Title

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PRODUCTION OF STRANGE-PARTICLE RESONANT STATES IN $\pi^- + p$ INTERACTIONS AT 3.2 AND 4.2 GeV/c*

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(Presented by D. H. Miller)

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The general properties of the three- and four-body final states containing a Λ or $\Sigma^{\pm,0}$ are being studied at 3.2 and 4.2 GeV/c. In this report we discuss the meson and baryon resonances that contribute most significantly to these final states. Evidence is presented for the increasing importance of peripheral collisions involving boson exchange as the incident π^- momentum is raised.

I. YπK FINAL STATES

Several investigations of $\pi^{\pm}p$ interactions in the 1.5 to 2.5-GeV/c region have demonstrated that most $Y\pi K$ events are produced through either

$$\pi^- + p \to Y + K^*(888) \to Y + \pi + K$$

or

$$\pi^- + p \to Y^* + K \quad\quad \to Y + \pi + K,$$

with Y^*'s and K^*'s produced with comparable rates in both the $\Lambda\pi K$ and $\Sigma\pi K$ final states.[1] This situation changes rapidly with increasing π^- momentum.

The effective-mass distributions for the $K\pi$ combinations are given in Fig. 1. At 3.2 GeV/c, most $\Lambda\pi^-K$ and $\Sigma^0\pi^-K^+$ events result from the YK^*

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intermediate state. In both cases, the YK^* system can be produced in peripheral collisions involving K or K^* exchange. It may be noted that the $\Sigma^-(K\pi)^+$ final state also contains a strong K^* contribution. However, the center-of-mass angular distribution for Σ^-K^{*+} production approximates $\cos^2\theta$, in contrast to that for ΛK^{*0} or Σ^0K^{*0}, where the K^*'s are peaked sharply in the backwards direction as expected for a boson-exchange mechanism. At 4.2 GeV/c, the two peripherally produced K^{*0}'s still contribute strongly, while the relative importance of the Σ^-K^{*+} intermediate state is decreased markedly. No evidence for any resonant $K\pi$ state other than $K^*(888)$ is observed.

The effective-masses for the $Y\pi$ combinations are plotted in Fig. 2. At 3.2 GeV/c, clear contributions arise only from those low-mass baryon resonances that may be produced peripherally - - $Y_1^{*0}(1385)$, $Y_0^*(1405)$, and $Y_0^*(1520)$; little evidence for $Y_1^{*-}(1385)$ is apparent. Although either statistical or measurement accuracy may obscure the presence of higher-mass baryon resonances, they cannot contribute strongly, since most of the remaining $Y\pi$ combinations are reflections of the YK^* intermediate state. At 4.2 GeV/c, the relative contributions of even the low-mass baryon resonances are further reduced.

II. THE $Y\pi\pi K$ FINAL STATES

The effective-mass distributions for all $\Lambda\pi$ and $K\pi$ combinations from the $\Lambda\pi\pi K$ events are plotted in Figs. 3 and 4. At 3.2 GeV/c, $Y_1^*(1385)$ production is copious in all charge states, although only Y_1^{*0} and Y_1^{*+} can be produced peripherally. In addition, both K^{*0} and K^{*+} are produced strongly. Further examination of the correlations in these events indicates that essentially all Y_1^{*0}'s are produced in association with K^{*0}'s, with a production angular distribution characteristic of boson exchange. However, substantial Y_1^{*-}

production also occurs with K^{*+}, although in this case there is additional resonance production when the remaining $\Lambda\pi$ or $K\pi$ combination is nonresonant. At 4.2 GeV/c most Y_1^* production has disappeared; some K^* production is still apparent.

The $\Sigma\pi$ and $K\pi$ effective masses for the $\Sigma\pi\pi K$ events at 3.2 GeV/c are plotted in Figs. 5 and 6. The distributions again show that resonance production occurs predominantly in those states accessible through boson exchange, K^*Y^*(1405 or 1520), and $K^{*0}Y_1^{*0}$(1660). The $(\Sigma\pi)^0$ distribution is remarkably similar to that for the $(\Sigma\pi)^0K^0$ final state studied from 2.0 to 2.4 GeV/c, where the same resonant states are strongly excited.[1]

All three-body effective-mass combinations from these states have been examined for evidence of $Y^*\pi$ of $K^*\pi$ resonances. Unfortunately, the complexity of the final states makes interpretation of possible enhancements ambiguous. However, in searching for new boson resonances in the $\Lambda\pi\pi K$ final state, it is not practical to eliminate all Y_1^* events in the same manner that N^* events are suppressed in the analogous $p\pi^-\pi^+\pi^+$ final state, since the Λ resonates equally strongly with pions of all charges. Nevertheless, it is of interest to compare the $K\pi\pi$ distributions with those observed in other experiments. Thus far, two $K\pi\pi$ enhancements have been reported in the mass interval accessible in the present experiment. The first, at 1230 MeV with full-width $\Gamma \approx 60$ MeV, was observed by Armenteros et al. in a study of $\bar{p}p$ annihilations at rest;[2] the second at 1175 MeV with $\Gamma \lesssim 50$ MeV, was observed by Wangler et al. in π^-p interactions at 3.0 GeV/c.[3]

In Fig. 7 we have plotted our data separately for the three momenta near 3.2 GeV/c, at which measurements were made (these were grouped together in the previous discussion). The solid curves represent phase space when modified for Y^* production. No systematic enhancement is apparent in the distributions. Only at 3.01 GeV/c is there any evidence for an enhancement, with a peak at ~ 1230 MeV and $\Gamma \simeq 80$ MeV. Since this peak is not observed at the other momenta shown, we cannot conclude that it represents a valid $K\pi\pi$ effect; although it might correspond to the enhancement reported by Armenteros et al.[2] In this case, the data would suggest a surprising energy dependence for the peak. No evidence is observed for a $K\pi\pi$ peak at 1175 MeV as reported by Wangler et al.[3]

We conclude that the contributions from baryon resonances to three- and four-body final states decrease rapidly with increasing π^- momentum; the K^* contribution decreases considerably more slowly. Only the low-mass baryon resonances are observed. At increasing π^- momentum, resonance production occurs predominantly in charge configurations accessible through boson exchange.

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FIGURE LEGENDS

Fig. 1. Effective-mass distributions for $K\pi$ systems in $Y\pi K$ final states: a, b, c are for 3.2 GeV/c ; d, e, f, are for 4.2 GeV/c.

Fig. 2. Effective-mass distributions for $Y\pi$ combinations in $Y\pi K$ final states: a, b, c, d are for 3.2 GeV/c; e, f, g, h are for 4.2 GeV/c.

Fig. 3. Effective-mass distributions for $\Lambda\pi$ systems in $\Lambda\pi\pi K$ final states: a, b, c are for 3.2 GeV/c; d, e, f are for 4.2 GeV/c.

Fig. 4. Effective-mass distributions for $K\pi$ systems in $\Lambda\pi\pi K$ final states: a, b, c are for 3.2 GeV/c; d, e, f are for 4.2 GeV/c.

Fig. 5. Effective-mass distributions for $\Sigma\pi$ combinations in $\Sigma\pi\pi K$ final states at 3.2 GeV/c.

Fig. 6. Effective-mass distributions for $K\pi$ systems in $\Sigma\pi\pi K$ final states at 3.2 GeV/c.

Fig. 7. Effective-mass distributions for positive and neutral $K\pi\pi$ combinations.

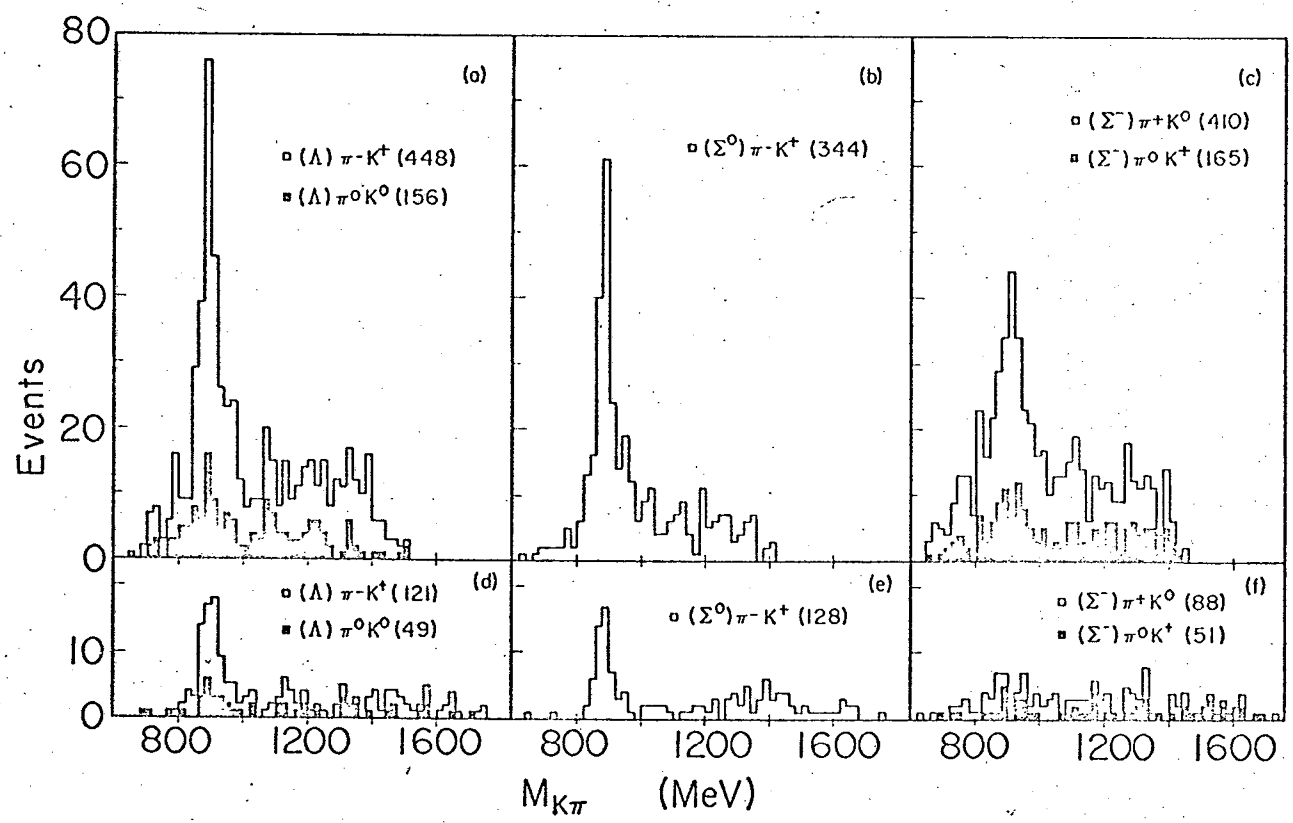


Fig. 1

MUB-3197

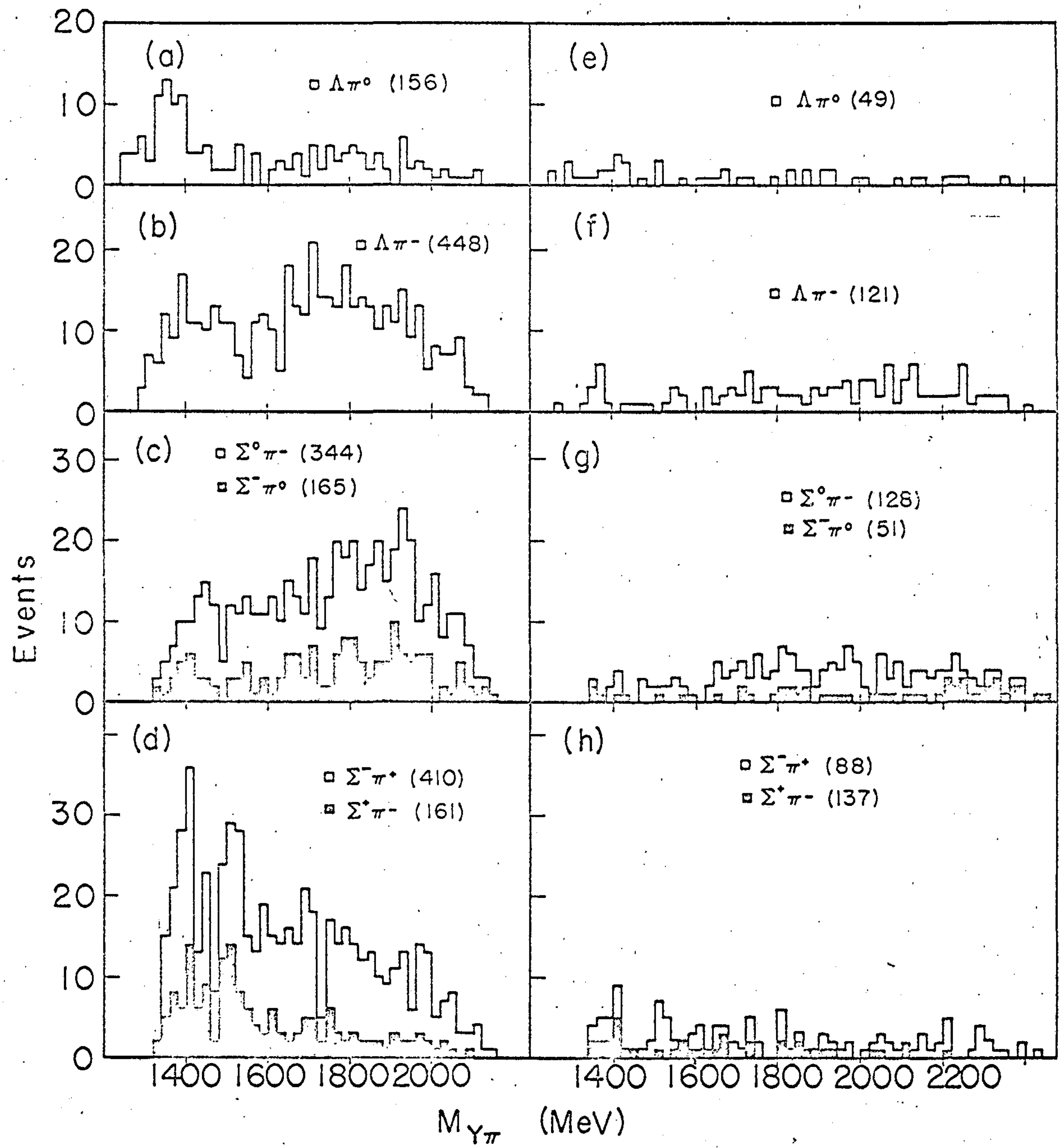


Fig. 2

MUB-3192

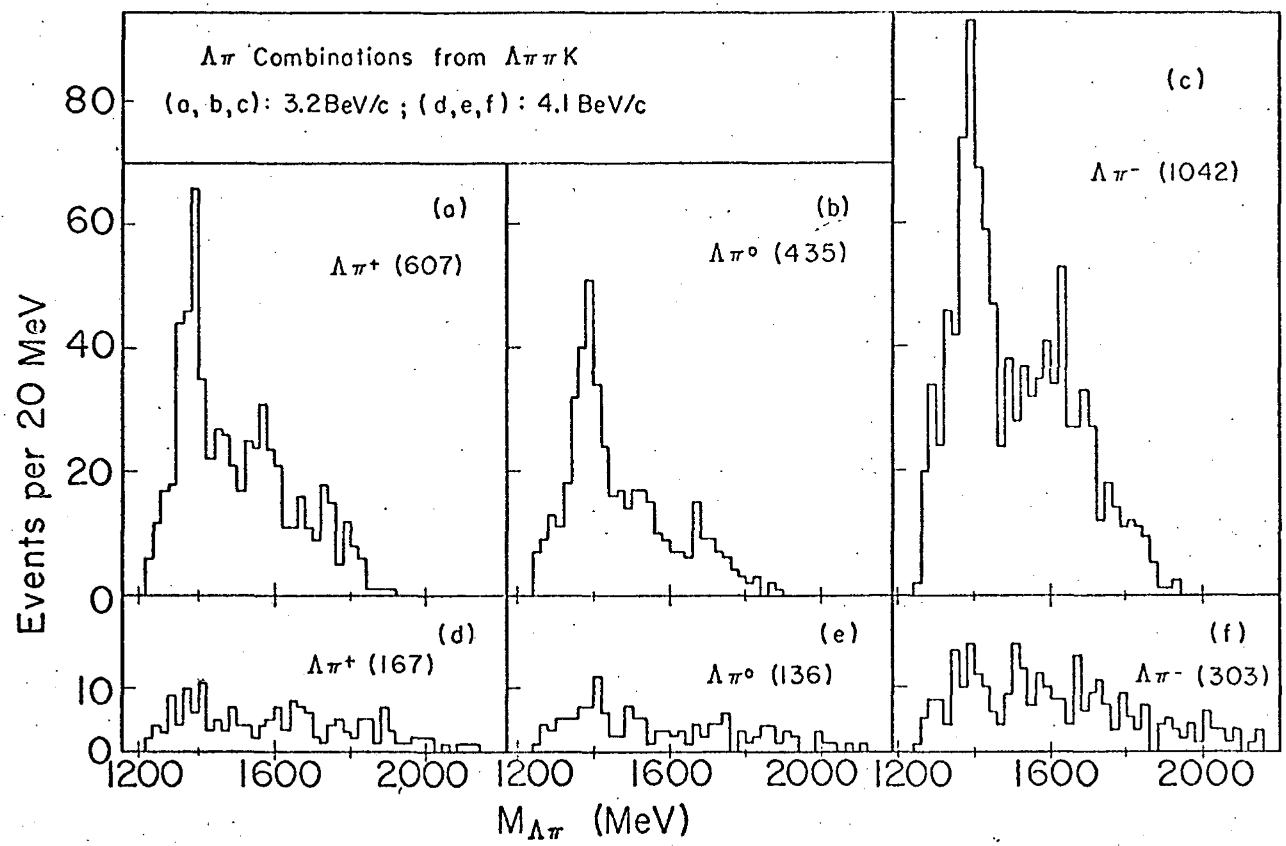


Fig. 3

MUB-3220

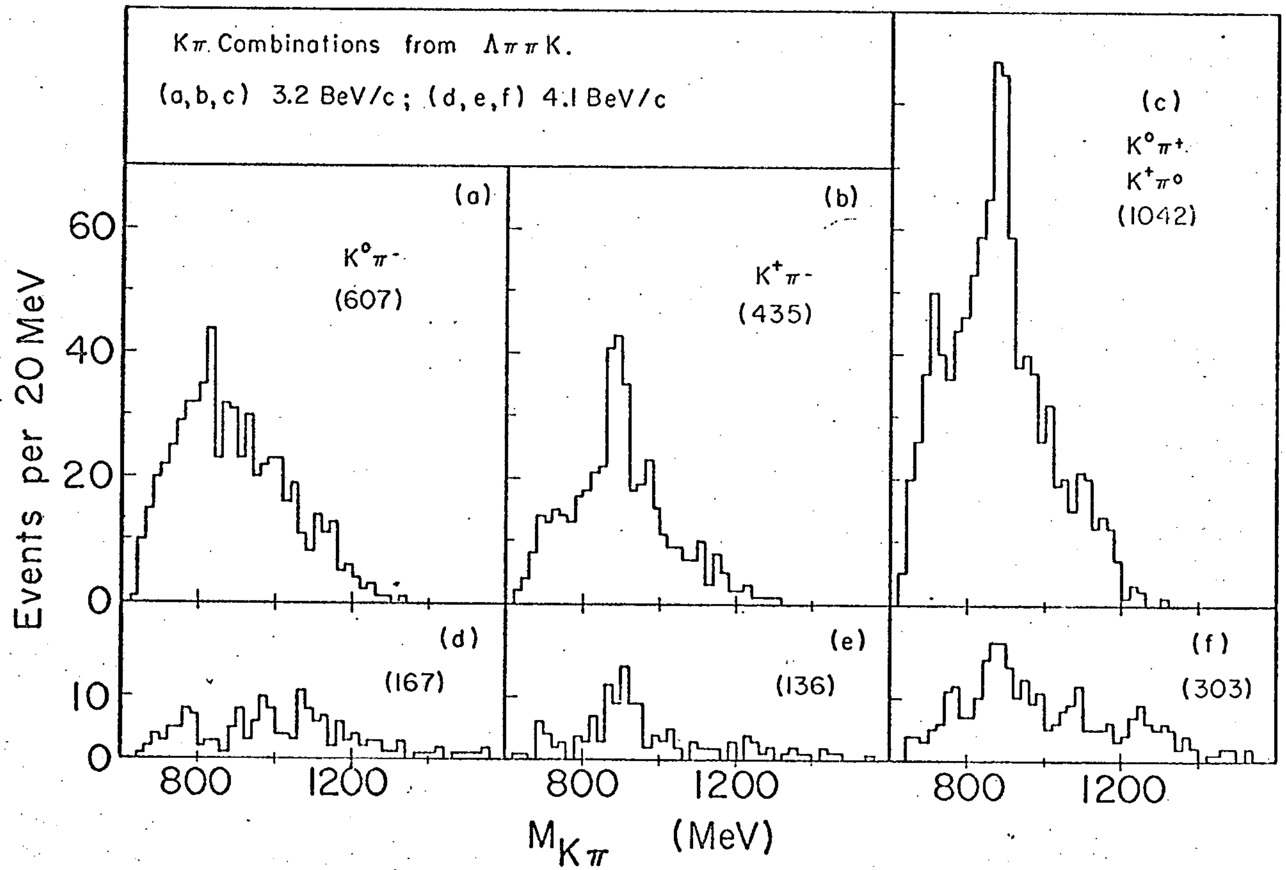
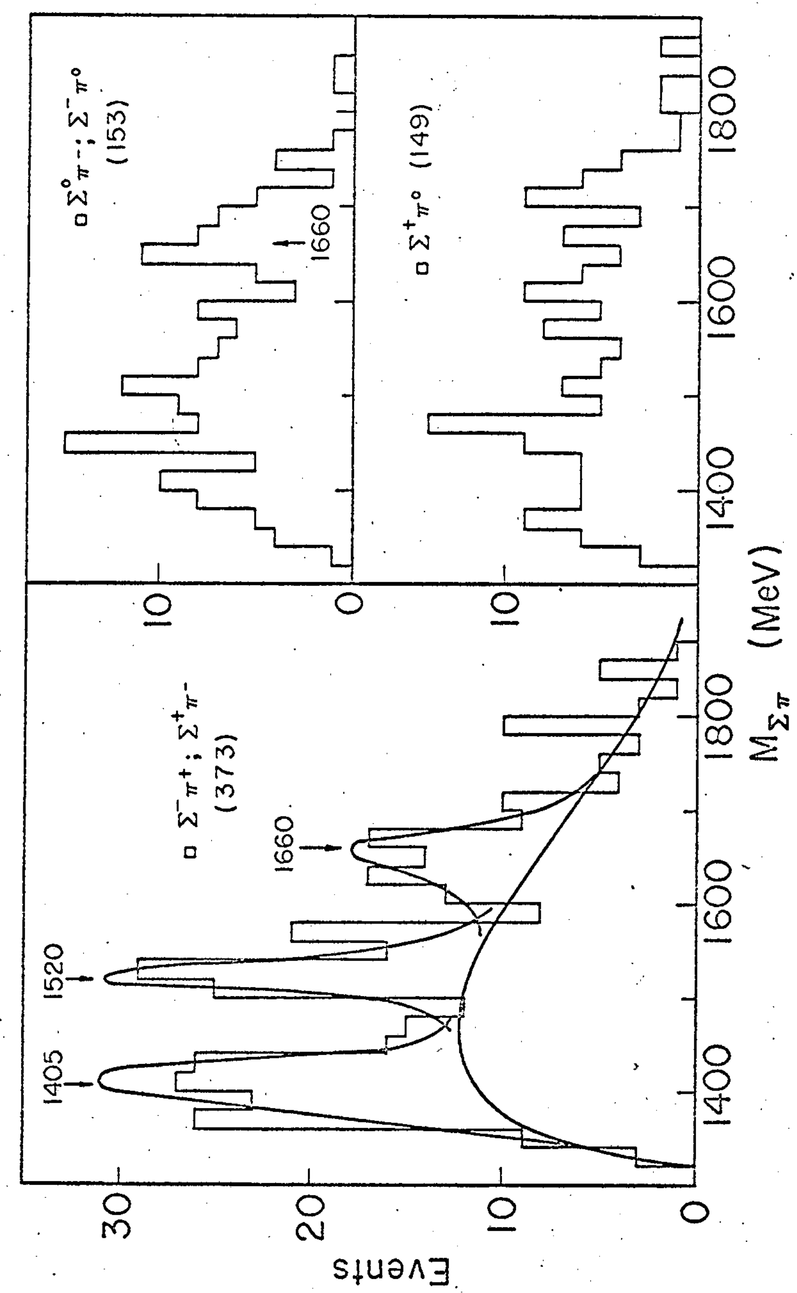


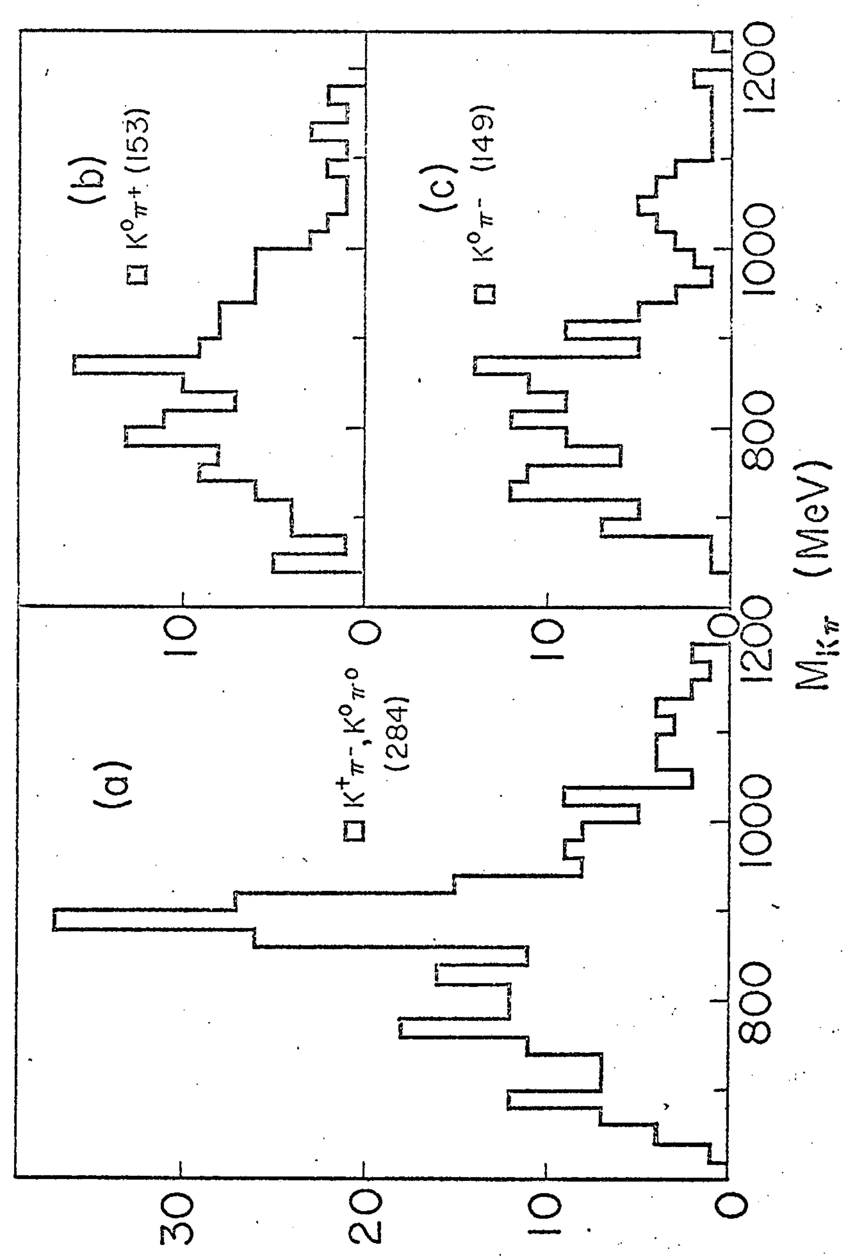
Fig. 4

MUB-3221



MUB-3195

Fig. 5



MUB-3200

Fig. 6

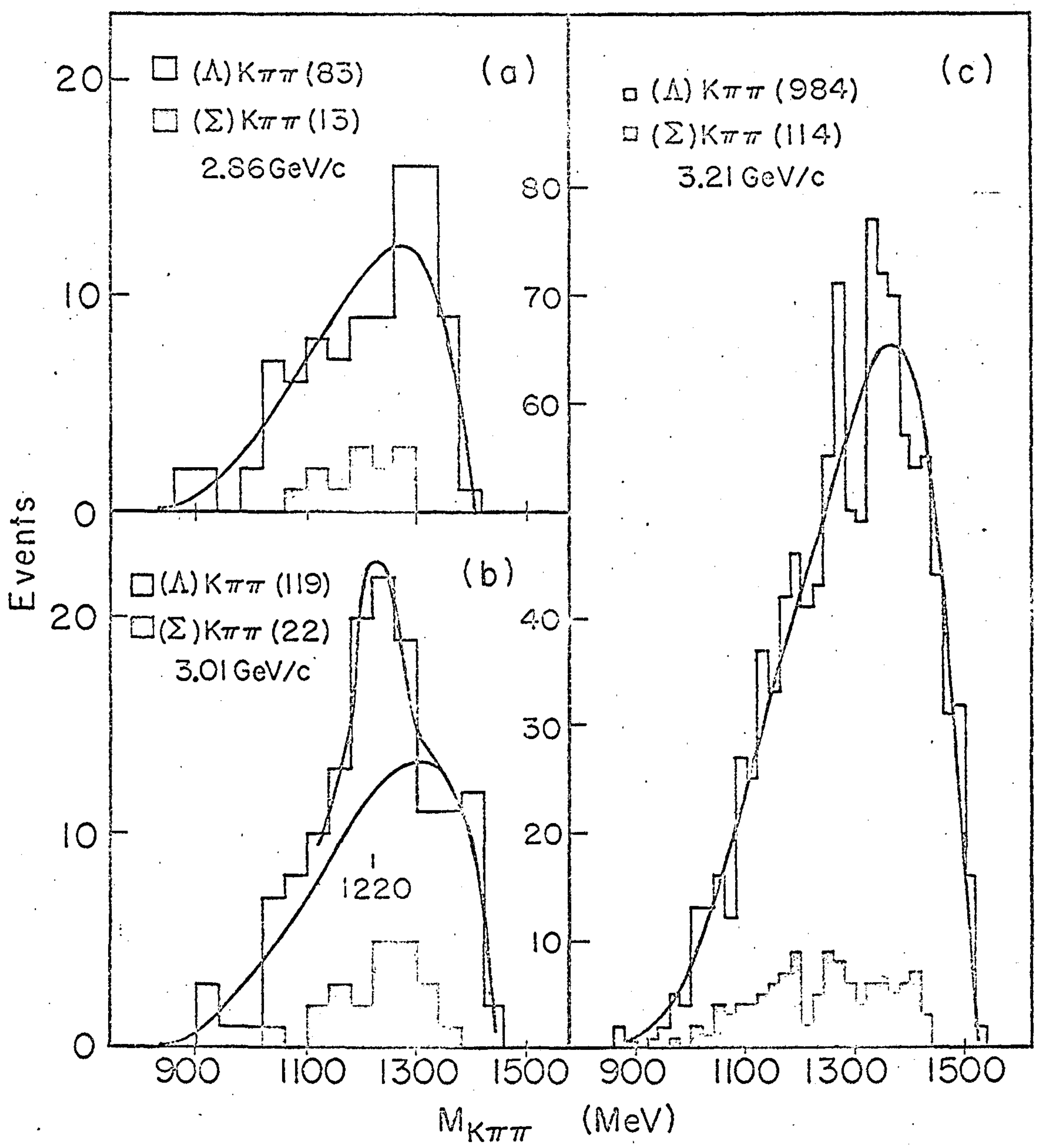


Fig. 7

MUB-3198