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Possibility of Measuring Ξ Parity

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[Abstract: This is an elaboration of a remark I made at the Short-Lived Beam Workshop at Fermilab on December 18, 1975, on the possibility of measuring the $\Xi\pi$ parity relative to ΛK in the decay of Ξ (1820).]

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Now that the Σ^0 lifetime has been measured at CERN (O. E. Overseth, private communication; the preliminary value for the lifetime is $(0.63 \pm 0.30) \times 10^{-19}$ sec., as compared to the SU(3) prediction 0.8×10^{-19} sec.), the only important omissions in the Particle Data Table seem to be the parity of the Ξ's, the magnetic moment of Ξ^0, and various properties of Ω^-, as far as stable baryons are concerned.

There is no doubt in most theorists' minds that the Ξ's are members of the $(1/2)^+$ baryon octet. Nevertheless, experimental verification of this supposition is not only desirable, but imperative. With an intense hyperon beam, the Ξ parity determination may not be too difficult. Let us assume that Ξ (1820) is produced with an appreciable rate and its decays are observed.

The SU(3) systematics assign Ξ (1820) to the $(3/2)^-$ baryon octet which includes N(1520). The spin-parity of Ξ (1820) plays no role in the following discussion, but the known fact that it decays into $\Xi\pi$ and ΛK (also ΣK) is crucial. As usual, we adopt the convention that π and K have the same parity. Irrespective of the relative $\Xi\Lambda$ parity, the decay angular distribution is the same for $\Xi\pi$ as for ΛK. This is related to the Minami ambiguity in πN scattering: if the Ξ and Λ parities are opposite Ξ (1820) decays into ΛK in the $D_{3/2}$ state, but into $\Xi\pi$ in $P_{3/2}$, both of which have the same angular distribution.

What is different, if Ξ and Λ have opposite parity, is that their transverse polarizations are opposite. It is possible to write down a formula (see for example J. D. Jackson's article in High Energy Physics, ed. C. DeWitt and M. Jacob, p 341, Gordon and Breach, publishers, 1965), for the transverse polarization of the decay baryon in terms of the polarization density matrix of the parent. It is not particularly illuminating, except that it affirms the assertion that the transverse polarization reverses sign under parity change of the decay baryon.

Thus the experiment I envision is a simple one; are the transverse polarizations of Ξ and Λ the same or opposite in the same kinematical configuration in the decays of $\Xi(1820)$? The transverse polarization of Ξ or Λ can be measured trivially from the angular distribution of daughters in nonleptonic decays: for the Ξ decay the distribution in angle of the decay Λ is

$$W(\theta)\, d\cos\theta = \frac{1}{2}\,(1 - \alpha_{\Xi}\, \hat{p}\cdot\vec{s})\, d\cos\theta$$

where $\vec{s}$ is the polarization of the parent, and $\hat{p}$ is the direction of the decay baryon. Both α_{Ξ} and α_{Λ} are known to be not small.

I thank Chris Quigg for leading me through the jungle of literature on polarization phenomena.