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PHYSICS

1960

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Fig. 1

Figure 1: Fig. 1

Abstract**Full Text**

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ANALYSIS OF SOME INELASTIC $p-n$ INTERACTIONS AT AN ENERGY OF 9 Bev**PHYSICS**

In an emulsion stack (NIKFI emulsion of type R), irradiated in the internal proton beam of the synchrophasotron of the Joint Institute for Nuclear Research, several cases of inelastic $p-n$ interactions were studied. Events of interaction were recorded by accelerated scanning along the track of the primary particle. Further selection of nucleon-nucleon interactions was carried out with the aid of the corresponding selection criteria ^(1,4).

The main attention was focused on studying such $p-n$ interactions in which it is possible to identify all secondary charged particles. Such a detailed investigation makes it possible to check certain assumptions and conclusions made earlier in a number of papers ⁽²⁻⁴⁾. Of special interest are cases in which, as a result of the interaction, three secondary charged particles are observed in the emulsion. According to paper ⁽⁴⁾, in three-prong interactions the greatest asymmetry is observed in the angular distribution of secondary charged particles in the center-of-mass system. Elucidation of the nature and character of the asymmetry is of great interest.

Fig. 1

Of the 72 recorded three-prong "stars," we processed 22 events in which it was possible to identify all secondary charged particles. Identification of particles was carried out by measuring ionization and multiple Coulomb scattering. The transformation of angles and energies to the center-of-mass system (c.m.s.) was performed in the usual way.

The angular distribution of all secondary charged particles in the c.m.s. is shown in Fig. 1. It indicates the presence of a noticeable asymmetry of the particles in the forward direction. The magnitude of the asymmetry is determined by means of the relation $\Delta = \Sigma(n_{\text{fwd}} - n_{\text{back}})/N$, where n_{fwd} and n_{back} are the numbers of particles flying forward and backward, respectively, in the c.m.s.; N is the number of interactions. In the case of our experiment $\Delta = 0.55 \pm 0.24$. This

Fig. 2

Figure 2: Fig. 2

magnitude of the asymmetry is smaller than the asymmetry value 0.83 ± 0.27 given in paper (4).

The reason for the overestimate of the asymmetry in paper (4) should be explained by the adoption of the assumption $\beta_\pi^* = \beta_c$, where β_c is the velocity of the c.m.s. relative to the laboratory system, and β_π^* is the velocity of the generated particles in the c.m.s. This assumption cannot in any way correspond to reality, since in the c.m.s. the generated particles are not monoenergetic, but have a definite distribution in energy. Preliminary-

measurements¹ showed that the energy spectrum almost coincides with the power-law spectrum A/E^2 in the region above μc^2 . Analysis of the angular distribution of shower particles also leads to a power-law spectrum for particles generated in the c.m.s. Hence the incorrectness becomes evident of the assumption $\beta_\pi^* = \beta_c$, which is equivalent to the assumption of monoenergeticity of the generated particles.

If, for all secondary particles in the 22 stars in which the energies of these particles were measured, one assumes $\beta_\pi^* = \beta_c$, then the asymmetry increases substantially and coincides with (or is even greater than) the asymmetry value reported in Ref. 2. Indeed, in our case the asymmetry under this assumption is $\Delta = 2.1 \pm 0.2$; however, the asymmetry found in this way is, of course, not the true one.

Fig. 2

In Fig. 2 the angular distributions in the c.m.s. are given for protons (a) and β -mesons (b). The angular distribution for protons is close to symmetric, whereas for π -mesons the distribution is noticeably asymmetric. This result contradicts the earlier assumption^[2-4] that the asymmetry in the angular distribution of secondary charged particles in the c.m.s. for $p-n$ interactions is due to protons. An analysis of possible errors in identifying secondary particles with high energy leads to the conclusion that the asymmetry in the angular distribution cannot be explained by protons. To refine this conclusion, a further increase in statistics is, of course, necessary.

The values found for the energies of protons and π -mesons in the c.m.s. lead to the following mean values:

$$\bar{E}_p = 1.303 \pm 0.043 \text{ BeV}, \quad \bar{E}_\pi = 0.436 \pm 0.030 \text{ BeV}.$$

The mean transverse momenta for protons and π -mesons are, respectively,

¹Yu. T. Lukin, Zh. S. Takibaev, E. V. Shalgina, ZhETF, **38**, issue 4 (1960).

²N. B. Bogachev, S. A. Bunletov et al., ZhETF, **37**, issue 11, 1225 (1959).

$$\bar{P}_p = 0.244 \pm 0.032 \text{ BeV}/c, \quad P_\pi = 0.158 \pm 0.022 \text{ BeV}/c.$$

Further results concerning the energy distributions, the distributions of transverse momenta for protons and π -mesons, the distribution of p - n -interaction events by inelasticity coefficients, etc., will be published in the near future.

Received
16 V 1960

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