EVIDENCE AGAINST AN $I=\frac{5}{2}$ BARYON RESONANCE OF MASS 1640 MeV/c^2*

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Recently evidence has been presented for the production of an $I=\frac{5}{2}$ nonstrange baryon resonance of mass $\cong$1640 MeV/c^2 in the reaction $\pi^- d \to (p)n\pi^-\pi^-\pi^+$. With much greater statistics, our data for the charge-symmetric reaction fail to show any evidence for such a resonance.

Benvenuti, Marquit, and Oppenheimer[1] have reported confirmation of an $I=\frac{5}{2}$ baryon resonance of mass 1640 MeV/c^2 previously seen by Banner et al.[2] It is the purpose of this paper to present equivalent data with greatly improved statistics, showing no enhancement in this mass region.

Benvenuti, Marquit, and Oppenheimer present data on the reaction

$$\pi^- d \to (p)n\pi^-\pi^-\pi^+ \qquad (1)$$

at an incident pion momentum of 2.26 BeV/c. Here (p) indicates that the final-state proton does not take part in the reaction. 2447 three-pronged events (with protons of momentum too low to produce a visible track in the bubble chamber) were analyzed in their paper. They report a narrow ($\Gamma \leq 60$ MeV/c^2) peak in the $n\pi^-\pi^-$ mass spectrum, which is enhanced to 4 standard deviations when the momentum transfer from the beam to the π^+ is restricted to less than 0.6 (BeV/c^2)^2. They also make cuts which indicate that the peak may decay via a $\Delta^-(1236)\pi^-$ mode.

We have analyzed $\approx$16 000 four-pronged events from the reaction

$$\pi^+ d \to (n)p\pi^+\pi^+\pi^- \qquad (2)$$

at incident momenta between 1.1 and 2.37 BeV/c. By charge symmetry this reaction is identical in its description to Reaction (1); however, these events admit a better mass resolution than the three-pronged events of Ref. 1. The events analyzed have been selected to have neutron laboratory momentum less than 300 MeV/c in order to insure that the neutron is a "spectator" to the collision. We have also excluded events with confidence level, for Reaction (2), of less than 1%. We estimate that the contamination from other final states is less than 5 %.

Our data have been divided into two intervals in beam momentum; the exposure size for each interval is about 7 events/μb. Interval I contains momentum settings at 1.10, 1.30, 1.52, 1.58, and 1.70 BeV/c; interval II contains momentum settings at 1.86, 2.15, and 2.37 BeV/c. The latter interval spans the momentum settings of Refs. 1 and 2.

Figure 1 shows the $p\pi^+\pi^+$ mass spectrum; the shaded events are those for which the beam-to-π^- momentum transfer is less than 0.6 (BeV/c^2)^2. We note that this figure is equivalent to Fig. 1(a) of Ref. 1. We see no enhancement at or near 1640 MeV/c^2, either in the raw data or after the momentum-transfer cut. For completeness, Figs. 2 and 3 show data corresponding to Figs. 1(b) and 2 of Ref. 1. Selecting $\Delta^{++}\pi^+$ events (Fig. 2) does not produce an enhancement, nor does excluding $\Delta^{++}\rho^0$ events (Fig. 3).

We note that the momentum-transfer cut made by Benvenuti, Marquit, and Oppenheimer, and reproduced in our Fig. 1, would enhance the production of an assumed $I=\frac{5}{2}$ baryon resonance if it were produced via the exchange of a meson.

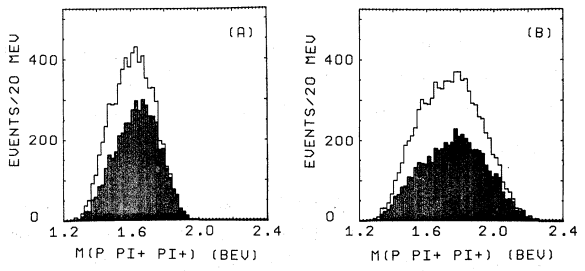

FIG. 1. $p\pi^+\pi^+$ mass spectrum; shaded events are those with beam-to-π^- momentum transfer $|t|$ less than 0.6 (BeV/c^2)^2. (a) 7081 events in beam momentum interval I. (b) 9056 events in interval II.

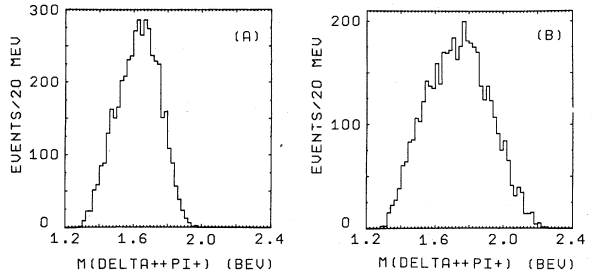

FIG. 2. $\Delta^{++}(1236)\pi^+$ mass spectrum for $|t|$ (beam to π^-) less than 0.6 (BeV/c^2)^2. Δ^{++} is defined as 1120 MeV/$c^2 < M(p\pi^+) <$ 1320 MeV/c^2. (a) Events in beam momentum interval I. (b) Events in interval II.

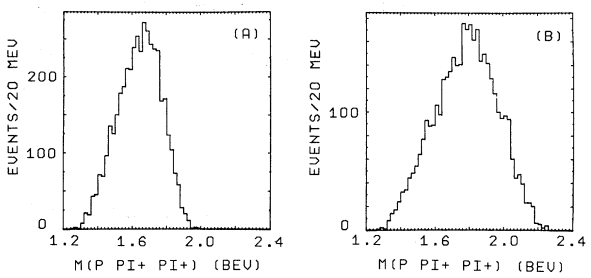

FIG. 3. $p\pi^+\pi^+$ mass spectrum for $|t|$ (beam to π^-) less than 0.6 (BeV/c^2)^2, and $\Delta^{++}\rho^0$ events excluded. Δ^{++} is defined as in Fig. 2; ρ^0 is defined as 710 MeV/$c^2 < M(\pi^+\pi^-) <$ 810 MeV/c^2. (a) Events in beam momentum interval I; (b) Events in interval II.

However, in this case the meson would have to be doubly charged. A more likely exchange mechanism for production of an $I=\frac{5}{2}$ baryon in these reactions would be $I=\frac{3}{2}$ baryon exchange. We have also made cuts corresponding to production by baryon exchange, and we see no enhancement. Finally we note that we have examined the $p\pi^+\pi^+$ mass spectrum at each of our momentum settings separately, and we find no evidence for an enhancement at any of them.

In conclusion, we see no evidence for a narrow ($\Gamma \leq$ 60 MeV/c^2) resonance in the mass range 1500-2000 MeV/c^2. The 40-μb production cross section reported by Benvenuti, Marquit, and Oppenheimer would correspond to a 6-standard-deviation enhancement in either of our beam momentum intervals.

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[1]A. Benvenuti, E. Marquit, and F. Oppenheimer, Phys. Rev. Letters 22, 970 (1969).

[2]M. Banner et al., in Proceedings of the International Conference on Elementary Particles, Heidelberg, Germany, 1967, edited by H. Filthuth (North-Holland Publishing Company, Amsterdam, The Netherlands, 1968), p. 112. Note added in proof.– Banner et al. now interpret their data as showing no structure identifiable as an $I=\frac{5}{2}$ baryon resonance (M. Banner et al., to be published).

OBSERVATION OF $A_1^{+,0}$ PRODUCTION IN K^+p INTERACTIONS AT 12.7 GeV/c †

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We observed statistically significant peaks in the charged and neutral three-pion mass spectra at the position of the A_1 in the reactions $K^+p \to K^{0,+}p\pi^+\pi^-\pi^{+,0}$ at 12.7 GeV/c. We discuss the possible interpretation of these peaks.

The A_1 meson has generally been observed as a low-mass enhancement in the charged tri-pion mass spectrum produced in the reaction[1]

$$\pi^\pm p \to \pi^\pm\pi^+\pi^- p. \quad (1)$$

In this reaction the events in the $A_1^\pm$ enhancement have highly peripheral characteristics and several nonresonant diffractive production mechanisms have been proposed to explain the observed charged three-pion mass enhancement characterizing the A_1 region.[2] It has thus never been clearly established whether the A_1 should be regarded as a true resonant state or considered to be a kinematic reflection of some particular production mechanism.[3]

Recently there have been indications of A_1 production in channels other than Reaction (1).[4] In this note we present evidence for the production of a state with the properties of the A_1 in the reactions[5]

$$K^+p \to \begin{cases} K^0p\pi^+\pi^+\pi^- \\ \quad\hookrightarrow \pi^+\pi^-, \end{cases} \quad (2)$$

$$K^+p \to K^+p\pi^+\pi^-\pi^0. \quad (3)$$