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JOINT INSTITUTE FOR NUCLEAR RESEARCH

Laboratory of High Energies

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It is known that in spite of the considerable phase volume the decay $\Xi^- \rightarrow n + \pi^-$ has not been observed until now. The absence of such a decay has led Gell-Mann and Pais to the supposition that for the decays in which the strongly interacting particles participate there exists the selection rule $|\Delta S| = I$, forbidding the decays by the change in "strangeness" by two(I). This selection rule requires the "strangeness" of Ξ^- hyperon to be 2 since its decay products Λ° and π^- have the total strangeness -I. It follows from here if the well-known relation $Q = I_z + N/2 + S/2$ is taken into account that under these assumptions Ξ -hyperon is an isotopic doublet, i.e.besides $\Xi^-(I_z = -1/2)$ there must exist $\Xi^\circ(I_z = +1/2)$. The principal decay of this hypothetical particle is very likely $\Xi^\circ \rightarrow \Lambda^\circ + \pi^\circ$ difficult to be observed. However, as it was mentioned above (2) the selection rule $|\Delta S| = I$ is but a working hypothesis. The absence of the violations of this rule is quite natural if one takes into account that $S = \pm 1$ is assigned to all the known "strange" particles /save Ξ /, Therefore, $|\Delta S| = I$ is the only possible change of "strangeness" in the decay into "old" particles. It should be also noted that within the Gell-Mann and Nishijima scheme there exists in principle one more possibility : to assign $S = -3$ to the cascade hyperon that leads to the isotopic singlet. In this case the selection rule might have been changed by assuming the decays with $|\Delta S| = I.2$ to be allowed and those with $|\Delta S| = 3$ to be forbidden Thus, the discovery of Ξ°-hyperon becomes of particular interest since it is a verification of the validness of the selection rule $|\Delta S| = I$.

In connection with the possible existence of Ξ° -particle the attention should be drawn to the appreciable difference between the mean lifetime of Λ° -particles observed in cosmic rays $\tau' = (3.5^{+0.2}_{-0.1}) 10^{-10}$ sec.and those obtained with the accelerators $\tau = (2.8 \pm 0.1) \cdot 10^{-10}$ sec/x/ I. In the first case besides Λ°, produced in the primary interaction Λ° which were created as a result of the nonobserved decay $\Xi^\circ \rightarrow \Lambda^\circ + \pi^\circ$ may be detected. The primary interaction is not observed as a rule. Therefore, to distinguish these two kinds of Λ° particles does not seem possible. Evidently, this circumstance should lead to the seeming increase, of the measured τ'_{Λ° if compared with the real one. This increase will depend upon relative probability of production (with subsequent decay) for Ξ° and Λ° -particles. On the other hand until now the experimentalists could obtain with the accelerators the "pure" in this sense Λ° -particles, since Ξ° - hyperon could not be produced in these experiments due to energy considerations. It is worth noting that for those few "cosmic" events when the primary interaction strictly complanar with Λ° - decay is seen in the chamber the τ_{Λ° measured was also found to be appreciably less: $(2.14^{+0.8}_{-0.5}) 10^{-10}$ sec. However, at high energies the mentioned complanarity cannot be considered as a criterion for Λ° being "pure", since in Ξ-decay Λ° almost keeps the direction of the disintegrated Ξ hyperon.

(x) The given values were determined as the average weighted value according to the results of the published papers till 1958.

τ_{Λ° - by 425 analyzed events

τ'_{Λ° - by 207 events.

The last number does not include 25 events published in /4 / for the reasons given below (that, by the way, did not almost affect the result).

In case when Λ^0 appears as a result of the decay $\Xi^0 \to \Lambda^0 + \pi^0$ the probability of observing Λ^0-decay in the definite interval of time dt_i (or in the corresponding interval of range $d\ell_i$) will be:

$$dp_i = f_i\, dt_i = B_i \frac{\tau_{\Lambda^0}}{\tau_{\Xi^0}-\tau_{\Lambda^0}} \left[\exp(-t/\tau_{\Xi^0}) - \exp(-t_i/\tau_{\Lambda^0}) \right] dt_i$$

where τ_{Λ^0} and τ_{Ξ^0} are the mean lifetimes of Λ^0 and Ξ^0 hyperons respectively, while B_i is the normalizing coefficient. Thus, not going into details of the statistical method for determining τ_{Λ^0} [4] it should be pointed out that the original distribution of the probability for all observed particles will be really not $dP = \prod_i^{1\cdots n} A_i \exp(-t_i/\tau'_{\Lambda^0})\, dt_i$ as it was supposed by the analysis of a:

$$dP' = \prod_i^{1\cdots n} A_i \exp(-t_i/\tau_{\Lambda^0})\, dt_i \prod_i^{1\cdots m} B_i \frac{\tau_{\Lambda^0}}{\tau_{\Xi^0}-\tau_{\Lambda^0}} \left[\exp(-t_i/\tau_{\Xi^0}) - \exp(-t_i/\tau_{\Lambda^0}) \right]^{x} dt_i$$

where n and m are the numbers of Λ^0 produced in the primary interaction and Λ^0 created as a result of Ξ^0 decay respectively. At the same time the mean lifetime was determined under the assumption that there is a purely exponential dependence of Λ^0 -decays upon t . It is evident that the exponent of function which is the best approximation for the real distribution function /a/ will depend upon the relative number of Ξ^0-particles $q = \frac{m}{n}$ and upon its lifetime τ_{Ξ^0}. The comparison of τ'_{Λ^0} with the real value of the lifetime of Λ^0 obtained in the experiments with the accelerators enables to evaluate roughly q and τ_{Ξ^0}.

For this purpose neglecting the influence of the normalizing coefficient A_1 and B_1 one may find those values of q and τ_{Ξ^0} when the distribution function

$$f'(t) = \exp(-t/\tau_{\Lambda^0}) + q \frac{\tau_{\Lambda^0}}{\tau_{\Xi^0}-\tau_{\Lambda^0}} \left[\exp(-t/\tau_{\Xi^0}) - \exp(-t/\tau_{\Lambda^0}) \right)$$

is best described by the exponential curve $(1+q)\exp(-t/\tau'_{\Lambda^0})$. The values of q and τ_{Ξ^0} found in such a way were found to be within rather reasonable limits $q = 0.15 \div 0.20$ and $\tau_{\Xi^0} = (4\div 6)\cdot 10^{-10}$ sec. Indeed, at present there are no reasons to expect strong difference in the production cross sections of Ξ^0 and Ξ^- . On the other hand, it is known that the number of Ξ^- produced in cosmic rays is $0.1 \div 0.2$ of the number of Λ^0 observed under the same condition[5] that is in the agreement with q by the order of the magnitude. As for τ_{Ξ^0} the analysis of the isotopic states appearing at Ξ^- and Ξ^0 decays shows that $\tau_{\Xi^0}/\tau_{\Xi^-} = 2$, if the decay interactions of such a kind is transformed in the isotopic space like the tensor of rank1/2, or $\tau_{\Xi^0}/\tau_{\Xi^-} = 1/2$,

x) We neglect a small difference in the velocities (more exactly in the values of $\beta\gamma$) of Ξ^0 -hyperon and Λ^0 obtained in its decay.

if there occurs a pure $\Delta I = 3/2$ transition [6]. Thus, the estimate made for τ_{Ξ^0} is also within the reasonable limits since as it was established experimentally. We think the mentioned fact indicates to the existence of the neutral cascade hyperon Ξ^0, though the possibility of some systematical error in the given case cannot be excluded.

In conclusion the author expresses his gratitude to M.I. Podgoretsky for valuable remarks.

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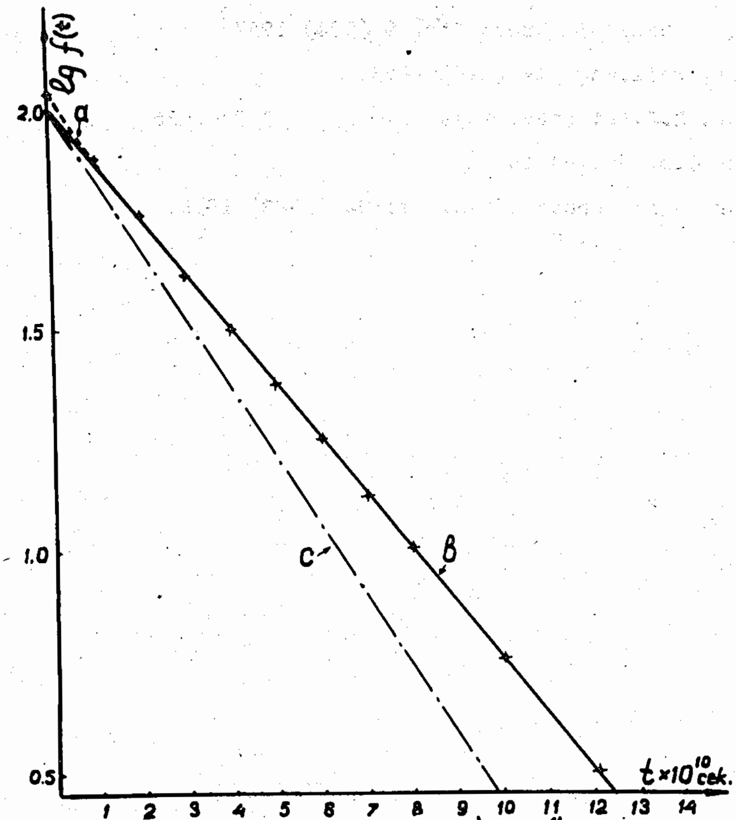

Distribution function of Λ^{0} - decays: a) +---+ $f(t)$, $q=0.2$ $\tau_{z}=4\cdot10^{-10}$ cek.
б) —— $f(t) \sim \exp(-t/\tau')$, $\tau'=3.5\cdot10^{-10}$ cek. c) ·—· $f(t) \sim \exp(-t/\tau)$, $\tau=2.8\cdot10^{-10}$ cek