SLAC-PUB-1387 (Rev.)
LBL 2634 (Rev.)
July 1974
Revised October 1974

AMBIGUITY RESOLVED: A SINGLE CONTINUOUS SOLUTION FOR $\pi N \rightarrow \pi\pi N$ BELOW 2000 MeV *

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ABSTRACT

New experimental data on $\pi^+ p \rightarrow \pi^+ p \pi^o$ at 1610 MeV has been analyzed within the framework of the isobar model. The partial wave amplitudes obtained from this single energy fit have been compared with the smooth K-matrix fits to the two continuous solutions obtained in a previous analysis of $\pi N \rightarrow \pi\pi N$ in the range 1300-2000 MeV. This test affords a clear choice between the two competing solutions: the 1973 Solution B is the best description of inelastic πN scattering at these energies.

(Submitted for publication.)

*Work supported in part by the U. S. Atomic Energy Commission.
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In the preceding letter[1] a partial wave analysis of the reaction

$$\pi N \rightarrow \pi\pi N$$

was described. Two continuous solutions — "A" and "B" — were found which had basically the same properties in the energy regions (1300-1540) MeV and (1640-2000) MeV where data existed, but which differed dramatically in the continuation across the 100 MeV energy gap.

We have now analyzed 6227 new events from an Imperial and Westfield College experiment on the reaction

$$\pi^+ p \rightarrow \pi^+ p \pi^o$$

at 1610 MeV. Details of the experiment and event selection are reported elsewhere.[2] A single-energy partial wave analysis was performed on the data, within the framework of the isobar model (see previous Letter[1]) and a unique 8-wave fit was obtained (using the same set of amplitudes required at that energy — see Fig. 2 of preceeding Letter[1]). However, only 4 of these Argand amplitudes can be quantitatively compared with both our solutions A and B.[3] This comparison is illustrated in Fig. 1. The four amplitudes at 1610 MeV are shown in the unitary circle at the left of the figure. They are labelled 1, 2, 3, 4, for $\Delta\pi$ (SD_{31}), ρN (SS_{31}), $\pi\Delta$ (DS33), ρN (DS33). Their overall phase is unknown, so the whole 1610-MeV solution can be rotated as a rigid body.

The top row of four Argand plots represents our solution A; the letters J through Z are single-energy fits, the smooth curves are energy-dependent K-matrix fits to these single-energy amplitudes,[4] and the predicted value of each amplitude at 1610 MeV is indicated with an arrow. We have rotated the 1610 MeV solution so that the largest amplitude ($\Delta\pi$ (SD_{31})) has the phase of the K-matrix prediction; then we find that 2 of the remaining 3 partial waves agree badly with the Solution A predictions.

The lower row displays the four corresponding Argand plots for Solution B. Again we rotate the 1610 MeV solution so that the phase of $\Delta\pi$ (SD_{31}) agrees with Solution B, but now all the other phases agree as well.

From visual inspection, it is clear that the new amplitudes fit Solution B much better than Solution A. More quantitatively, two χ^2 have been calculated and are shown below each Argand plot in Fig. 1; a χ^2_K which measures how well all data other than the new 1610 amplitudes fit to the K-matrix curve, and a χ^2 calculated just for the new amplitudes, based on the Imperial College/Westfield College events. It is already clear from the general fit to the previous data (χ^2_K) that solution B is strongly preferred, but the analysis of this new experiment in the "gap" region gives a strong discrimination between the two solutions described in the accompanying letter.[1]

Thus we conclude that Solution B, which, as discussed in Ref. 1, contains evidence for a new $D_{13}(1700)$ and a new $P_{33}(1700)$, confirms the existence of a $P_{13}(1700)$ and a $P_{11}(1700)$, and possesses signs of resonance amplitudes in good agreement with theory[5,6] is the best description of inelastic πN scattering in this energy range.

FIGURE CAPTION

1. Comparison of 4 amplitudes from a fit to the I. C. /Westfield Coll. events at 1610 MeV (the four numbered points in the left circle) with our 1972 Soln. A (top row) and our 1973 Soln. B (bottom row). The letters represent the results of our single-energy fits (D-L 1310-1540 MeV, at approximately 30 MeV intervals, and M-Y 1650-1920 MeV, at approximately 40 MeV intervals), and the curves are K-matrix fits to these single-energy points.

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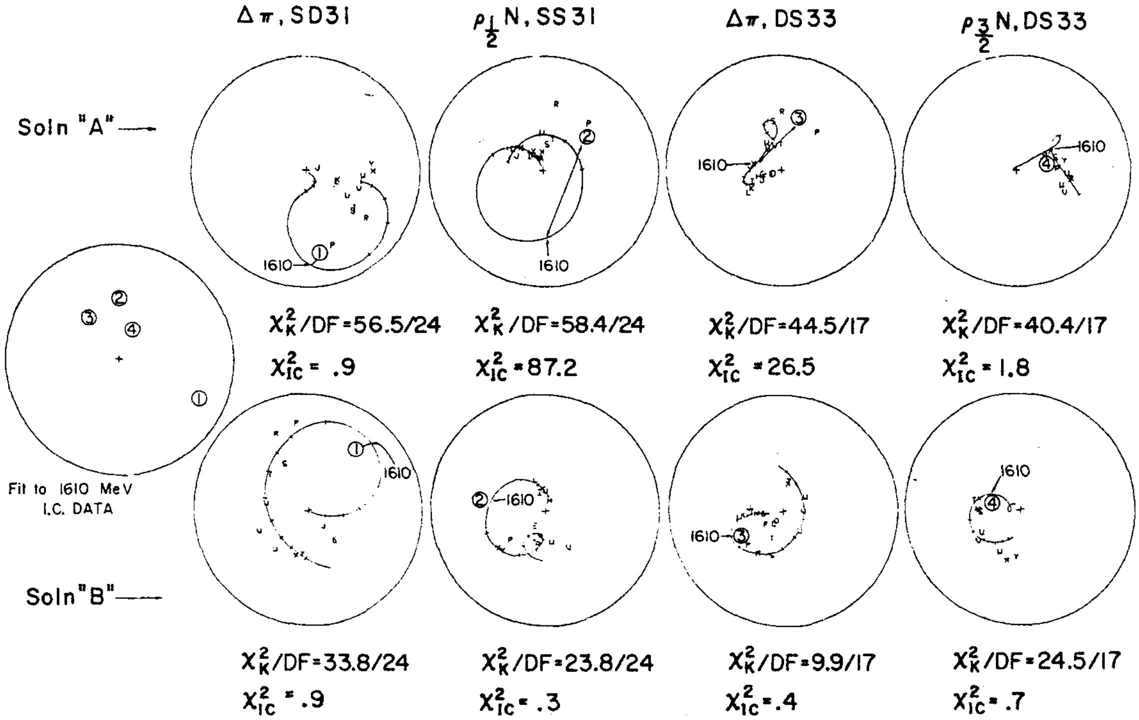

Fig. 1. Comparison of 4 amplitudes from a fit to the I. C./Westfield Coll. events at 1610 MeV (the four numbered points in the left circle) with our 1972 Soln. A (top row) and our 1973 Soln. B (bottom row). The letters represent the results of our single-energy fits (D-L 1310-1540 MeV, at approximately 30 MeV intervals, and M-Y 1650-1920 MeV, at approximately 40 MeV intervals), and the curves are K-matrix fits to these single-energy points. XBL 741-2326