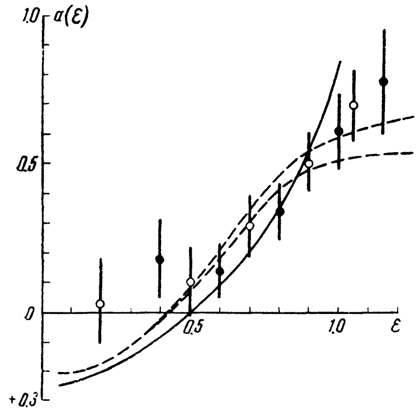

dispersion and tracks 1 mm long. More than 85% of all the particles contained in the spectrum lie between these two extreme cases. The values of the asymmetry coefficient, shown as empty circles, correspond to energy intervals 0 — 0.4, 0.4 — 0.6, 0.6 — 0.8, 0.8 — 1.0, and 1.0. The filled circles are the values of the asymmetry coefficient for the shifted energy intervals 0.5 — 0.7, 0.7 — 0.9, 0.9 — 1.1, and > 1.1. These values are therefore not independent statistically, but do indicate the absence of an effect due to grouping of the data by intervals. The resultant differential spectrum of the values $a(\epsilon)$ increases rapidly with energy and agrees with the two-component neutrino theory. These measurements show no positive asymmetry at low energies. In our previous work,[2] performed with NIKFI-R photoemulsions (a = − 0.077 ± 0.012), an average asymmetry coefficient a = +0.14 ± 0.10 was obtained in the energy region 0 — 0.3, whereas the value expected from the two-component theory was approximately +0.04. Were such high a value of the asymmetry coefficient real, a pronounced positive excess would appear in the present series of measurements. This, however, did not happen.

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ON A SYMMETRY IN τ^0 DECAY

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SUPPOSE the decay process $K_2^0 \to \pi^+ + \pi^- + \pi^0$ is invariant under charge conjugation. We shall show that then the angular distribution of the π^+ and π^- has the following symmetry:

$$F(-\mathbf{p}, \mathbf{p}') = F(\mathbf{p}, \mathbf{p}'), \qquad (1)$$

where $\mathbf{p}$ is proportional to the difference of the momenta of the π^+ and π^- in the center-of-mass system of the reaction (c.m.s.), and $\mathbf{p}'$ is the sum of these momenta.

Let us denote by $\langle \mathbf{pp}' | S | JM \rangle$ the transition amplitude from the initial state (the spin of the K meson is J, the spin projection M) to a state with definite values of $\mathbf{p}$ and $\mathbf{p}'$. It can also be called the wave function of the decay products, written in the momentum representation. As a function of the spherical angles ϑ, φ and ϑ', φ' of the momenta $\mathbf{p}$ and $\mathbf{p}'$, it can be put in the form of an expansion

$$\langle \mathbf{pp}' | S | JM \rangle = \sum_{l,\mu,l',\mu'} Y_{l\mu}(\vartheta, \varphi) Y_{l'\mu'}(\vartheta', \varphi') \langle l\mu p, l'\mu' p' | S | JM \rangle.$$

Assuming that if $J \neq 0$ the decaying K mesons are unpolarized, we have for the angular distribution in the c.m.s.:

$$F(\mathbf{p}, \mathbf{p}') \equiv \sum_M |\langle \mathbf{pp}' | S | JM \rangle|^2 = \sum Y_{l_1\mu_1}(\mathbf{n}) Y^*_{l_2\mu_2}(\mathbf{n}) Y_{l_1', \mu_1'}(\mathbf{n}') Y^*_{l_2', \mu_2'}(\mathbf{n}') \times \langle l_1\mu_1 p, l_1'\mu_1' p' | S | JM \rangle \langle l_2\mu_2 p, l_2'\mu_2' p' | S | JM \rangle^*, \qquad (2)$$

where the summation is taken over M, l_1, μ_1, l_2, μ_2, l_1', μ_1', l_2', μ_2'.

If charge parity is conserved, then $-1 = (-1)^l \cdot (+1)$, where $(+1)$ is the charge parity of the system of the π^0 meson, and $(-1)^l$ is the charge parity of the system (π^+, π^-). Therefore $(-1)^{l_1} =$

$(-1)^{l_2} = -1$; i.e., the parities of l_1 and l_2 in Eq. (2) are the same and $(-1)^{l_1 + l_2} = +1$. From Eq. (2) and the equation $Y_{l\mu}(-\mathbf{n}) = (-1)^l Y_{l\mu}(\mathbf{n})$ we get Eq. (1).

If, in addition, the spatial parity is also conserved, then the spatial parity of the K meson must be $(-1)^{l'+l}(-1)(-1)(-1)$. Together with $(-1)^l = -1$, this gives the result that l_1' and l_2' then also have the same parity, from which it follows that $F(\mathbf{p}, -\mathbf{p}') = F(\mathbf{p}, \mathbf{p}')$. This property exists also if only the combined parity is conserved [the symmetry (1) does not exist in this case].

The property (1) means symmetry relative to the origin from which the momenta are reckoned, and does not depend on the choice of the coordinate axes. If as the z axis we choose the direction of p′, then in view of the fact that $Y_{l'\mu'}(0, \varphi') \sim \delta_{\mu' 0}$, we shall have $\mu_1 = \mu_2 = M$ in Eq. (2), and instead of Eq. (1) we get

$$F(\theta) = F(\pi - \theta), \tag{3}$$

where θ is the unoriented angle (i.e., $0 \leq \theta \leq \pi$) between $\mathbf{p}$ and $\mathbf{p}'$.

The symmetry (1) or (3) can be proved for any decay of the type $a \rightarrow b^+ + b^- + c$, where a and c have definite charge parities, and b^+ and b^- are each other's charge conjugates (a, $b^\pm$, c can have arbitrary spins).

But for $K_{1,2}^0$ mesons, decays of this type other than the one we have discussed,

$$K^0 \rightarrow \pi^+ + \pi^- + \gamma, \qquad K^0 \rightarrow \mu^+ + \mu^- + \pi^0(\gamma),$$
$$K^0 \rightarrow e^+ + e^- + \pi^0(\gamma).$$

are not observed.

It would seem that a check of Eq. (1) or Eq. (3) for the reaction $\pi^0 \rightarrow e^+ + e^- + \gamma$ could serve as a check of invariance under charge conjugation,* or of the presence of a charge-odd part in π^0. But for this purpose, only a search for the decay $\pi^0 \rightarrow 3\gamma$ is useful from a practical point of view† (for such a search, a xenon bubble chamber is particularly suitable, as M. A. Markov has pointed out).

I express my gratitude to Professor M. A. Markov and Chou Kuang-Chao for discussions.

*The Feynman diagrams of this decay can contain vertices of the types (πYY), (KYN), etc. The possibility of non-conservation of charge parity in such decays is so far not excluded.

†Chou Kuang-Chao has remarked that since virtual photons have definite charge parity, only an admixture of a virtual decay channel $\pi^0 \rightarrow 3\gamma \rightarrow e^+ + e^- + \gamma$ to the ordinary channel $\pi^0 \rightarrow 2\gamma \rightarrow e^+ + e^- + \gamma$ can lead to violation of Eqs. (1) and (3). It must be expected, however, that this admixture will be small, simply because the diagrams for the channel $\pi^0 \rightarrow 3\gamma \rightarrow e^+ + e^- + \gamma$ contain two additional electromagnetic vertices as compared with the diagrams for the ordinary channel.

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