A POSSIBLE METHOD FOR THE DETERMINATION OF THE PARITY OF STRANGE PARTICLES

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It is suggested that the K-meson parity can be determined by investigation of the left-right asymmetry in $\pi(K) + p \rightarrow Y + K(\pi)$ reactions with a polarized proton target.

In the weak interactions responsible for K-meson and hyperon decays parity is not conserved. Therefore the intrinsic parity of strange particles can be studied only in their strong interactions.

In this note it is pointed out that the intrinsic parity of K mesons and hyperons can be determined from the reactions

$$\pi + p \rightarrow \Lambda(\Sigma) + K, \quad K + p \rightarrow \Lambda(\Sigma) + \pi \qquad (1)$$

with a polarized proton target. We assume spin $\frac{1}{2}$ for the hyperons and spin 0 for the K mesons in agreement with experimental data. The density matrix for a reaction of type (1) then has the form

$$M = a + \mathbf{b}\cdot\sigma \qquad (2)$$

and is a scalar if the total intrinsic parity in the reaction does not change, a pseudoscalar otherwise (a and **b** are functions of the relative momenta in the initial and final states). Using (2) it is easy to obtain by standard[1] methods the following expression for the differential scattering cross section:[2]

$$\sigma(\theta, \varphi) = \sigma_0(\theta)(1 \pm \mathbf{P}_0\cdot\mathbf{P}_Y). \qquad (3)$$

Here σ_0 is the cross section for an unpolarized target, $\mathbf{P}_0$ is the initial polarization of the protons, $\mathbf{P}_Y$ is the hyperon polarization in a reaction with unpolarized proton targets (the vector $\mathbf{P}_Y$ is perpendicular to the reaction plane).

The plus sign in formula (3) is to be used if $I_Y I_K = I_p I_\pi$, the minus sign if $I_Y I_K = -I_p I_\pi$ (I stands for intrinsic parity of the particle).

If the y axis is taken in the direction of the initial polarization $\mathbf{P}_0$, we can rewrite (3) as follows

$$\sigma(\theta, \varphi) = \sigma_0(1 \pm P_0 P_Y \cos\varphi). \qquad (4)$$

Therefore the asymmetry is given by

$$e(\theta) = \frac{\sigma(\theta, 0) - \sigma(\theta, \pi)}{\sigma(\theta, 0) + \sigma(\theta, \pi)} = \pm P_0 P_Y. \qquad (5)$$

Since the initial polarization P_0 is known, the asymmetry measures directly the hyperon polarization for reactions with unpolarized targets. Most important, the sign of the asymmetry makes it possible to determine the product of the intrinsic parities $I_Y I_K I_p$. To this end an independent measurement is needed of the sign of the hyperon polarization from reactions with unpolarized targets. A ready-made analyzer is provided by the subsequent decay of the polarized hyperon. As is well known,[3] a measurement of the asymmetry of the decay π mesons permits the determination of the product αP_Y (α stands for the asymmetry coefficient). The coefficient α may be obtained by measuring the polarization of the protons from the decay of the hyperon.[4] At the Geneva Conference (1958) such a measurement of the coefficient α for the Λ hyperon was reported ($\alpha = +0.85^{+0.15}_{-0.21}$).[5]

In this manner, utilizing the data on the sign of the polarization obtained from a study of the decay of polarized hyperons, it is possible to deduce uniquely the value of the product $I_Y I_K I_p$ from experiments with a polarized proton target. We would like to emphasize that the basic formula (3) is a rigorous one; the only assumptions in its derivation are that (1) parity is conserved in strong interactions involving K mesons and hyperons, (2) the hyperon spin is $\frac{1}{2}$ and the K-meson spin is 0.

In conclusion we note that the study of various reactions of type (1) with a polarized proton target would permit the determination of relative parities of hyperons. For example, from the reactions

$$\pi^- + p \rightarrow \Lambda^0 + K^0, \quad \pi^+ + p \rightarrow \Sigma^+ + K^+$$

one finds $I_\Lambda I_K I_p$ and $I_\Sigma I_K I_p$ respectively. Together they determine $I_\Sigma I_\Lambda$.

Finally let us note that all that was said above applies equally well to reactions with polarized spin $\frac{1}{2}$ nuclei where a hypernucleus of spin $\frac{1}{2}$ is formed in the final state.

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