Measurement of the elastic $\pi^- d$ backward scattering at 1.57, 1.66, and 1.76 GeV/c.

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The results of measuring elastic $\pi^- d$ backward scattering, which emphasize the structure in the energy dependence of this cross section observed by us at slightly lower energies, are presented. Its possible theoretical interpretation is discussed.

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Investigation of the interactions of elementary particles with a deuteron is of great importance for the expansion of knowledge about the elementary interactions to the interactions with a system of nucleons. If in the processes of interaction with light nuclei with small momentum transfer the Glauber theory is a good approximation of reality, then in the region of large momentum transfer we are still far from such regularity. The existing theoretical models need a comprehensive experimental verification. For this purpose we performed systematic measurements of the elastic $\pi^- d$ backward scattering in the momentum range of the primary π mesons from 0.98 to 1.45 GeV/c.[1] Below we present data obtained as a result of continuing this series of measurements at momenta of 1.57, 1.66, and 1.76 GeV/c.

The experiment was performed using π^--meson beam of the ITÉF accelerator and a 3-meter magnetic spectrometer with optical spark chambers.[2] The tracks of a beam π meson emitted in the forward direction from a fast particle (p or d) of a liquid deuterium target and the track of a secondary π^- meson emitted in the backward direction were isolated by means of a system of scintillation counters and then were measured. By using the spectrometer to measure very accurately (better than 1%) the momentum and the time of flight of the fast particle, we were able to reliably identify the deuterons from the reaction of elastic $\pi^- d$ backward scattering against a proton background that was 1000-fold more intensive. The results of the measurement of the angles and momentum of the secondary π meson gave additional information that confirmed the reliability of isolating the elastic events. The events corresponding to the quasi-elastic scattering of π^- mesons by deuteron protons were recorded simultaneously. An agreement between the measured cross section of the quasi-elastic scattering and that of the elastic $\pi^- p$ backward scattering by a free proton (with accuracy to 10–20%) convinced us that there are no systematic errors. The three indicated pulses gave approximately 90,000 photographs which were scanned on the PSP-2 scanner[3] and processed by using the BÉSM-6 and M-220 computers. The number of events of the elastic $\pi^- d$ backward scattering and the results of calculation of cross sections in c.m.s are given in Table I and in Fig. 1.

It can be seen in Fig. 1 that the obtained data are in agreement with the depen-

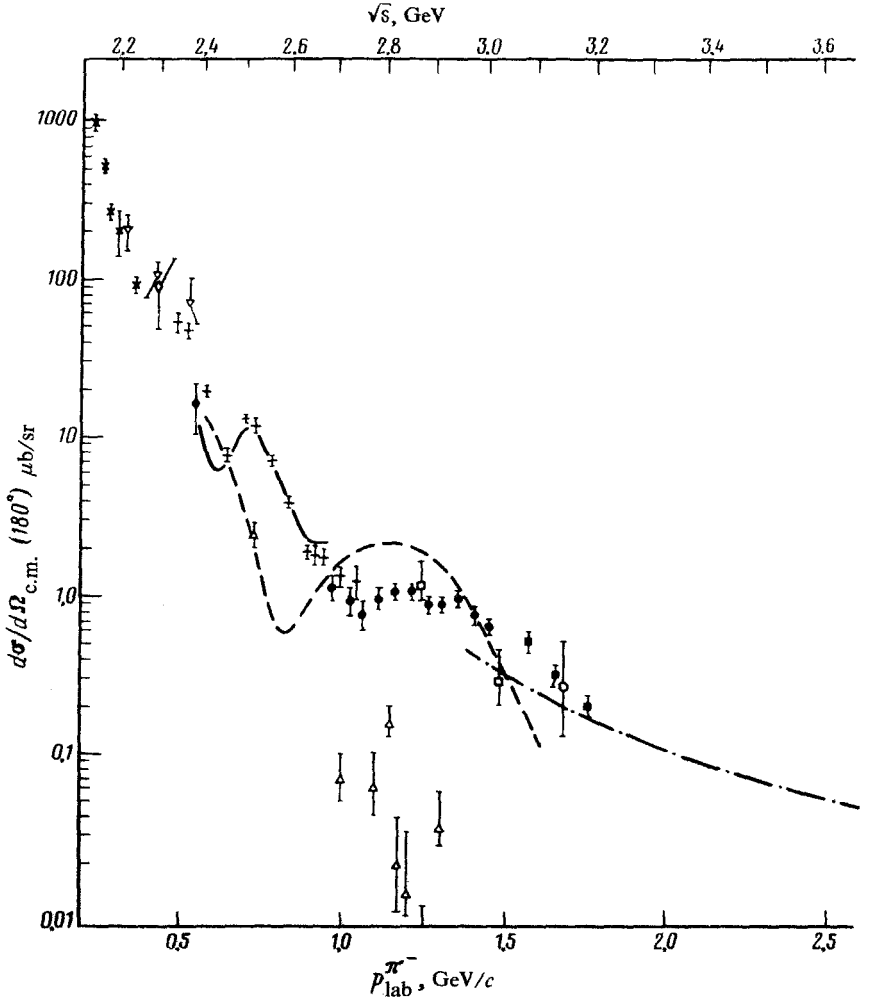

FIG. 1. Dependence of the differential cross section of elastic πd backward scattering in the c.m.s. on the laboratory momentum of the π meson: ○ Abramov *et al.* (1973); ×, Gabathuler *et al.* (1973); +, Keller *et al.* (1975); □, Abramov *et al.* (1975); Δ, Aref'ev *et al.* (1978); ▽, Cole *et al.* (1978); ◇, Kravtsov *et al.* (1978); ●, Abramov *et al.* (1979); ◆, Dakhno *et al.* (1979); ■, our experiment.

dence of the cross section in Ref. 1, with our earlier measurements,[4] and with the data of Ref. 5. For the smaller momenta the results of Ref. 5 are also in good agreement with the data from Los Alamos[6] and from LIYaF.[7] The results of Ref. 8, which contradict the aggregate of the available experimental data, are not used in further analysis.

The obtained data (see Table I) emphasize the presence of structure in the energy dependence of the elastic $\pi^- d$ backward scattering.[1] The center of this structure can be approximately identified with $p_{\text{lab}}^{\pi^-} = 1.25$ GeV/c, $\sqrt{s} = 2.9$ GeV. The proximity of this energy to the sum of the nucleon masses and to Δ (1950) indicates that the

TABLE I.

Momentum, GeV/c	Number of elastic events	$d\sigma/d\Omega(180°)$[1], μb/sr
1.57	73	0.53 ± 0.06
1.66	70	0.300 ± 0.035
1.76	54	0.20 ± 0.03

[1]The cross section was averaged over the entire angular capture of the facility, which was equal to $-1 \leqslant \cos\theta_{c.m.} \leqslant -0.985$ at half height and $-1 \leqslant \cos\theta_{c.m.} \leqslant -0.93$ at the base.

dibaryon resonance[9] or the isonucleus[10] can exist. However, a nonexotic explanation of the observed dependence of the cross section, which is based on the calculations of Kondratyuk and Lev[11] in the model of the inelastic intermediate states, is also possible. The dashed line in Fig. 1 represents the calculated contribution to the cross section from a single scattering of a π^- meson by one of the deuteron's nucleons. The peak in the neighborhood of 1.25 GeV/c in this model is attributable to the peculiarity of the πN amplitude due to the isobaric Δ (1950). This calculation does not have free parameters and in the region of the structure is in satisfactory agreement with the experiment. In the other regions, calculation of only the single scattering from the momentum of the incident π meson is clearly not enough to describe the experimental data. At lower energies the description can be improved substantially by calculating the double scattering with η mesonic intermediate state (solid line). At higher energies the intermediate inelastic mesonic states of the continuous spectrum should be taken into account (dot-dash line).

Myhrer[12] used another approach to explain the energy dependence of the cross section for elastic $\pi^- d$ backward scattering. The appearance of structure can possibly be attributed to a sharp variation of the q^2 dependence of the deuteron's form factor in the region of 2 to 3 (GeV/c)^2, which was postulated by Gurvitz and Rinat[13] in order to describe consistently the data for *ed* scattering and for *pd* backward scattering. The structure in the elastic $\pi^- d$ backward scattering can be observed expressly at these q^2.

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