$$\Big\{E-\sum_\alpha E_\alpha\Big\}\langle E_1\ldots E_n\,|\,E\rangle=\sum_{\alpha\beta}\langle E_\alpha E_\beta\,|\,H(\alpha\beta)|\,\langle\ldots(E_\alpha E_\beta)\ldots|\,E\rangle\rangle-\sum_\alpha\langle E_\alpha|U(\alpha)|\,\langle\ldots(E_\alpha)\ldots|\,E\rangle\rangle;$$

$$\begin{aligned}\Big\{E-\sum_{\alpha\neq\gamma}E_\alpha-T(\gamma)\Big\}\langle\ldots(E_\gamma)\ldots|\,E\rangle&=\sum_{\alpha\beta\neq\gamma}\langle E_\alpha E_\beta\,|\,H(\alpha\beta)|\langle\ldots(E_\alpha E_\beta E_\gamma)\ldots|\,E\rangle\rangle\\&+\sum_{\alpha\neq\gamma}(E_\alpha\,|\,H(\gamma\alpha)-U(\alpha)|\langle\ldots(E_\alpha E_\gamma)\ldots|\,E\rangle\rangle;\\&\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots;\\\Big\{E-E_\gamma-\sum_{\alpha\neq\gamma}T(\alpha)-\sum_{\alpha\beta\neq\gamma}H(\alpha\beta)\Big\}\langle E_\gamma\big|E\rangle\Big|&=\langle E_\gamma\Big|\sum_{\alpha\neq\gamma}H(\alpha\gamma)-U(\gamma)\Big|E\rangle.\end{aligned}\tag{1}$$

System (1) jointly with the equations

$$\Big\{E-\sum_\alpha T(\alpha)-\sum_{\alpha\beta}H(\alpha\beta)\Big\}\,|\,E\rangle=0,\quad\{E_\alpha-T(\alpha)-U(\alpha)\}\,|\,E_\alpha\rangle=0$$

determines the single-particle potential U on the surface of constant energy $\Big(E-\sum_\alpha E_\alpha=0\Big)$ and is equivalent to the model transformation $|\,E\rangle=M_n\,|\,E_1\ldots E_n\rangle$. The last assertion becomes obvious, if we introduce the sequence of model operators

$$\begin{gathered}\langle\ldots(E_\alpha)\ldots|\,E\rangle=M_1(\alpha)|\,E_\alpha\rangle;\\\langle\ldots(E_\alpha E_\beta)\ldots|\,E\rangle=M_2(\alpha\beta)|\,E_\alpha E_\beta\rangle;\\\ldots\ldots\ldots\ldots\ldots\ldots;\\\langle E_\alpha\,|\,E\rangle=M_{n-1}(\ldots\alpha-1,\alpha+1,\ldots)|\,E_1,\ldots E_{\alpha-1}E_{\alpha+1}\ldots E_n\rangle;\\|\,E\rangle=M_n\,|\,E_1\ldots E_n\rangle\end{gathered}$$

and find the operator equations for M_p.

Consideration of stationary transitions on a constant energy surface corresponds in this case to examination of such single-particle states which satisfy the requirement $\partial_t\langle\varphi_1,\ldots\varphi_n\,|\,\Psi\rangle=0$, that is an analogue of the usual condition of normalization of $\partial_t\langle\Psi\,|\,\Psi\rangle=0$.

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Some Remarks on Slow Processes of Transformation of Elementary Particles

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AS IS KNOWN, there are two types of slow processes:

(a) lepton:

$$n\to e+\bar\nu+p,\ \mu\to e+\nu+\bar\nu,\ \mu+p\to n+\nu,\ \pi\to\mu+\nu,$$
$$K\to\mu+\nu,\ K\to\mu+\nu+\pi,\ K\to e+\nu+\pi,$$

(b) non-lepton:

$$K\to2\pi,\ K\to3\pi,\ \Lambda(\Sigma)\to N+\pi,\ \Xi\to\Lambda+\pi.$$

The constants of the interactions responsible for these processes in units of $\hbar=\mu=c=1$ (where μ is the π-meson mass) are of the same order of magnitude as $G^2=10^{-14}-10^{-12}$. This suggests that the same mechanism (for example, the universal Fermi interaction[1]) may lie at the basis of all* these processes. This idea is supported by the fact that

*Non-conservation of parity in the decay of hyperons, although it has not yet been proved experimentally, almost inescapably follows from the established parity non-conservation in the decay of K-mesons.

parity is not conserved in all these processes.[2] In the case of lepton processes (a) the non-conservation of parity can be interpreted as following from the concept of the longitudinal neutrino.[3] It is tempting to speculate that this property of the neutrino could also explain the non-conservation of parity in the other slow processes (b) in which no neutrino is emitted. Inasmuch as processes (a) and (b) have comparable probabilities, it would be natural to assume that they are all second order processes as regards neutrino interactions. In this case first order processes will be interactions with the participation of a neutrino and an X baryon with a mass greater than the hyperons mass. The coefficient g^2 of such a first order interaction must be of the order of $10^{-6}-10^{-7}$ in $\hbar=\mu=c=1$ units ($g^2=G$). The lifetime of the X baryon for decay into two leptons and a baryon must then be of the order of 10^{-17} sec and the cross section for its formation in collisions (for example, of fast electrons with nucleons) must be approximately 10^{-34} cm^2.

Obviously, one can image other schemes describing universal non-conservation of parity in slow processes.

The close connection between processes (a) and (b), on the one hand, and the signal lack of success of attempts to extend the concepts of isotopic spin T and strangeness S to leptons, on the other, make it very desirable to evaluate the applicability of these concepts to slow processes of type (b) as well. We have in mind here the selection rules $|\Delta T|=\frac{1}{2}$ and $|\Delta S|=1$ for slow non-lepton processes which have been examined by a number of authors.[4] Actually all the well-studied processes of type (b) are characterized by $|\Delta S|=1$. However, in any of these processes (except decay of Ξ-hyperons) there occurs disintegration of particles with $S=1$ into particles with $S=0$ and it is difficult to see how the change in strangeness could differ from 1. We note, incidentally, that for the K_1^0 and K_2^0 mesons introduced by Gell-Mann and Pais[5] the concept of strangeness is not unambiguous. Thus, the only argument remaining in favor of the $|\Delta S|=1$ rule is that based on the fact that the Ξ-hyperon, the strangeness of which in the scheme of Gell-Mann equals -2, does not decay into $n+\pi^-$ but rather into $\Lambda^0+\pi^-$ (Ref. 6). However, from the experimental viewpoint the Ξ-hyperon is determined precisely as a particle decaying into $\Lambda^0+\pi^-$. In view of the fact that there have been very few observations of Ξ-hyperons the $\Xi^-\to n+\pi^-$ decay could simply have escaped identification so far.

In view of what has been said above it may be of interest to examine some of the consequences following from the assumption that slow processes with $|\Delta S|=1$ and $|\Delta S|>1$ can have comparable probabilities.

1. If there exist K-fragments — nuclear fragments containing a K-meson — then for them in accord with the $|\Delta S|=1$ selection rule only so-called mesonic and nonmesonic decays are possible.[7] However, under the assumption that processes with $|\Delta S|=2$ have a probability comparable to that for other slow processes, the decay of K-fragments with the emission of a hyperon becomes possible. In this case one could also except to observe a "cascade fragment" effect, when the K-fragment in decaying emits an ordinary Λ-fragment. The observation of even one case of emission of a hyperon from a nuclear fragment or one case of "fragment cascade" would invalidate the $|\Delta S|=1$ rule.

2. Let us consider the Gell-Mann — Pais — Piccioni effect.[5,8] The equations describing K^0 and $\tilde{K}^0$-mesons in vacuum have the form

$$-i\partial\psi(K^0)/\partial t=m_0\psi(K^0)+H\psi(\tilde{K}^0),$$
$$-i\,\partial\psi(\tilde{K}^0)/\partial t=m_0\psi(\tilde{K}^0)+H\psi(K^0),$$

where $\psi(K^0)$ and $\psi(\tilde{K}^0)$ are wave functions, m_0 is the mass of the K^0 and $\tilde{K}^0$-particles, and H is the matrix element of the $K^0\to\tilde{K}^0$ transition. The masses of the symmetric combination K_1^0 and antisymmetric combination K_2^0 are, respectively, m_0+H and m_0-H. It is usually assumed[5,9] that the transformation $K^0\to\tilde{K}^0$ is due to processes of the

$$K^0\xrightarrow{|\Delta S|=1}\pi+\pi\xrightarrow{|\Delta S|=1}\tilde{K}^0$$

type *i.e.*, two successive transitions in each of which $|\Delta S|=1$. This leads to the mass difference $\Delta m=2H$ between K_1^0 and K_2^0 being $\sim G^2m\sim10^{-11}m_e$. In this case the time of the transition $K^0\rightleftarrows\tilde{K}^0$ is equal to $T=2\pi\hbar/\Delta m\approx10^{-10}$ sec and is comparable with the lifetimes of K_1^0 and K_2^0-mesons ($\tau_1\sim10^{-10}$ sec and $\tau_2\geq3\times10^{-9}$ sec).[10]

If it be assumed that the $K^0\to\tilde{K}^0$ transition can be due to interaction with $|\Delta S|=2$, for example, that it can proceed according to the scheme.

$K_0\xrightarrow{|\Delta S|=0}$ antihyperon + nucleon $\xrightarrow{|\Delta S|=2}$ hyperon + antinucleon $\xrightarrow{|\Delta S|=0}\tilde{K}^0$, then the matrix element H will be proportional to G and not to G^2. In this case the mass difference $\Delta m'$ between the K_1^0- and K_2^0-mesons proves to be $\sim Gm\approx10^{-5}m_e$. Accordingly, the transformation $K^0\rightleftarrows\tilde{K}^0$ in vacuum will occur with a characteristic transition time $T' = 2\pi\hbar/\Delta m' \approx 10^{-16}$ sec, a time that is appreciably shorter than the lifetime of K_1^0 and K_2^0-mesons.

The distance R from the K^0 particle source, at which the numbers of K^0 and $\tilde{K}^0$ particles become comparable, will no longer be of the order of centimeters, but of the order of 10^{-6} cm. The smallness of the distance R may lead to apparent violations of conservation of strangeness in processes resulting in the formation of strange particles. The formation of K^--mesons at energies below the threshold for the formation of K-meson pairs ($K^0 \rightarrow \tilde{K}^0$ transitions in vacuum and $\tilde{K}^0 - K^-$ transitions in matter) have been discussed by Lande *et al.*[10] who assumed that the time of the $K^0 \rightleftarrows \tilde{K}^0$ transition is close to τ_1. Accurate measurements of the mechanism of formation of K^--mesons in thin targets as a result of nuclear collisions of nucleons or π-mesons having energies below the threshold for K-meson pair formation could resolve the question of the time of the $K^0 \rightleftarrows \tilde{K}^0$ transition. This however presents certain difficulties connected with the fact that the nuclear range even in dense material is not only $\gg cT'$ but even $> cT$.

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Anomalous Decay of a Hypernucleus

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A CASE OF AN UNUSUAL decay of a hypernucleus has been observed in an emulsion chamber (Type "R" NIKFI film) exposed to cosmic radiation in the stratosphere.

The hypernucleus was emitted from a type $10+0n$ star and, after traveling a distance of 2930 μ, disintegrated in flight into three charged particles which were stopped in the emulsion chamber. A microphotograph of this event is reproduced in Fig. 1; the decay products are listed in the table below.

The masses of the decay products were determined by the grain density-range method (with reference to π-mesons). The charge and residual range of the hypernucleus in the emulsion, as determined from the δ-electron density along the residual path, proved to be $2e$ and $600 \pm 100\ \mu$, respectively.

Inasmuch as the mass of particle (2) proved to be $850 \pm 300\ m_e$, it was natural to assume that this particle is K-meson. On the other hand, inasmuch as the charge of the hypernucleus, which was determined with great accuracy, equals $2e$, it could be assumed that the K-meson is negative (the absence of decay products for the K-meson also points to its charge being negative).

The non-coplanarity of the decay products of the hypernucleus indicates the emission of at least one neutron, the energy of which was determined from the momentum vector diagram. Thus it may be assumed that the decay of the hypernucleus occurs according to the scheme

$$(\mathrm{He}_2^5)^* \rightarrow \mathrm{H}_1^1 + K^- + n + \mathrm{He}_2^3 + (103 \pm 5)\,\mathrm{Mev},$$