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AN ESTIMATE OF THE CROSS SECTION FOR Λ AND Σ^0 PARTICLE PRODUCTION IN LEAD BY LONG-LIVED K^0 MESONS WITH A MEAN ENERGY $E = 150$ MeV

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The cross section for production of Λ and Σ^0 particles in lead by K_L^0 mesons with a mean energy $E = 150$ MeV is measured. The cross section is found to be $\sigma = (212 \pm 38) \times 10^{-27}$ cm^2.

THE first estimate of the cross section for the production of Λ and Σ^0 particles in lead under the influence of long-lived K^0 mesons was made in[1] by recording in a cloud chamber (400 mm diameter) 28 decays of Λ particles produced in a lead plate. In the present note we report a refinement of this estimate in accordance with data obtained with a 1-meter cloud chamber[2)] exposed to the neutral-particle beam of the JINR proton synchrotron.

The procedure for identifying the $\Lambda \to \pi^- + p$ decay was the same as in[1], except that in this case, in order to ensure good conditions for the registration of the Λ decays, we selected Λ particles produced in the central part of the lead plate, the boundaries of which were at some distance from the side walls of the chamber and from the upper and lower limits of the illuminated volume respectively. The distribution of the Λ particles over the range to the decay (expressed in units of the range λ) is shown in Fig. 1. The dip in the distribution at small values of λ is due to decays of the Λ particles inside the plate and in the volume adjacent to it, which were not registered during the scanning of the photographs.

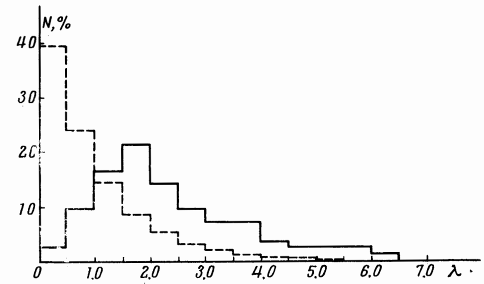
The distribution of the directions of the emission of Λ particles with range $\lambda > 1.5$ with respect to the azimuthal angle is

$\Delta\psi$, deg:	0–30	30–60	60–90
N:	25	21	14

The dashed line in the figure shows the calculated distribution corresponding to 100% efficiency of Λ-decay registration. This distribution does not include six Λ decays for which we were unable to measure reliably the momenta of one or both decay particles.

From a comparison of the distributions given in the figure it is seen that, starting with $\lambda > 1.5$, the numbers of events in the intervals of the experimental and calculated distributions are approximately proportional to each other. This circumstance indicates that the efficiency of Λ-decay registration is close to 100%. Only for those Λ particles whose decay range is $\lambda > 1.5$.

The Λ-particle range distributions given in the table for the two momentum intervals $P \leq 320$ MeV/c and $P > 320$ MeV/c show that the efficiency of registration does not depend (within the limits of the statistical deviations) on the momentum of the Λ particle, and thus confirm the foregoing conclusions. However, the registration of the Λ particles is likewise not 100% efficient in the region $\lambda > 1.5$, since the azimuthal distribution has a dip in the angle interval $\Delta\psi = 60$–$90°$, corresponding to their emission from the plate upward and downward, i.e., in directions along which the dimensions of the illuminated region of the chamber are smaller than in the directions corresponding to the remaining interval of the azimuthal angles. Therefore, in order to determine the number of Λ particles produced in the lead plate, it is necessary to correct the observed number of Λ decays for the registration efficiency, in accordance with the azimuthal distributions and the figure.



Distribution of Λ particles along the range to the decay (expressed in units of the mean free path).

The corrected number of Λ particles produced in the separated part of the lead plate with allowance for the unregistered decay $\Lambda \to \pi^0 + n$ is equal to 542. In determining this number, the six poorly-measured Λ decays were distributed among the intervals $\lambda \leq 1.5$ and $\lambda > 1.5$ in the same manner as the well-measured events. The aforementioned corrected number of Λ particles corresponds to 1.52×10^5 passages of K_L^0 mesons through the lead plate. These data yield for the cross section for the production of the Λ particles by the K_L^0 mesons on lead nuclei a value $\sigma = (212 \pm 38) \times 10^{-27}$ cm^2. The

$\Delta\lambda$	N		$\Delta\lambda$	N	
	$P \leq 320$ MeV/c	$P > 320$ MeV/c		$P \leq 320$ MeV/c	$P > 320$ MeV/c
0.0–0.5	0	2	3.5–4.0	3	3
0.5–1.0	0	8	4.0–4.5	2	1
1.0–1.5	7	7	4.5–5.0	1	1
1.5–2.0	10	8	5.0–5.5	0	2
2.0–2.5	5	7	5.5–6.0	1	1
2.5–3.0	5	3	6.0–6.5	1	0
3.0–3.5	0	6	6.5–7.0	0	0

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[2)]The experimental conditions are described in detail in [2].

error in the determination of the cross section includes the statistical deviations, the error in the measurement of the average lifetime of the K_L^0 mesons (equal to $\tau = (5.2 \pm 0.4) \times 10^{-8}$ sec), and also the inaccuracies connected with the introduction of corrections. The background due to the Λ particles produced in the gas of the chamber was not more than one event, and therefore was disregarded in the determination of the cross section.

Since the ratio of the experimental and calculated numbers of Λ particles in the distribution intervals has a tendency to increase also for values $\lambda > 1.5$ (see the figure), it is possible that the obtained cross section is somewhat underestimated. As a result of the fact that the Λ particles emitted from the lead plate can be either directly produced in absorption of K_L^0 mesons by lead nuclei or can result from the decay of Σ^0 hyperons produced in the plate in capture of K_L^0 mesons, the obtained cross section must be ascribed to the production of Λ and Σ^0 particles. The obtained cross section agrees, within the limits of errors, with the estimates in the earlier paper[1], where we obtained $\sigma = (200 \pm 70) \times 10^{-27}$ cm.

Among the selected Λ decays, we found only four events in which one fast proton was emitted from the point of Λ-particle production on the plate. This fact (as well as the data cited in[1]) shows that the two-nucleon mechanism of K_L^0-meson capture is not predominant. Unlike[1], we have established here that the angular distribution of the Λ particles in the laboratory frame is nonisotropic with predominant emission of Λ particles in the forward direction.

Simultaneously with selecting the Λ particle decays used to determine the cross section, we searched for the decays of the Λ particles contained in the incident beam of the neutral particles. This search was undertaken in order to check on the exponential law of decay of the unstable particles. We found not a single Λ particle with zero emission angle within the limits of errors.

At the same time, if the presence of the decays of neutral K mesons into two pions at large distance from the target is ascribed not to K_L^0 but to K_S^0 mesons and if it is assumed that in the case of the Λ particles the violation of the "exponentiality" of the decay is the same as for K_S^0 mesons, then we should expect in the entire material more than 15 decays of long-lived Λ particles. Thus, in our experiment (just as in the similar investigation[3] by a parallel group), no violation was observed of the exponential law in the Λ-particle decay.

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