ASYMMETRY IN THE DECAY OF Λ^0 HYPERONS GENERATED BY 2.8 Bev/c NEGATIVE PIONS, DETERMINED BY OBSERVATIONS IN A FREON BUBBLE CHAMBER

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The asymmetry in the decay of Λ^0 hyperons relative to the plane of creation was investigated in a freon bubble chamber for Λ^0 particles created on carbon, chlorine, and fluorine nuclei by 2.8-Bev/c negative pions. The measured value of the asymmetry coefficient is $\alpha\bar{P} = -0.30 \pm 0.15$.

WE know[1,2] that the decay products of Λ^0 hyperons generated in the reaction

$$\pi^- + p \to \Lambda^0 + K^0, \tag{1}$$

are emitted asymmetrically with respect to the plane of creation of the Λ^0, owing to the transverse polarization of the Λ^0 hyperons due to parity nonconservation in the process of decay of the Λ^0 particles. The distribution of the decay products of the Λ^0 particles relative to the plane of their creation is described by the relation

$$W(\xi)\,d\xi \sim (1 + \alpha\bar{P}\xi)\,d\xi, \tag{2}$$

where α is the asymmetry coefficient characterizing the degree of parity nonconservation in the Λ^0 decay, $\bar{P}$ is the hyperon polarization averaged over all the values of the angles of emission of the Λ^0 during creation, and $\xi = [\mathbf{p}_{\pi\,\mathrm{pri}} \times \mathbf{p}_\Lambda] \times \mathbf{p}_{\pi\,\mathrm{decay}}$, where $\mathbf{p}_\Lambda$, $\mathbf{p}_{\pi\,\mathrm{pri}}$ and $\mathbf{p}_{\pi\,\mathrm{decay}}$ are the momentum vectors of the Λ^0 particle, primary pion, and "decay" pion respectively. Usually the value of $\alpha\bar{P}$ is calculated from the formula

$$\alpha\bar{P} = 2(N_\uparrow - N_\downarrow)/(N_\uparrow + N_\downarrow), \tag{3}$$

where $N_\uparrow$ and $N_\downarrow$ are the numbers of pions emitted upward and downward relative to the plane of creation.

This asymmetry was investigated in several researches (see, for example, references 3 – 6) at a generating pion energy near 1 Bev. According to the latest data, the value of $\alpha\bar{P}$ measured in a hydrogen chamber[6] is 0.73 ± 0.14. In a xenon bubble chamber $\alpha\bar{P} = 0.45 \pm 0.15$.[6]

Of considerable interest are the values of $\alpha\bar{P}$ at energies above 1 Bev, since they can give an idea of the polarization of the Λ^0 hyperons created at this energy.

We have set up experiments on the asymmetry of the decay of Λ^0 hyperons generated by negative pions with momenta (2.8 ± 0.3) Bev/c on light nuclei, in a 17-liter freon bubble chamber[7] without a magnetic field. The measurements were made with the negative-pion beam from the proton synchrotron of the Joint Institute for Nuclear Research.

The Λ^0 particles are generated by 2.8-Bev/c negative pions essentially via the reaction

$$\pi^- + N \to \Lambda^0 + K + n\pi \tag{4}$$

(with a tentative estimate $\bar{n} \approx 1.5$).

In addition, the considered Λ^0 decays contain several Λ^0 hyperons due to the decay of the Σ^0 hyperons generated in a reaction analogous to (4). Because of the Λ^0-particle contamination due to the decay $\Sigma^0 \to \Lambda^0 + \gamma$, our calculated value of $\alpha\bar{P}$ may be somewhat too low.

A total of about 60 thousand stereophotographs were obtained, in which the first scanning disclosed approximately 1200 "forks" connected with termination of a pion track. The Λ^0 particles in these events were identified by estimating ionization, multiple scattering, and in many cases also the ranges of the protons or pions, and also by kinematic analysis, with the aid of the tables of reference 8, of the angles between the direction of motion of the Λ^0 particle and its decay products.

By the same token, the result included only the Λ^0-hyperon decays for which a noticeable difference in ionization was observed for at least one of the decay products, relative to the minimum ionization corresponding to the beam particles.

A total of 183 Λ^0-decay cases were selected, of which 165 were due to the production of Λ^0 particles by the freon, i.e., by the C, F, or Cl nuclei, and 18 cases were due to production by the propane-

Material in the chamber	Total no. of Λ^0-decay events	No. of negative pions from the Λ^0-hyperon decay emitted			$\alpha\bar{P}$
		upward	downward	in the creation plane	
Freon	165	67	95	3	-0.34 ± 0.16
Xenon-propane	18	9	8	1	$+0.12 \pm 0.47$
Total number of events	183	76	103	4	-0.30 ± 0.15

xenon mixture, i.e., the H, C, or Xe nuclei. The average momentum of the Λ^0 particles used in the measurements was 650 Mev/c in the laboratory system. Owing to the stringent selection criteria, the K^0-decay contamination of the Λ^0 decays did not exceed 5%.

The measured values of $\alpha\bar{P}$ are listed in the table (the errors indicated are statistical). The systematic errors connected with the measurement procedure do not change our result by more than 20%. It follows from the data obtained, with considerable probability, that a negative value of $\alpha\bar{P}$ is observed in the decay of hyperons generated by negative ~3-Bev pions on light nuclei. This may be connected with the fact that on going from 1 Bev to higher negative-pion energies a change takes place in sign of the polarization of the Λ^0 hyperons. However, the statistical accuracy of our experiment is insufficient for an unequivoval conclusion that $\alpha\bar{P}$ is negative.

In connection with the foregoing result, it should be noted that the authors of reference 4 conclude that $\alpha\bar{P}$ decreases somewhat on going from a generating-meson energy of 0.9 — 1.0 Bev to 1.2 — 1.3 Bev. In another investigation,[5] carried out with 1.3 — 1.9 Bev generating mesons for targets made of iron, no asymmetry was observed. However, the statistical accuracy of both results is low.

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