THE MASS SPECTRUM OF (Λp) FROM THE REACTION $K^- d \to \pi^- \Lambda p$

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We investigate in the present paper the mass spectrum of the (Λp) system from the reaction where a K^- meson at rest is captured by a deuteron. This spectrum was investigated experimentally by a number of workers [1 - 3] and in the best of these investigations [3] a mass resolution of 1 MeV was attained with statistics of 4901 cases. The form of the (Λp) spectrum obtained in [3] near 2130 MeV is shown in Fig. 1 (histogram). The center of the maximum is located precisely at the threshold of the ($\Lambda p \to \Sigma N$) reaction. We attempt to explain this maximum as being due to the interaction in the final state. Near the threshold of the ($\Lambda p \to \Sigma N$) reaction, the amplitude of the ($K^- d \to \pi^- \Lambda p$) reaction is taken in the following form:

$$M(\omega) = M_\Delta(\omega) + C, \tag{1}$$

where ω is the critical energy of Λ and p in their c.m.s.; $M_\Delta(\omega)$ is the amplitude corresponding to the triangular diagram of Fig. 2, and C is a certain complex constant, which reflects the contribution of all other diagrams to the amplitude of the ($K^- d \to \pi^- \Lambda p$) reaction near the ($\Lambda p \to \Sigma N$) threshold.

The hope of describing the 2130-MeV peak lies in the fact that the $M_\Delta(\omega)$ amplitude has a maximum at the threshold of the reaction ($\Lambda p \to \Sigma N$). Figure 3 shows plots of the real and imaginary parts of this triangular diagram[1]. We see that the real part of this diagram has a sharp maximum at the threshold energy. In the concrete calculation, the wave function of the deuteron was

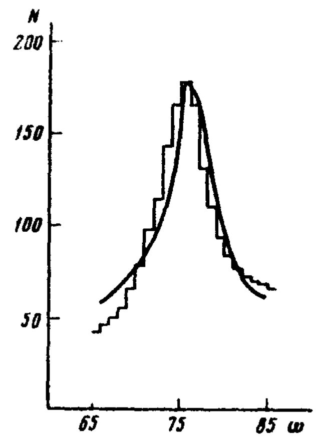

Fig. 1. (Λp) mass spectrum. The abscissas represent the kinetic energies of (Λp) in MeV. The ordinates represent the number of events. The solid curve is the calculated plot.

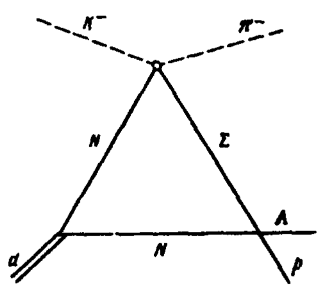

Fig. 2

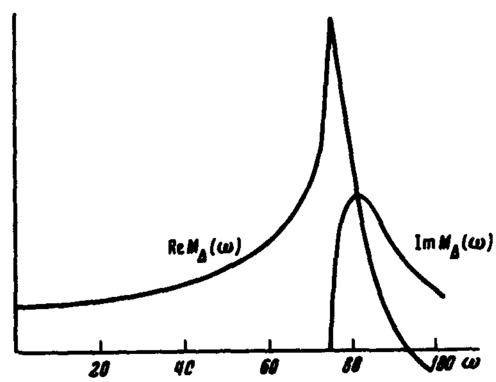

Fig. 3. Plot of the energy dependences of the real and imaginary parts of the triangular diagram of Fig. 2.

[1]More details concerning features of the triangular diagrams can be found in [4].

taken in the form proposed by Hulthen [5], the amplitude of the ($KN \to \pi\Sigma$) reaction was taken from [6], and the amplitude of the ($\Sigma N \to \Lambda p$) reaction was assumed constant. It should be noted that in such an analysis of the experimental data we cannot claim to obtain estimates of the cross section of the ($\Sigma N \to \Lambda p$) reaction near threshold.

This is connected with the fact that the spectrum presented in Fig. 1 is not normalized, i.e., no data are given on the probability of this reaction. Therefore a comparison with experiment determines the amplitude (1) accurate to within a constant factor. The property of the ($K^-d \to \pi^-\Lambda p$) reaction is expressed in terms of (1) as follows

$$w(\omega) = N|M(\omega)|^2 \rho(\omega), \qquad (2)$$

where N is a constant factor and $\rho(\omega)$ is the phase volume. The unknown parameters of the problem were the real and imaginary parts of the constant C. The normalization of the function $w(\omega)$ was based on the value of this function at the threshold.

The obtained diagram is shown by the solid line in Fig. 1. We see that the height and half-width of this peak are in satisfactory agreement with experiment ($\chi^2 = 1.8$ for 21 degrees of freedom).

It can be concluded from the foregoing that to describe the 2130-MeV peak in the (Λp) mass spectrum there is no need to introduce a (Λp) resonance. An estimate of the ($\Sigma N \to \Lambda p$) reaction amplitude based on the study of the entire (Λp) mass spectrum, shows that

$$\frac{d\sigma_{\Lambda p \to \Sigma N}}{d\Omega} \approx (1.4\ \mathrm{F})^2 \frac{k_{\Sigma N}}{k_{\Lambda p}}, \qquad (3)$$

i.e., the $\Lambda p \to \Sigma N$ amplitude at the threshold has the same order of magnitude as the (Λp) elastic scattering length ($a_{\Lambda p} = -1.6$ F; k_{ij} is the relative momentum of the particles i and j).

In conclusion, I wish to thank I.S. Shapiro for useful advice and a discussion of the results, and also V.M. Kolybasov for a discussion as a result of which the initial variant of the paper was substantially revised.

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SCATTERING OF NEUTRONS BY NUCLEI IN THE REGION OF NON-OVERLAPPING RESONANCES OF THE NUCLEUS

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We have measured the differential cross sections of elastic scattering of neutrons with energies (1.8 ± 0.2) MeV by the nucleus ^{208}Pb in the angle range