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INVESTIGATION OF THE MOMENTUM SPECTRUM OF PROTONS FROM π-p and π-π INTERACTIONS AT 10 GEV

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A field of great interest is provided by the study of the momentum spectrum of nucleons from π-N and N-N interactions and by their comparison with each other. On the one hand, such information makes it possible to evaluate the ratios of the cross-section of the processes with large and small four-momentum transfer(1). On the other hand, it is shown in(2) that, if there are two peaks in the momentum spectrum of the protons, they shift when the primary energy changes. This would serve as an indirect indication of the existence of heavy mesonic resonances with a mass of about 2 GeV. Despite the importance of this question, there is no clear indication of the shape of the momentum spectrum of the recoil protons, since the results of separate groups differ not only quantitatively but also sometimes qualitatively.

In the study of π-N interactions in the 7.5 GeV region, by means of the emulsion method, it was shown(3) that the momentum spectrum of recoil protons has two peaks. This picture shows up most distinctly in stars with a small number of prongs ($n_s \leqslant 4$) where the peaks are almost equal in magnitude and are in the region $p \simeq 0.5$ GeV/c and $p \simeq 1$ GeV/c in the laboratory system of coordinates. However, in (4) the momentum spectrum has a smooth shape with one peak.

In work done with bubble chambers, two peaks are obtained in the momentum spectrum of Λ hyperons produced in p-N interactions at 7 GeV(5) and 16 GeV (6). In the investigation of p-N interactions in nuclear emulsions at 20 GeV, an indication was also found of the existence of two peaks in the momentum spectrum of secondary protons(7). On the other hand, such a structure does not appear in a series of researches(8). For chamber work, this may be connected with the fact that the identification was done only for the low energy part of the spectrum. It has therefore become most desirable to increase the precision of experimental data and to collect more statistics. For a more complete comparison with theoretical predictions, it is advisable to carry out research at two energies of primary particles, for instance at 7-10 GeV and 17-24 GeV.

In view of the importance of the task envisaged, it would be very interesting to do the work in a hydrogen target since, even with a careful kinematic analysis, the selection of interactions on free and quasi-free nucleons, both in emulsions and in heavy liquid chambers, remains ambiguous(9). In hydrogen bubble chambers, the research suggested comes up against the difficulty of determining the nature of the energetic protons, since in the region of high momenta ($>$ 1.5 GeV/c), it is not possible to identify particles by measuring ionization. However, if the chamber has a large working volume, this difficulty can be overcome, since there is a possibility of identification by means of energetic p rays [10]. We estimate that in liquid hydrogen, on tracks of protons of 10 GeV/c and over a distance of 100 cm, about 5 p rays $\geq$200 keV are formed. On account of the constancy of the traverse momentum of high-energy protons, collimated with a high measure of probability within a small angle with respect to the direction of the beam, they will form tracks with a "good geometry". Consequently, the use of p rays for the identification of tracks seems to be very effective in chambers of about 1 m or larger. To test the correctness of the method used for the identification of protons in p-p events, one can proceed from the condition of symmetry in the centre of mass system. Accordingly, we consider it desirable to perform the following work, i.e. to investigate the momentum spectrum of recoil protons in π-p and p-p interactions in a hydrogen chamber, of the largest dimensions available (the 1.5 m hydrogen chamber*), in the energy region of primary pions of 7-10 GeV and protons of 10 GeV and 20-24 GeV. To solve the problems, it is necessary to have at least a thousand interactions at each energy.

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* if this was not available, the 81 cm hydrogen chamber might be adequate.

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