INELASTIC TWO-PRONG π^-—p-INTERACTIONS AT 17.2 GeV IN EMULSION

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1. INTRODUCTION

We have investigated the inelastic two-prong interactions at 17.2 GeV in emulsion. The aim of our work was to study the quasi-elastic diffraction character of inelastic process at small multiplicities suggested originally by Morrison [1, 2] and confirmed later by other authors [3—5], and extend our previous investigations carried out at 7 GeV [6] to higher energies.

2. EXPERIMENTAL

The measurements were made in Ilford G5 emulsion irradiated by a π^--beam of energy of (17.2 $\pm$ 0.2) GeV. The plates were 14.5 cm$\times$ $\times$ 23.5 cm $\times$ 0.06 cm in size.

Scanning the plates by following along the tracks of primary pions and using appropriate selection criteria 100 two-prong inelastic π^--p interactions were found. In the analysis 40 more events of the same type, and having the same primary energy measured by the Alma-Ata group are also included [7].

The mass and momentum of the particles were determined by a combination of blob-density and multiple scattering measurements on relativistic tracks having dip angles $\leqslant 5°$. For the remaining relativistic particles geometrical correction was applied. For tracks, where $b/b_0 \geqslant 1.4$, irrespective to their dip angles the combination of two of the following three parameters were measured: blod density, multiple scattering and range.

For the scattering measurements a Koristka R4 microscope was used. The scattering of secondary particles was determined at cell lengths for which the ratio of the signal to noise was at least 2. The spurious scattering was determined by means of scattering measurements on primary tracks of well known energy on a total length of about 15 m.

3. RESULTS AND DISCUSSION

In Fig. 1 and 2 one can see the momentum and transverse momentum distributions of

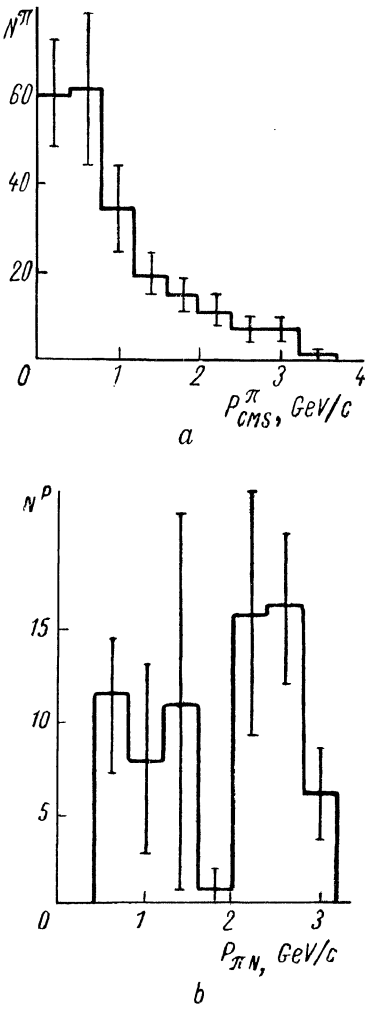
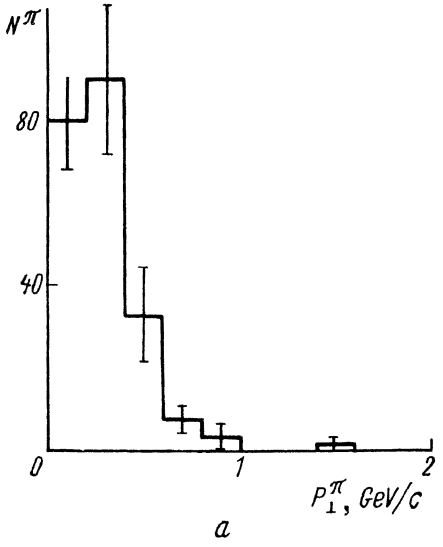


Fig. 1. The momentum distribution of secondary pions and protons in the CMS.

secondary pions and protons given rise in two-prong π^--p interactions in the center of mass system (CMS) of the colliding pion and nucleon.

The average momentum of pions and that of protons in the CMS are $\langle P_{cms}\rangle = (0.93 \pm \pm 0.08)$ GeV/c and $\langle P^{p}_{cms}\rangle = (1.8 \pm 0.3)$ GeV/c. The average transverse momentum



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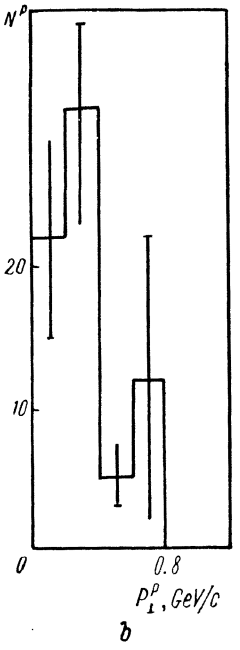


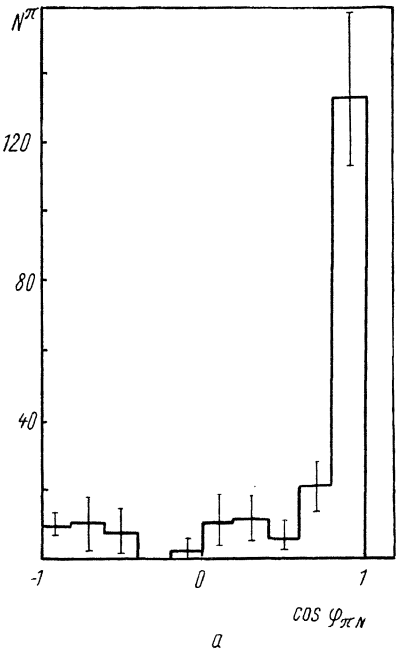
b

Fig. 2. The transverse momentum distribution of pions and protons in the CMS.

of pions and that of protons are $\langle P_{\perp}^{\pi}\rangle = = (0.29 \pm 0.02)$ GeV/c and $\langle P_{\perp}^{p}\rangle = (0.34 \pm \pm 0.05)$ GeV/c.

Fig. 3 shows the angular distribution of pions and protons in the CMS.

One can see clearly from Fig. 3, that all protons are emitted backward in the CMS. The distribution of pions is also very asymmetric, they are emitted, however, most in the forward direction.



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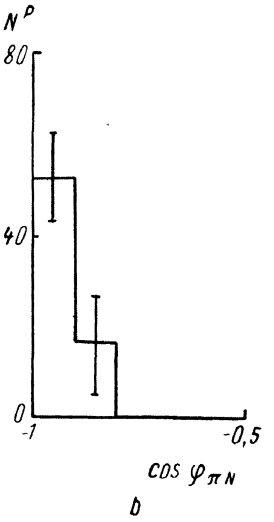

b

Fig. 3. The angular distribution of pions and protons in the CMS.

The four-momentum transfer in the two-prong $\pi^- p$ interactions was investigated in the same way as it was suggested by some of the authors in a previous paper [8]. We have calculated the four-momentum transfer squared, t, for π^--mesons in the reaction:

$$\pi^- + p \rightarrow p + \pi^- + k\pi^0 \qquad (1)$$

$$(k = 1, 2, \ldots)$$

and the four-momentum transfer squared for charged pions having the smaller four momentum transfer (irrespective of their charge) in the reaction:

$$\pi^- + p \rightarrow n + \pi^- + \pi^+ + k'\pi^0 \quad (k' = 0,\ 1). \qquad (2)$$

The distributions which were obtained applying appropriate geometrical correction [6] can be seen in Fig 4a and 4b.

The shape of these histograms is very similar to those obtained by some of the authors

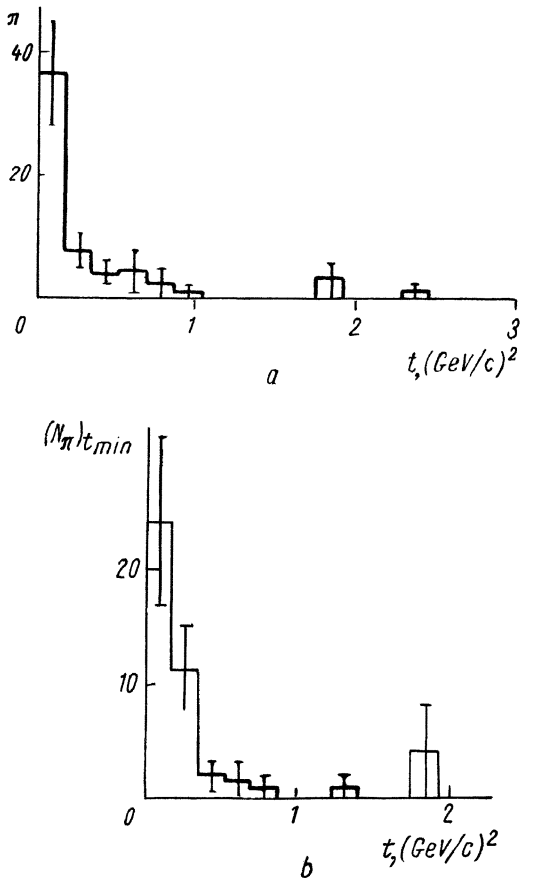

Fig. 4. For four-momentum transfer distribution:

a) of π^- in reaction (1) and b) that of pions having the minimum four-momentum transfer in reaction (2) irrespective of their charge.

in the analysis of $\pi^- p$ interactions in emulsions at 7 GeV and bubble chambers at 7 and 16 GeV [8]. Both distributions are rapidly falling off with increasing (t) quite similar to the characteristic four-momentum transfer distribution in high-energy elastic scattering. In ref. [8] it was also shown from the bubble chamber data, that in reactions of the type (2) in the majority of cases the four-momentum transfer calculated for the π^--meson is less then that obtained for the π^+-meson. From these results the authors of ref. [8] have concluded in accordance with Morrison [1, 2] and other authors [3—5], that in the inelastic two-prong $\pi^- p$ interactions the incident pion undergoes a quasi-elastic diffraction scattering and has a certain tendency to maintain its charge. Our present experimental results give further support to this conclusion. From the observed number of events having fast forward emitted pions the cross section of the quasi-elastic diffraction scattering can be roughly estimated. Taking into account the probabilety of collisions on free and quasi-free protons in emulsion, the cross-section for the $\pi^- p$ quasi-elastic diffraction scattering turnes out to be $\sigma \approx 2$ mb at 17 GeV. This value is in good agreerrent with the results of Morrison [1], who has foud $\sigma = 2.25$ mb for the same type of events produced by 16 GeV π^--mesons in a hydrogen bubble chamber.

Several attempts were made to explain these experimental results [9]. One interpretation was that the incident pion undergoes a diffraction scattering on a virtual pion of the target nucleon. Another interpretation was given by the exchange of a Pomeranchukom between the incoming pion and the target proton or between the incoming pion and virtual target pion. All these models are, however, at present only in a very preliminary stage and must be treated with large precaution. The only conclusion we can draw unambiguously is the quasi-elastic diffraction character of inelastic interactions at small multiplicities.

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