On the Mechanism of Fast Deuteron Production in Proton-Nucleus Collisions.

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A great deal of attention has been given lately \(^{(1)}\) to the mechanism by which fast \((\geq 1 \text{ GeV})\) deuterons, tritons and \(^3\text{He}\) nuclei are emitted from p-nucleus interactions at primary energies at and above \(10^{19} \text{ eV}\), the main alternative explanations being: \(a\) a high energy tail in the evaporation process of the target nucleus, and \(b\) pick-up of one or two nucleons by the primary proton in an interaction with large momentum transfer.

As such interactions might prove a useful tool in the study of short-range \((\approx \text{ central})\) collisions, we thought it of interest to perform an experiment aimed at settling finally the above-mentioned alternative.

The idea of this experiment stems from the fact that in pion-nucleon collisions in this energy range, the momentum transfer to nucleons is very low, and hence if in p-nucleus collisions, fast heavy hydrogen nuclei originate in \(\approx \text{ direct}\) interactions, they should be absent in \(\pi\)-nucleus collisions. If, on the contrary, the fast heavy hydrogen nuclei belong to the high energy evaporation tail, they should be present in both p-nucleus and \(\pi\)-nucleus stars, since the evaporation process is practically independent of the primary particle \((2,3)\).

The measurements were performed on two stacks of NIKFI-R emulsions \(100 \times (100 \times 200 \times 0.4) \text{ mm}^3\) irradiated in: \(A\) the internal beam of the JINR proton-synchrotron circulating at \(10 \text{ GeV}\) proton kinetic energy and \(B\) a \(7.3 \text{ GeV}/c\) \(\pi^\pm\)-beam of the same accelerator.

The plates were area-scanned for stars produced by beam particles. In each stack we selected 200 stars which had at least one shower particle \((g^* \approx 1.5)\) fit for measurement \((i.e.\) a projected length in the same plate exceeding 5 mm). Each accepted particle was identified by the \(g^*-p\beta\) method.

The calibration curve was taken from ref. \((4)\). In order to choose the optimal basic cell length, spurious scattering was estimated from measurements on the beam tracks.


For each track an estimate of the true Coulomb sagitta was obtained by means of the multiple cell method (5). Blob counts were performed on at least 1000 blobs on each track and 3000 blobs on calibration (beam) tracks in each plate.

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As can be seen the (14) deuterons and (two) tritons appear well resolved from the proton peak.

None of the measured 200 tracks in stack B could be identified either as a deuteron or as a triton. If equal number of deuterons and tritons would be produced on the average in proton-stars and pion-stars, the probability of a 16:0 division in our sample of 400 stars is \(1.6 \times 10^{-3}\).

We therefore conclude that the evaporation mechanism cannot be responsible for the production of fast heavy hydrogen nuclei.

The sixteen d- and t-tracks occurred...