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Laboratory of High Energies

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It has been pointed out[1] to the importance of studying the longitudinal asymmetry in the angular distribution of π^- - mesons produced in hyperon decay.

In[2] when investigating the strange particle generation by 9 BeV protons there has been obtained an indication on a possible existence of such an asymmetry in $\Sigma^\pm$ - hyperon decay.

In this connection we attempted to obtain more accurate data on the angular distribution of $\pi^\pm$ - mesons from the decay of $\Sigma^\pm$ - hyperons produced in 9 BeV proton interaction with emulsion nuclei.

The main attention was given first of all the choice of the method for searching the hyperons which is free from any experimental bias, and, secondly, to the carefulness of the identification of the decay events found.

The search for Σ^- hyperons was being performed by continuing the tracks in the stars which are due to the primary proton interaction with emulsion nuclei (NIKFI BR–400 -type emulsions). Each pellicle of the emulsion stack was area scanned and the stars with $N_h \geq 10$ were selected, in which, at least, one track satisfied the following selection criteria:

a/ the particle producing the track emerges in the direction of the front semisphere, with respect to the motion of the beam proton;

b/ the length of the horisontal projection of the track in one pellicle of the emulsion is $\geq$ 3 mm;

c/ the magnitude of the ionization J is within the limits

$$1.5 \leq J \leq \sim 7 J_{min}$$

The tracks satisfying these criteria were followed at a distance of, at least, 2 cm or until they come to rest in the emulsion, if their length was less than 2 cm. At first the events of hyperon decay in flight by the scheme $\Sigma^\pm \to \pi^\pm + n$ were selected visually. With this aim all the places of the disappearance of the tracks of the particles which actually do not come to rest inside the emulsion pellicle were carefully scanned with a high magnification (60 x 10 x 1.5) in order to find a secondary relativistic or almost relativistic track. Such events could be the decay in flight of $\Sigma^\pm$ hyperons or $K^\pm$-mesons. At the same time one could expect beforehand that due to a large difference between the lifetimes of these particles the $K^\pm$-meson contamination has to be extremely insignificant.

The final identification was made on the basis of the results of measurements of the multiple scattering and the ionization. The magnitudes of the hyperon and K-meson velocities (β_Σ , β_K) corresponding to the measured magnitude of $p\beta$ and calculated by the Tables[3] were compared with the results of the measurements of the ionization by the method suggested in[4]. The statistical error in the measurement of the magnitude of $p\beta$ did not, as a rule, exceed 10–15%, whereas the relative error in the measurement of the ionization was 6–8%. The measurements of such an accuracy turned out to be sufficient for a reliable identification of hyperons. For the verification analogous measurements were made of the genuine K meson tracks* in the ionization interval $(2.5 \div 7)\, J_{min}$. The identification of the particles for all the cases was found to be correct. Besides, for two hyperons identified by the method described above we succeded in continuing the tracks of π^- - mesons produced in their decay. The π^- - mesons ranges were in good agreement with the kinematics of the decay via the scheme $\Sigma^\pm \to \pi^\pm + n$.

Using this method for searching the decays the only reason for which the $\pi^{\pm}$ -mesons may be missed is the low recording efficiency of a relativistic particle. To evaluate this efficiency there were investigated 226 events of $\pi \to \mu$ decay with the μ^- meson stopping inside the emulsion stack. The electrons from μ^- meson decay were not found in 8 events. Therefore, one may think that in the $\Sigma^{\pm}$ - hyperon decay events found there is, likely, no preferential selection of $\pi^{\pm}$ -mesons in any direction.

By such a method altogether there were found 72 events of $\Sigma^{\pm}$- hyperon decay in flight. If we assume that the angular distribution is of the form $(1 + \alpha \cos\theta)$, where θ is the angle between the directions of a Σ^- hyperon and a π^- meson in the rest system of a hyperon, then the magnitude of $'\alpha'$ is found to be 0.09 ± 0.2. After adding 7 events found in the same way but under somewhat different conditions the value of the coefficient $'\alpha'$ became 0.03 ± 0.2.

In the course of the search and the identification of hyperons there were found two events in which the secondary particle turned out to be an electron. The kinetic energies of electrons were $\sim$1.5 MeV and (11 ± 2)MeV. Both events may be accounted for the charge exchange of the proton on the emulsion carbon nucleus with a subsequent β^- decay of the produced nitrogen isotope N^{12}:

$$p + C^{12} \to N^{12} + n \quad , \quad N^{12} \to C^{12} + \beta^+$$

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