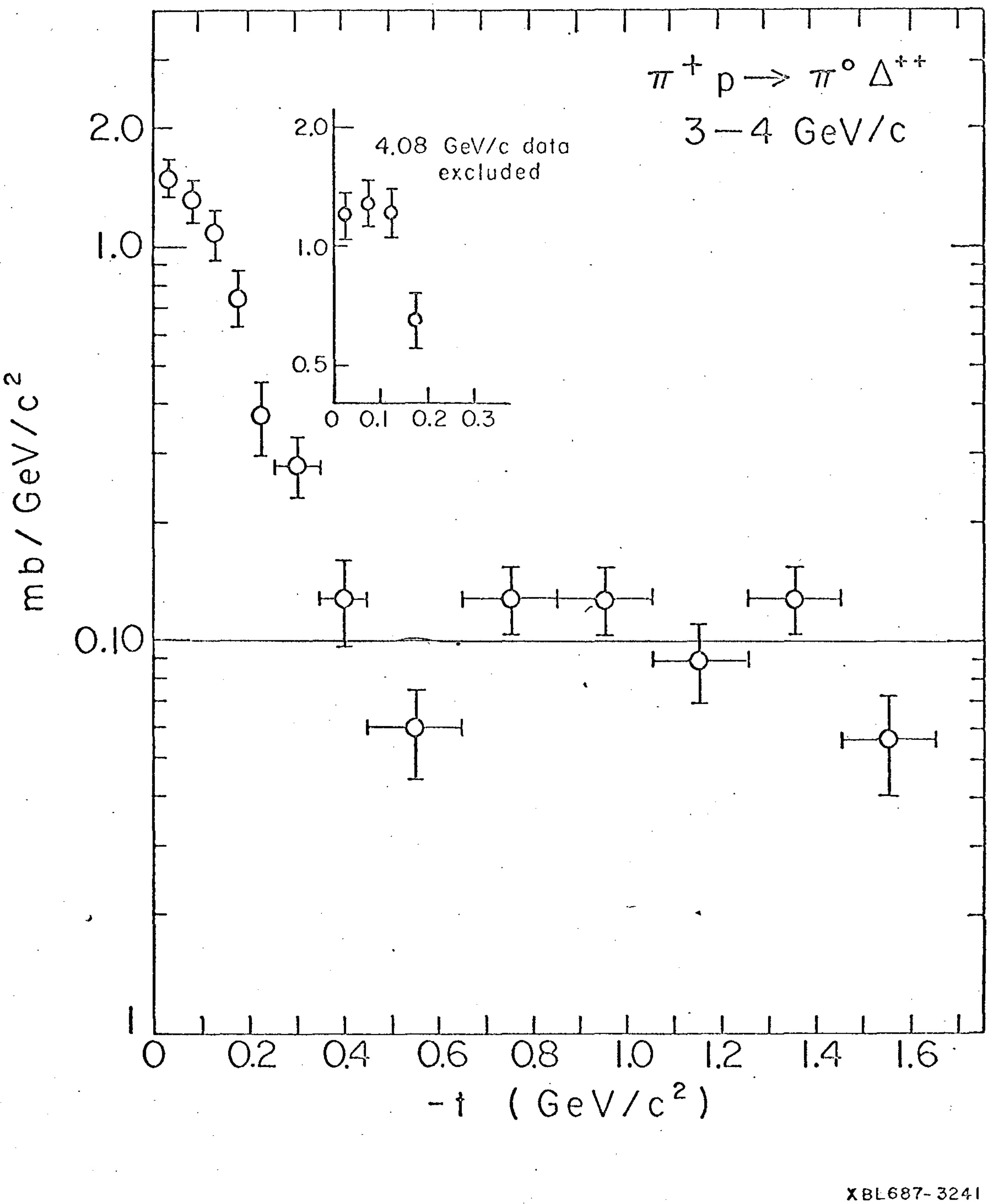
π⁺ p → π° Δ⁺⁺
3—4 GeV/c
4.08 GeV/c data
excluded
2.0
1.0
0.5
0
0.1
0.2
0.3
2.0
1.0
0.10
1
mb / GeV/c²
0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6
-t (GeV/c²)
XBL687-3241

Fig. 1

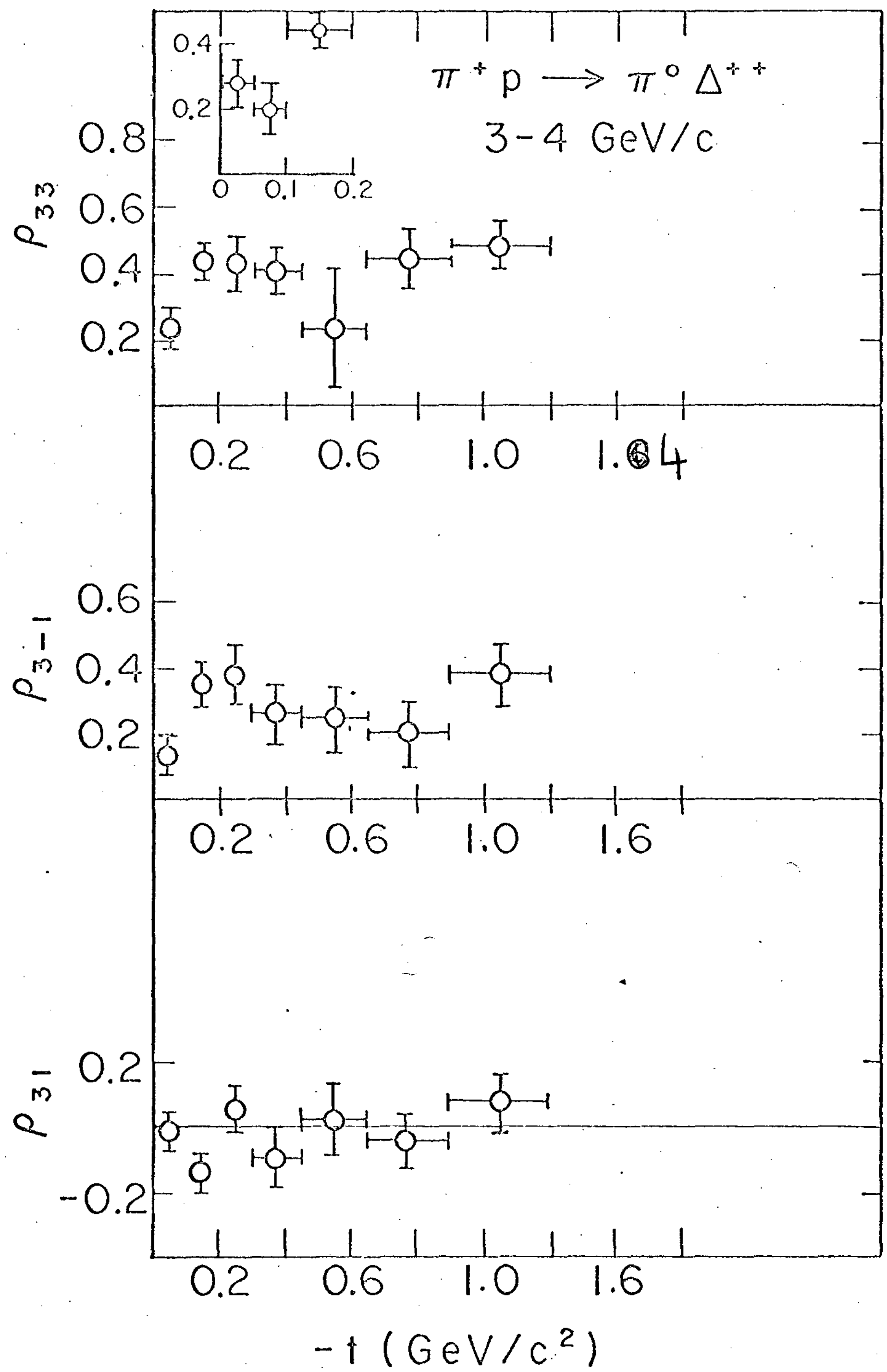

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Fig. 2

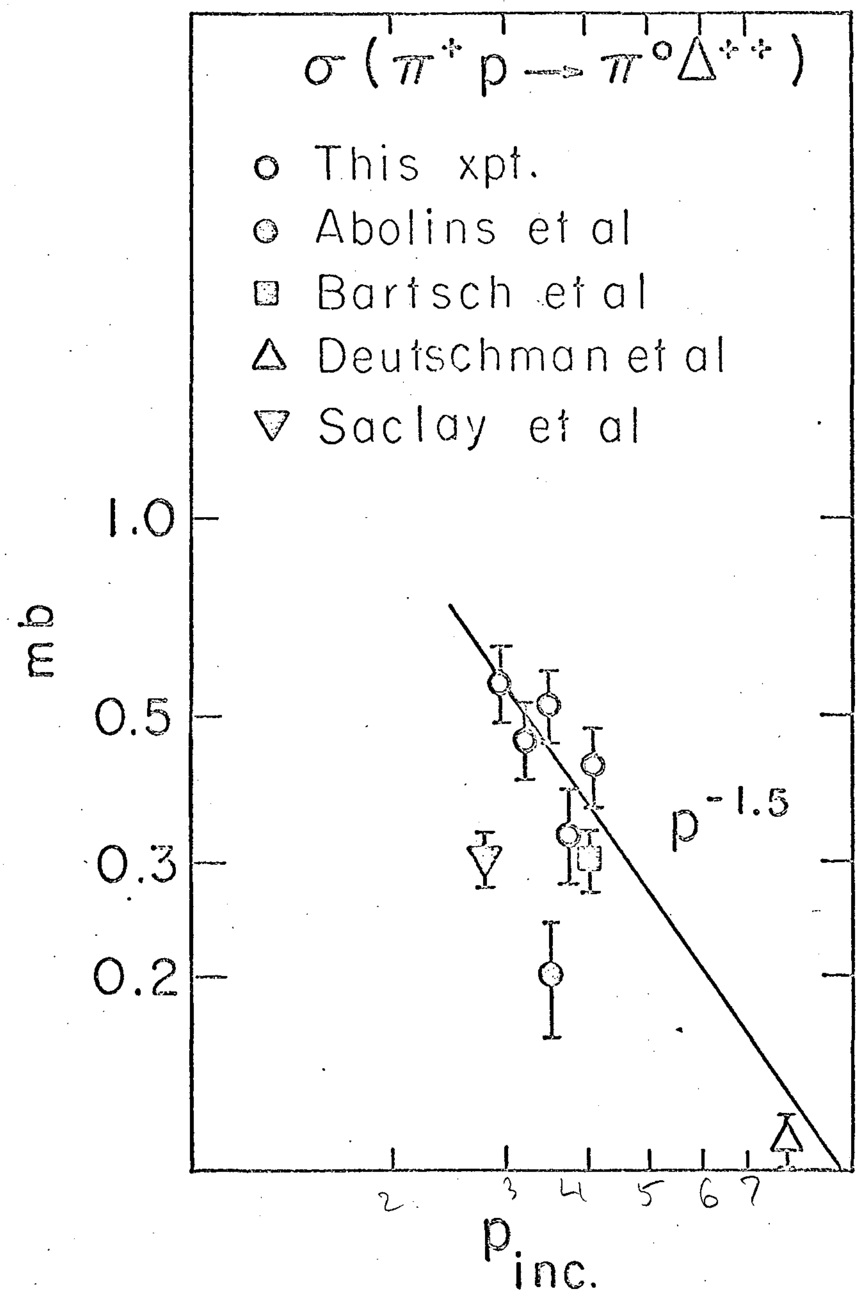

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Fig. 3

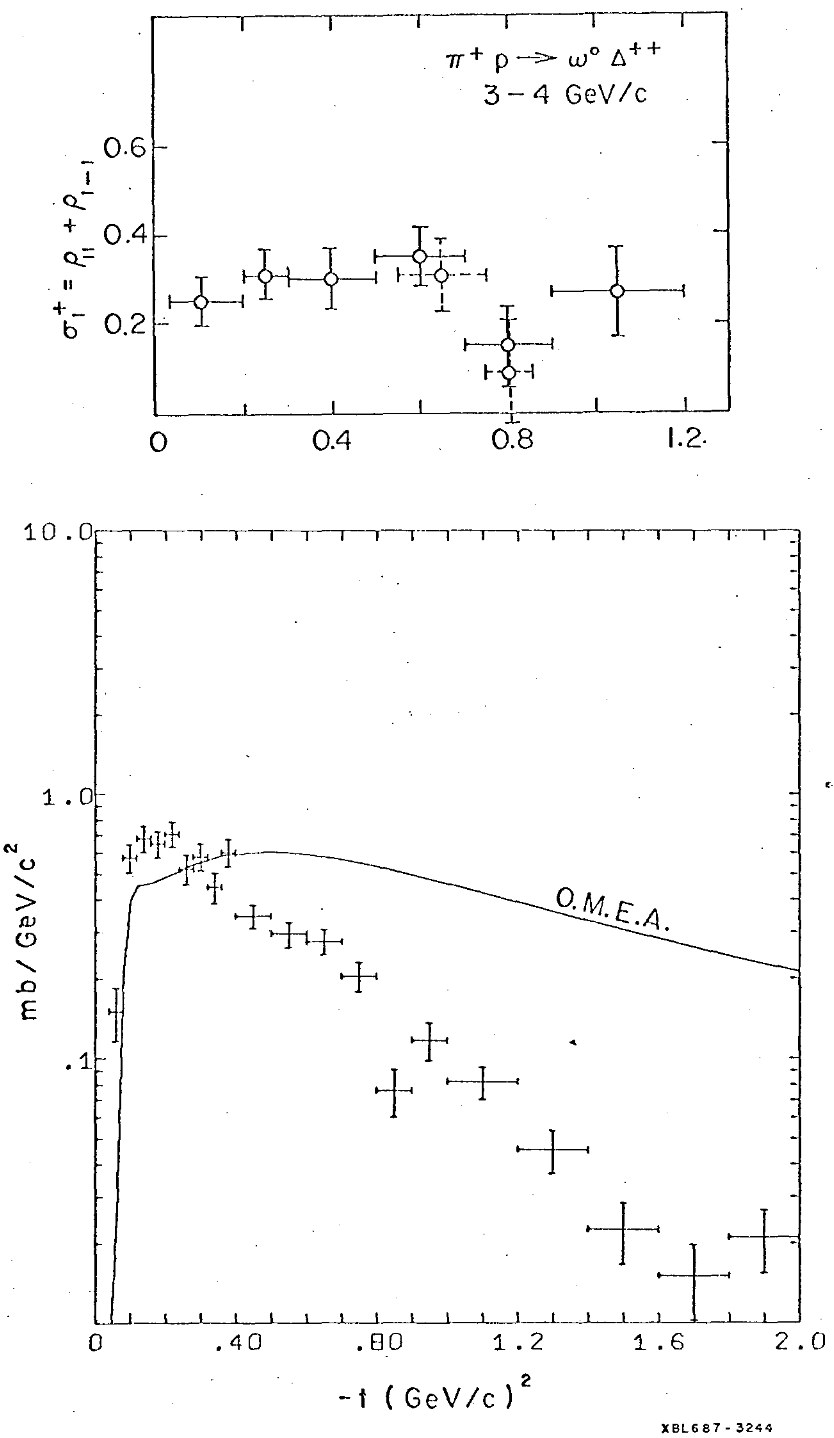
$\pi^+ p \to \omega^\circ \Delta^{++}$
3 - 4 GeV/c
$\sigma_1^+ = \rho_{11} + \rho_{1-1}$
0.6
0.4
0.2
0
0.4
0.8
1.2
10.0
1.0
.1
mb/GeV/c²
O.M.E.A.
0
.40
.80
1.2
1.6
2.0
-t (GeV/c)²
XBL687-3244

Fig. 4