TOTAL CROSS SECTIONS FOR THE π^-p REACTIONS WITH 276 MeV π^- MESONS

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The total cross sections for the $\pi^- + p \to \pi^- + \pi^+ + n$ and $\pi^- + p \to \pi^- + \pi^0 + p$ reactions with π^--meson energy 276 ± 10 MeV have been measured with a 25-centimenter liquid hydrogen bubble chamber in a magnetic field. The experimental data are compared with the theoretical predictions.

GOEBEL and Schnitzer [1,2] obtained by analysis of the available experimental data on the total cross section of the process $\pi^+ + p \to \pi^+ + \pi^+ + n$, and also on the angular distribution of the secondary positive pions from the reaction $\pi^- + p \to \pi^- + \pi^+ + n$, the following $\pi\pi$-scattering lengths:

$$a_0 = 0.50, \quad a_1 = 0.07, \quad a_2 = 0.16,$$
$$a_0 = 0.65, \quad a_1 = 0.07, \quad a_2 = -0.14,$$

which pertain respectively to states with isotopic spins T = 0, T = 1, and T = 2. In view of the large scattering length in the isotopic state with T = 0, a check of the correctness of the small scattering lengths is best carried out by comparing the predictions of the theory with experiment for those interactions, where the $\pi\pi$ system does not have a state with T = 0. This condition is satisfied, in particular for the reaction $\pi^- + p \to \pi^- + \pi^0 + p$, for which the total cross sections were measured at incident negative-pion energies 340 [3] and 380 MeV [4]. Experimental data are also available for this process at lower energies [5-7], but their use for comparison with theory is difficult, because the data are either too much in error [5,6], or pertain to the total cross section of π^0-meson production on free protons as well as on the nucleons bound in the nucleus [7].

In the present investigation we measured the total cross sections of the reactions:

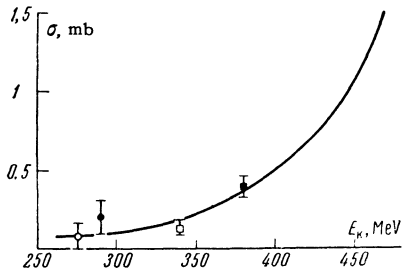
$$\pi^- + p \to \pi^- + \pi^+ + n, \qquad (1)$$

$$\pi^- + p \to \pi^- + \pi^0 + p \qquad (2)$$

at a laboratory-system energy of incoming negative pions 276 ± 10 MeV. The measurements were carried out with the aid of a 25-centimeter liquid-hydrogen bubble chamber [8] situated in a magnetic field. The experiment yielded 6000 photographs, among which five events were found pertaining to the reaction (1) and one event pertaining to the reaction (2). The corresponding values of the total cross sections, which were obtained by comparing the number of inelastic-interaction events with the previously investigated [5] elastic-scattering events, turn out to be

$$\sigma_1 = 0.4\ ^{+0.2}_{-0.3}\ \text{mb}, \quad \sigma_2 = 0.08 \pm 0.08\ \text{mb}.$$

The energies of the primary π^- mesons were determined and the events selected in the same manner as before [9].



Plot of the total cross section of reaction (2) against the kinetic energy of the incoming π^- mesons: ○ – present work, ● – 290 MeV,[7] □ – 340 MeV,[3] ■ – 380 MeV[4]; continuous curve – theoretical.[2]

The figure shows the available data on the total cross sections of reactions (2) as a function of the kinetic energy of the incoming π^- mesons. The figure shows also the theoretical curve obtained from the data of Goebel and Schnitzer. The points obtained in [5,6] have not been included in the plot in view of the large errors, which go beyond the limits of the figure.

As can be seen from the plot, there is a correspondence between the calculated and measured cross sections over a wide range of energies, thus indicating that small $\pi\pi$-interaction phase shifts can be described in the scattering-length approxi-

mation, and that the scattering lengths themselves have been qualitatively chosen in correct fashion.

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86