weak magnetism, and are taken into account adequately by considering terms of first order in

$$\delta = (m_i - m_f)/(m_i + m_f) , \quad \text{where}$$

m_i and m_f are the masses of the initial and final baryons.

The experimental quantities of interest are the total decay rate, the lepton-neutrino angular correlation, the asymmetry coefficients in the decay of a polarized initial baryon, and the polarization of the decay baryon in its own rest frame for an unpolarized initial baryon. Formulae for these quantities are derived by standard means [5] and are analogous to similar formulae for beta decay [6]. For comparison with high-precision experiments, it is necessary to modify the form factors at $q^2 = 0$ by a "dipole" q^2 dependence, and also to apply appropriate radiative corrections [7].

The ratio g_A/g_V may be written as

$$g_A/g_V = |\, g_A/g_V \,|\, e^{i\phi_{AV}} \ .$$

The presence of a "triple correlation" term in the transition probability, proportional to $\mathrm{Im}(g_A/g_V)$ and of the form

$$\boldsymbol{\sigma}_i \cdot (\mathbf{p}_\ell \times \mathbf{p}_\nu)$$

for initial baryon polarization or

$$\boldsymbol{\sigma}_f \cdot (\mathbf{p}_\ell \times \mathbf{p}_\nu)$$

for final baryon polarization, would indicate failure of time-reversal invariance. The phase angle ϕ has been measured precisely only in neutron decay (and in ^{19}Ne nuclear beta decay), and the results are consistent with T invariance.

Hyperon nonleptonic decays

The most general decay amplitude for $J^P = 1/2^+$ hyperons may be written in the form

$$M = G_F\, m_\pi^2 \cdot \overline{B}_f\, (A - B\gamma_5)\, B_i \ ,$$

where A and B are constants [1]. Then the transition rate is proportional to

$$R = 1 + \gamma\, \widehat{\boldsymbol{\omega}}_f \cdot \widehat{\boldsymbol{\omega}}_i + (1-\gamma)(\widehat{\boldsymbol{\omega}}_f \cdot \widehat{\mathbf{n}})(\widehat{\boldsymbol{\omega}}_i \cdot \widehat{\mathbf{n}})$$
$$+ \alpha(\widehat{\boldsymbol{\omega}}_f \cdot \widehat{\mathbf{n}} + \widehat{\boldsymbol{\omega}}_i \cdot \widehat{\mathbf{n}}) + \beta \widehat{\mathbf{n}} \cdot (\widehat{\boldsymbol{\omega}}_f \times \widehat{\boldsymbol{\omega}}_i) \ ,$$

where $\widehat{\mathbf{n}}$ is a unit vector in the direction of the final baryon momentum, and $\widehat{\boldsymbol{\omega}}_i$ and $\widehat{\boldsymbol{\omega}}_f$ are unit vectors in the directions of the initial and final baryon spins. (The sign of the last term in the above equation was incorrect in our 1988 and 1990 editions.) Also,

$$\alpha = 2\,\mathrm{Re}(s^* p)/(\,|\,s\,|^2 + |\,p\,|^2) \ ,$$

$$\beta = 2\,\mathrm{Im}(s^* p)/(\,|\,s\,|^2 + |\,p\,|^2) \ ,$$

and

$$\gamma = (\,|\,s\,|^2 - |\,p\,|^2)/(\,|\,s\,|^2 + |\,p\,|^2) \ ,$$

where $s = A$ and $p = |\,\mathbf{p}_f\,|\, B/(E_f + m_f)$; here E_f and $\mathbf{p}_f$ are the energy and momentum of the final baryon. The parameters α, β, and γ satisfy

$$\alpha^2 + \beta^2 + \gamma^2 = 1 \ .$$

If the hyperon polarization is $\mathbf{P}_Y$, the polarization $\mathbf{P}_B$ of the decay baryons is

$$\mathbf{P}_B = \frac{(\alpha + \mathbf{P}_Y \cdot \widehat{\mathbf{n}})\widehat{\mathbf{n}} + \beta(\mathbf{P}_Y \times \widehat{\mathbf{n}}) + \gamma \widehat{\mathbf{n}} \times (\mathbf{P}_Y \times \widehat{\mathbf{n}})}{1 + \alpha \mathbf{P}_Y \cdot \widehat{\mathbf{n}}} \ .$$

Here $\mathbf{P}_B$ is defined in the rest system of the baryon, obtained by a Lorentz transformation along $\widehat{\mathbf{n}}$ from the hyperon rest frame, in which $\widehat{\mathbf{n}}$ and $\mathbf{P}_Y$ are defined.

An additional useful parameter ϕ is defined by

$$\beta = (1 - \alpha^2)^{1/2} \sin\phi \ .$$

In the Listings, we compile α and ϕ for each decay, since these quantities are most closely related to experiment and are essentially uncorrelated. When necessary, we have changed the signs of reported values to agree with our sign conventions. In the Baryon Summary Table, we give α, ϕ, and Δ (defined below) with errors, and also give the value of γ without error.

Time-reversal invariance requires, in the absence of final-state interactions, that s and p be relatively real, and therefore that $\beta = 0$. However, for the decays discussed here, the final-state interaction is strong. Thus

$$s = |\,s\,|\, e^{i\delta_s} \text{ and } p = |\,p\,|\, e^{i\delta_p} \ ,$$

where δ_s and δ_p are the pion-baryon s- and p-wave strong interaction phase shifts. We then have

$$\beta = \frac{-2\,|\,s\,|\;|\,p\,|}{|\,s\,|^2 + |\,p\,|^2} \sin(\delta_s - \delta_p) \ .$$

One also defines $\Delta = -\tan^{-1}(\beta/\alpha)$. If T invariance holds, $\Delta = \delta_s - \delta_p$. For $\Lambda \to p\pi^-$ decay, the value of Δ may be compared with the s- and p-wave phase shifts in low-energy $\pi^- p$ scattering, and the results are consistent with T invariance.

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