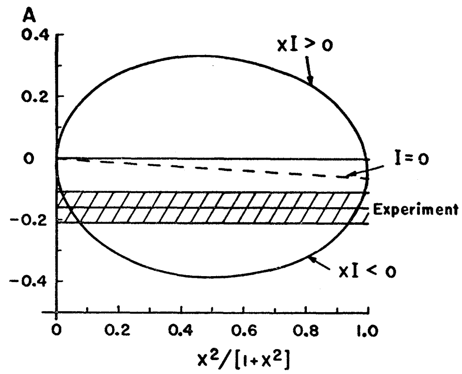

FIG. 1. Anisotropy coefficient A for the circular polarization of γ rays from Mn^{52}. The experimental value of $A=-0.16\pm0.05$ is indicated. The theoretical curves correspond to the following different choices of the interference term I and the ratio x between Gamow-Teller and Fermi interaction: $x\cdot I>0$ and $|I|=$maximum (upper branch of the ellipse), $x\cdot I<0$ and $|I|=$maximum (lower branch of the ellipse), and $I=0$ (dotted straight line). In the case $I=0$ the maximum theoretical value for the anisotropy is $A=-0.056$. The abscissa represents the percentage of Gamow-Teller contribution. The experimental value indicates the presence of an interference term.

of δ an asymmetry coefficient, $A=-0.16\pm0.05$, is derived. A decrease of the circular polarization of the three γ rays due to nuclear recoil effects has not been considered. Our experimental value for $|A|$, therefore, can be considered as a lower limit.

Figure 1 shows the experimental value of A in comparison with theoretical curves derived from the paper by Alder, Stech, and Winther,[3] assuming the maximum amount of interference (ellipse) and no interference (dotted straight line). The abscissa represents the percentage of Gamow-Teller contribution. The upper and lower branch of the ellipse hold for positive or negative values, respectively, of the product $x\cdot I$, where x is the ratio of the matrix elements for Gamow-Teller and for Fermi transitions multiplied with the ratio of the respective coupling constants and I is the interference term between both interactions as defined in reference 2. Independent of the unknown ratio of matrix elements, our experimental value indicates the presence of an interference term and shows that $x\cdot I<0$. The sign of I would follow from this if the sign of the nuclear matrix elements could be predicted.

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Internal Pair Creation in Σ^0 Decay*

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THE existence of a neutral counterpart of the charged Σ hyperons has been established in the past year by several groups.[1] This particle (Σ^0) has been found to decay rapidly (presumably $\tau<10^{-20}$ sec) into a Λ^0 and photon. It is to be expected that as in the case of other radiative decays, the Σ^0 will exhibit an alternate decay mode in which the photon is internally converted to give an electron pair. One example of such a decay has been found recently by the Columbia bubble chamber group.[2]

A discussion of the internal pair conversion of high-energy photons has been given by Kroll and Wada,[3] who have emphasized that the branching ratio for this process as compared with the radiative decay does not depend strongly on the detailed properties of the system undergoing decay. This conclusion has been found to be essentially valid in the case of Σ^0 decay. However, it may be pointed out that there is some dependence of the result on the relative parity of the Σ^0 and Λ^0, and that a measurement of the branching ratio

$$\rho=\frac{\Sigma^0\rightarrow\Lambda^0+e^++e^-}{\Sigma^0\rightarrow\Lambda^0+\gamma}$$

with an accuracy of 5% would give some indications of the relative parity of the hyperons.

The effective interaction responsible for the Σ^0 decay is taken to be of the form

$$H_{\text{int}}=g\bar{\psi}_{\Lambda^0}\sigma_{\mu\nu}\psi_{\Sigma^0}F_{\mu\nu} \quad (1)$$

in the case where Λ^0 and Σ^0 have the same parity, and

$$H_{\text{int}}=g'\bar{\psi}_{\Lambda^0}\gamma_5\sigma_{\mu\nu}\psi_{\Sigma^0}F_{\mu\nu} \quad (2)$$

in the case of opposite parity. It has been assumed that Σ^0 and Λ^0 have spin $\frac{1}{2}$. These are the simplest gauge-invariant interactions which give the decay $\Sigma^0\rightarrow\Lambda^0+\gamma$. It is of course understood that the interactions (1) and (2) may arise through virtual dissociation of the Σ^0 into charged particles, rather than being primary interactions.

With this choice of interactions, the differential transverse and longitudinal conversion factors, R_T and R_L, respectively, which are defined in Eq. (7) of reference 3, are, in the notation of that paper:

$$R_T(x)=1-(x^2/E^2),\quad R_L(x)=0, \quad (3)$$

in the case of the same parity for Σ^0 and Λ^0, and

$$R_T(x)=1,\quad R_L(x)=\tfrac{1}{2},$$

in the case of opposite parity. Here $E=m_\Sigma-m_\Lambda$, the mass difference of the hyperons and x is an integration variable, which is given by $x^2=2m_e^2+2E_+E_--2\mathbf{p}_+\cdot\mathbf{p}_-$ where $(\mathbf{p}_+,E_+)$, $(\mathbf{p}_-,E_-)$ are the momentum and energy of the positron and electron, respectively. We have neglected terms of order $(E/m_\Sigma)^2$ which are about $\frac{1}{2}\%$.

The corresponding values of the branching ratio ρ are $\rho=1/184$ for equal parity of the hyperons and $\rho=1/165$ for opposite parity of the hyperons.

The difference in the values of the branching ratio is about 12% and a decision between the two cases might be possible with a large number of Σ^0 decays.

The distribution of the pairs as a function of the variable x is given in Fig. 1. It may be seen that the difference between the two distributions is no more than 12% at any point, which means that the distribution in x is not a sensitive test of the parity difference either.

A possible deviation from the values quoted here could arise from structure-dependent effects not yet considered. A general expression for the interaction responsible for the radiative decay can be written as an expression similar to that given by Foldy for the interaction of a spin $\frac{1}{2}$ particle with a photon.[4] This is essentially an expansion in powers of qR, where q is the photon four-momentum and R is the "electromagnetic radius" of the particle. None of these terms in the expansion other than (1) and (2) contribute to the decay into a free photon, but they may all contribute to the internal conversion. For a Σ^0 radius of the pion Compton wavelength, the contribution of these terms will be of the order of 2%, which should not seriously effect the comparison of the cases of same and opposite parities of the hyperon. A much bigger deviation would perhaps indicate a very large radius.

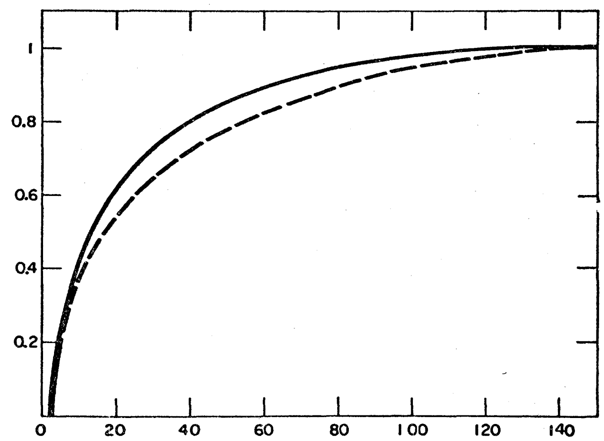

FIG. 1. Distribution in x of the pairs produced in Σ^0 decay. The ordinate gives the proportion of all the pairs produced which have $x\leq$ the abscissa. The variable x is defined by $x^2=2m_e^2+2E_+E_- -2\mathbf{p}_+\cdot\mathbf{p}_-$. The solid curve is for Σ^0 and Λ^0 with the same parity, while the broken curve is for opposite parity.

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