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THE ANALYZING POWER OF THE $pp \to d\pi^+$ REACTION BETWEEN Tp = 725 MeV AND Tp = 2.3 GeV AND THE EXCITATION OF THE N^* ISOBARS

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Angular distributions of the analyzing power Ayo of the reaction $pp \to d\pi^+$ have been measured between Tp = 725 and Tp = 2300 MeV [1,2]. The data have been expressed as a function of the Mandelstam invariant u. In that frame the value $u \simeq 0$ corresponds to the best matching of the neutron and proton momenta to form the deuteron. The values of Ayo at u = 0, obtained by interpolation when necessary, have been plotted as a function of the invariant mass $\sqrt{s_{\pi d}}$ and are shown in Fig. 1. A dip and two bumps centered approximately at $\sqrt{s_{\pi d}} = 2.29$ GeV, $\sqrt{s_{\pi d}} = 2.46$ GeV and $\sqrt{s_{\pi d}} = 2.66$ GeV respectively can be observed.

The forward angle differential cross section for the reaction $pp \to d\pi^+$ shows [3], as a function of the energy, three bumps at $\sqrt{s_{\pi d}} = 2.17$ GeV, $\sqrt{s_{\pi d}} = 3.0$ GeV and $\sqrt{s_{\pi d}} = 3.7$ GeV respectively. These structures have been interpreted in the one pion exchange model (O.P.E.) to correspond [4] to the excitation of the Δ isobars (1232, 1950, 2420) at the pure T = 3/2 $\pi+p \to \pi+p$ scattering vertex. Excitation of T = 1/2 N^* isobars can be obtained by the charge exchange reaction $\pi^o p \to n\pi^+$ at the same vertex. This diagram has not been considered so far in the O.P.E. calculations as it is expected to contribute 16 times less than the Δ isobar excitation to the $pp \to d\pi^+$ cross section. However the energy region scanned by the present experiment falls between the first two Δ structures, where the cross section is more than ten times smaller than at the adjacent peaks. Therefore we think that the N^* excitation should be taken into account.

To prove this assertion we have also plotted in Fig. 1, as a function of $\sqrt{s_{\pi N}}$, the total cross section $\sigma_{1/2}$ leading to a pure T = 1/2 state. Values of $\sigma_{1/2}$ have been computed from the data of ref. 5 through the relation $\sigma_{1/2} = 3/2\, \sigma_{\pi^- p} - 1/2\, \sigma_{\pi^+ p}$. The center of mass energies $\sqrt{s_{\pi d}}$ and $\sqrt{s_{\pi N}}$ are related in the symmetric O.P.E. model by the simple formula $2s_{\pi N} = s_{\pi d} + m_\pi^2 - 2m_N^2$.

A striking similarity can be observed in the shape of the two curves. However there is a shift of about 60 MeV between the positions of the structures ; this can be explained using arguments similar to those developed in ref. 6. Taking the reasonable assumption that the relative angular momentum in the pN^* system is $\mathcal{L} = 0$, and that the mean Fermi momentum of the nucleon in the deuteron is q = 70 MeV/c, then a simple kinematical calculation can account for the observed shift.

In conclusion we have shown that the Ayo(u = 0) data for the $pp \to \pi d$ reaction can be related to the excitation of the N^* isobars (1520 and 1680) in the intermediate state.

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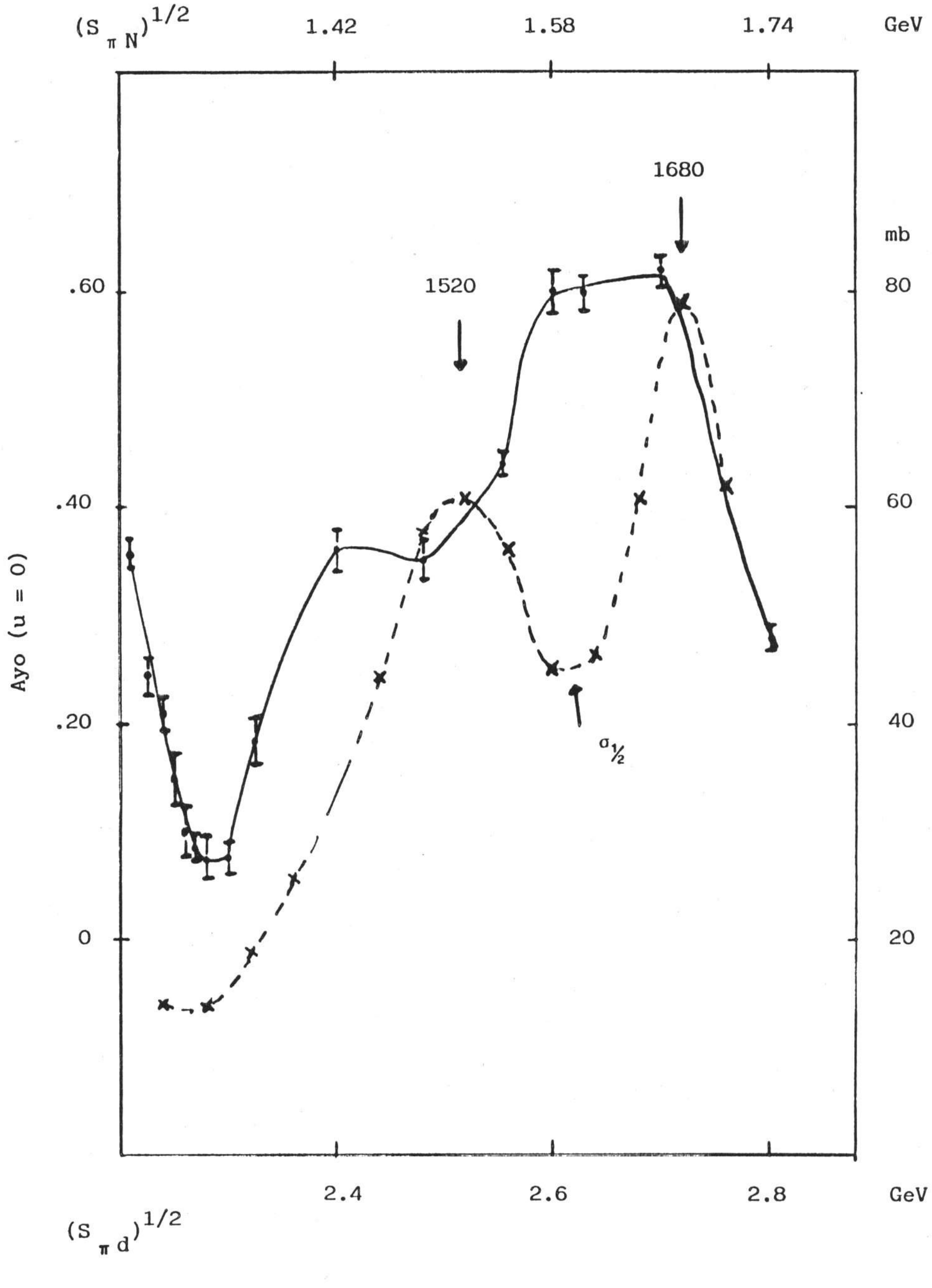

Fig. 1

The analyzing power Ayo, taken at u = 0 is plotted against $\sqrt{s_{\pi d}}$. Values of $\sigma_{1/2}$ (dasked curve) are also plotted as a function of $\sqrt{s_{\pi N}}$. Curves are just a guide for the eye.