INVESTIGATION OF THE REACTION $\pi^- p \to \pi^0 n$ AT 4.0 GeV/c

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The reaction $\pi^- p \to \pi^0 n$ at 4.0 GeV/c was analysed using spark chamber technique. Cross-section was found to be:

$$\sigma_{\pi^- p \to \pi^0 n} = (0.130 \pm 0.020) \text{ mb}.$$

The ratio $X = |\text{Re } T(t=0)/\text{Im } T(t=0)| = 0.89 \pm 0.10$ corresponds, according to the Regge pole approach, to $\alpha_\varrho(t=0) = 0.46 \pm 0.06$. The comparison with theoretical prediction is presented.

The charge exchange reaction $\pi^- p \to \pi^0 n$ at 4.0 GeV/c was analysed using spark chamber technique. The experiment was performed at the Proton Synchrophasotron of JINR at Dubna [1, 2].

The experimental set-up is shown in Fig. 1. The momentum spread of the beam was $\Delta p/p = 1.5\%$. The direction of the beam was determined by two small (six gaps) thin-plate chambers $K1$ and $K2$. The liquid hydrogen target $H2$ was surrounded by a set of anticoincidence scintillation counters: the pot-shaped counter $C5$, and the counters $C3$ and $C4$ forming walls of a box. A γ-converting lead plate, 1 cm thick was inserted between the counters $C5$ and $C3, 4$. The bottom side of the box was formed by the anticoincidence counter $C6$

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with lead shielding in the form of a ring, defining the space angle of the fiducial volume of spark chambers $K3$ and $K4$. These chambers were separated by the threshold counter $C7$, to select events with more than 4 charged tracks in electron showers. The radiation length of the spark chamber $K3$ was 3.15 c.u., and that of $K4$ was 6.95 c.u. The spark gaps were 1 cm wide, and were photographed in two perpendicular directions (horizontal and vertical).

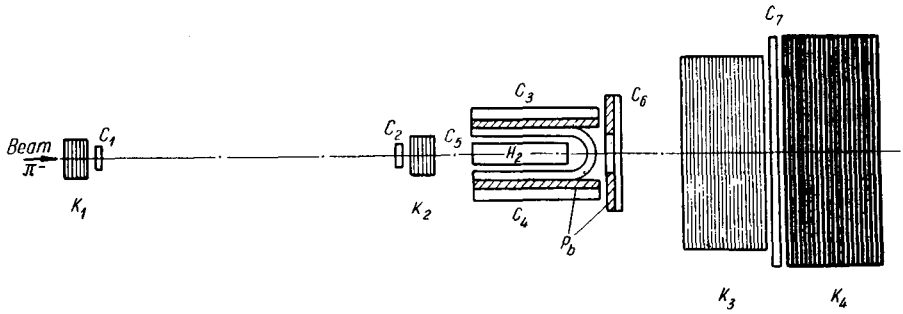

Fig. 1. The experimental set-up

To detect gamma showers, the triggering logic used was of the type $C1$, $C2$, $\overline{C3}$, $\overline{C4}$, $\overline{C5}$, $\overline{C6}$, $C7$. The spark chambers were triggered when a primary pion entering the target did not produce any outgoing charged particles or photons converted in the lead plates between the anticoincidence counters.

By using photographs of π^- mesons traversing the whole apparatus we were able to align the positions of the chambers better than to ± 1 mm.

About 16000 pictures were taken in two runs. The photographs were scanned twice. The scanning efficiency was better than 98%. The total of 2860 pictures contained measurable 2γ events. These photographs were measured using several points on the straight part of each γ shower in the spark chamber $K3$. Then the events were processed through the geometry and kinematic programmes [2, 3].

In order to reduce the contamination of the sample, only the events from the π^0 peak in the opening angle distribution were accepted (see Fig. 2):

$$0.8 \leqslant R \leqslant 2.2; \quad \text{where } R = \theta^*_{\gamma\gamma}/\theta^*_{\gamma\gamma MIN}$$

(Starred quantities refer to the CM system of $\pi^- p$).

The following sources of bias and background were considered:

— muon contamination of the beam (~10%),
— the contribution from inelastic interactions (~10%),
— empty target effect (~5%),
— scanning efficiency (~98%),
— the probability that one or both γ-rays convert before or after the fiducial volume of the spark chamber (~5%),
— the correction for detection efficiency against the recoil neutron and the correction for the forward solid angle, are included in the weight of each event.

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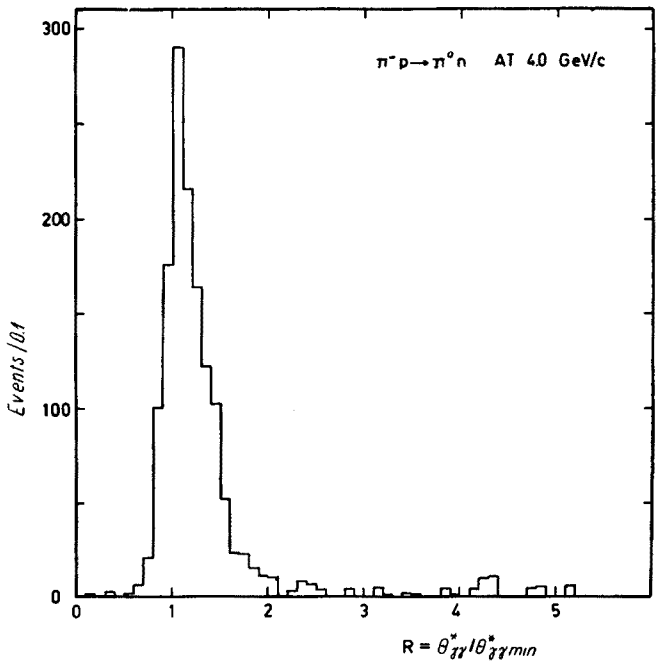

Fig. 2. Distribution of R (R is the ratio of the angle between γ's in CMS, divided by the minimum opening angle)

The cross-section for the reaction $\pi^- p \to \pi^0 n$ at 4.0 GeV/c in the t interval from 0 to -0.5 (GeV/c)^2 was found to be

$$\sigma_{\pi^- p \to \pi^0 n} = (0.130 \pm 0.020) \text{ mb}.$$

This value is in agreement with other data [4, 5]. The ambiguity on the reconstruction of the direction of flight of π^0 was removed in more than 60% of events by the estimate of relative energy of the two γ eays. Events in which the energies were so close that such an estimate was unreliable, correspond to the region of kinematics for which the two solutions are almost identical. Here the direction of bisectrix of both direction was used.

The differential cross-section is shown in Fig. 3. The errors are statistical only. The solid line represents the Regge-pole prediction based on the parameters given by Rarita *et al.* [6].

Using the data about $\pi^{\pm} p$ total cross-section [7], the ratio:

$$X(t=0) = \left| \frac{\text{Re } T(t=0)}{\text{Im } T(t=0)} \right|$$

for charge exchange scattering in forward direction at 4.0 GeV/c was found to be

$$X(t=0) = 0.89 \pm 0.10.$$

Assuming the exchange of one Regge pole, connected with ϱ-meson, and using the relation

$$X(t=0) = \mathrm{tg}\left(\frac{\alpha_\varrho(0)\,\pi}{2}\right)$$

one obtains the value of the intercept $\alpha_\varrho(t=0) = 0.46 \pm 0.06$. This value is in agreement with the results given by other authors [6, 8, 9].

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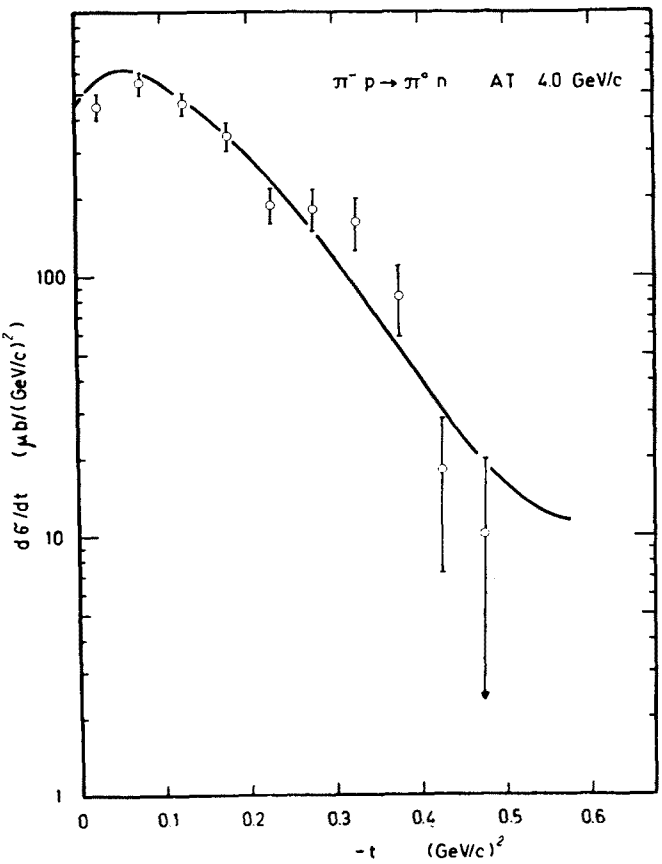

Fig. 3. Differential cross-section for reaction $\pi^- p \to \pi^0 n$. The solid line represents the Regge pole prediction [6]

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