POLARIZATION OF Λ HYPERONS PRODUCED IN π^--C INTERACTIONS AT 7 GeV

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A search was made for Λ hyperons produced in collisions between 7 GeV negative pions and carbon nuclei. The Λ hyperons are produced without longitudinal polarization.

THIS work was begun in 1960 to study the longitudinal polarization of Λ hyperons produced in complex nuclei. The longitudinal polarization is manifested in a forward-back asymmetry of the angular distribution of protons (or π^- mesons) from the Λ decay relative to the direction of the Λ hyperon momentum in the system in which the Λ hyperon is at rest. Up to the time our experiment was begun, only a few results had been published, and these were in disagreement with one another. Thus, in the study of the Λ-hyperon production by cosmic rays in complex nuclei[1] a very large forward-back asymmetry was observed, while no asymmetry was found in the production of Λ hyperons by negative pions at 1.12 and 1.23 GeV/c on hydrogen[2,3]. The problem was of definite interest, since the presence or absence of a longitudinal polarization is evidence of the violation or nonviolation of spatial parity conservation in strong interactions.[4,5]

It was very important to verify whether the asymmetry in the angular distribution observed in [1] depended on the energy of the incident particle or whether the interaction involved complex nuclei. Therefore, along with the study of the polarization of Λ hyperons produced in π^--p interactions by 7—8 GeV π^- mesons,[6,7] we studied the polarization of Λ hyperons produced in π^--C interactions by 7-GeV π^- mesons. For this purpose, we used the same pictures obtained with the 24-liter propane bubble chamber of the High-energy Laboratory, which was also used for the study of Λ-hyperon polarization in π^--p interactions. All events with Λ hyperons and K^0 mesons whose characteristics did not satisfy the selection criteria for π^--p interactions[6,7] were considered to be π^--C interactions.

It follows from [7] that of all the corrections the most important is the correction for the loss of the events in which the π^- meson from the Λ decay has a very short range. In our propane chamber, such cases will be Λ decays with π^- mesons of range between 0 and 2 cm. Hence at the very outset of the scanning for V^0 events, we paid special attention to such cases.

All V^0 events whose kinematic characteristics corresponded to Λ-hyperon and K^0-meson decays were considered to be Λ hyperons, since it was shown in [7] that at our energies more than 90% of the V^0 events whose decay kinematics are ambiguous are Λ hyperons.

It is known that Λ hyperons have a spin 1/2 and hence the angular distribution of the protons (and also the π^- mesons) from the Λ decay can be written in the form

$$f(\theta) = 1 + \alpha\bar{p}\cos\theta,$$

where α is the asymmetry parameter, $\bar{p}$ is the polarization component, $\cos\theta$ characterizes the emission angle of the proton (or π^- meson) from the Λ decay in the Λ rest system (the direction of one of the coordinate axes coincides with the direction of the Λ momentum), where

$$\alpha\bar{p} = \frac{3}{N}\sum\cos\theta \pm \sqrt{\frac{3}{N}[1-(\alpha\bar{p})^2]}$$

(N is the total number of analyzed Λ hyperons).

For $\alpha\bar{p}$ not equal to zero, the polarization will have a nonzero value, since $\alpha \neq 0$ (thus, $\alpha_\Lambda = 0.62 \pm 0.07$ according to Cronin[8] while $\alpha_\Lambda = 0.68 \pm 0.07$ and $\alpha_\Lambda = 0.66 \pm 0.20$ according to the data of Crawford and Leutner—Geneva Conference, 1962).

In our experiment, we found for 260 Λ hyperons that

$\alpha\bar{p}_1 = -0.01 \pm 0.11$ for the forward back distribution,

$\alpha\bar{p}_2 = -0.06 \pm 0.11$ for the right-left distribution,

$\alpha\bar{p}_3 = +0.04 \pm 0.11$ for the up-down distribution.

As before,[7] we paid special attention to the dependence of the quantity $\alpha\bar{p}_1$: 1) on the Λ-hyperon momentum p^*_Λ in the pion-nucleon c.m.s. and 2) on the multiplicity n_s of charged particles produced together with the Λ hyperons. We found

$$1)\quad \alpha\bar{p}_1 = -0.02 \pm 0.14 \text{ for } p^*_\Lambda < 1000 \text{ MeV},$$
$$\alpha\bar{p}_1 = -0.02 \pm 0.16 \text{ for } p^*_\Lambda > 1000 \text{ MeV},$$
$$2)\quad \alpha\bar{p}_1 = -0.24 \pm 0.15 \text{ for } n_s \leqslant 3,$$
$$\alpha\bar{p}_1 = +0.24 \pm 0.15 \text{ for } n_s \geqslant 4.$$

We note that for Λ hyperons produced in π^--p interactions we found[7] the following values of $\alpha\bar{p}_1$

$$\alpha\bar{p}_1 = +0.15 \pm 0.10 \text{ for } n_s = 0 \text{ and } 2,$$
$$\alpha\bar{p}_1 = -0.25 \pm 0.15 \text{ for } n_s = 4 \text{ and } 6.$$

The change in the sign of the quantity $\alpha\bar{p}_1$ as a function of the charged-particle multiplicity in π^--p and π^--C interactions can be ascribed only to statistical fluctuations.

Thus the obtained results are in agreement with spatial parity conservation in strong interactions involving strange particles in interactions of 7-GeV negative pions with carbon nuclei.

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