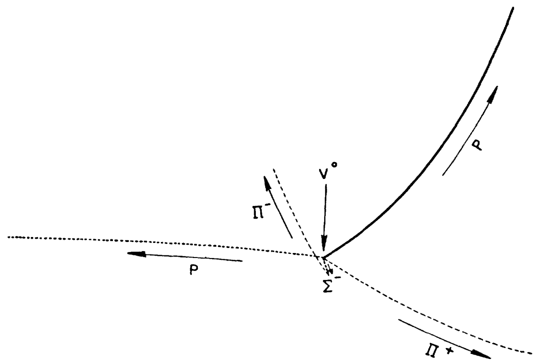

FIG. 4. Tracing of V^0 interaction in helium. See text.

the same particle, one would expect of the order of, or less than, one-third of the θ_2^0's to show 3π decay, a prediction quite consistent with our results.

The particle mixture theory[3] predicts that the long-lived θ_2^0's should interact with equal probability in a manner characteristic of strangeness $+1$ and -1. We have observed, in our K^0 beam, the interaction depicted in Fig. 4. The event is interpreted as the absorption of a θ_2^0 in a helium nucleus to give a Σ^- of 82 Mev, a π^+ of 81 Mev, and protons of 144 Mev and 9 Mev. A neutron of 30 Mev is required for energy-momentum conservation. This requires an incident θ_2^0 of 250-Mev kinetic energy, which is quite reasonable at our production angle. Since the V^- primary is unmeasurable, an alternative interpretation that the unstable particle is a K^- is possible, but this would require an incident θ_2^0 energy of $\sim$1 Bev. In either case, negative strangeness is observed in a beam which originates with an overwhelming proportion of positive strangeness K's. The event is $\gtrsim$ ten θ_1^0 mean lives from any wall. Neutron production is excluded by the arguments in reference 1.

These results, together with the observation that only one-half the Λ^0's produced in the Columbia bubble chamber[8] are accompanied by $\theta_1^0\to 2\pi$ events, now constitute an experimental picture completely consistent with the particle mixture theory of the neutral K mesons. The relevance of the failure of charge conjugation invariance to the K^0 problem has recently been discussed by Lee, Oehme, and Yang.[9] The interference effects discussed there are being sought, but the problem is made difficult by the effect of scanning bias.

We wish to note here the contributions of Professor E. T. Booth to the planning and execution of the early phases of this experiment and to thank Dr. Morton Fuchs for his assistance in the analysis of data. Mr. G. Impeduglia continues his invaluable scanning efforts. The cooperation of the Cosmotron staff is gratefully acknowledged.

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Angular Distributions of Positrons from $\pi^+-\mu^+-e^+$ Decays Observed in a Liquid Hydrogen Bubble Chamber*

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LEE and Yang[1] have shown that the nonconservation of parity in weak reactions, predicted by them and confirmed by Wu, Ambler, Hayward, Hoppes, and Hudson,[2] is likely to lead to the polarization of the μ mesons from $\pi-\mu$ decay and to a fore-aft asymmetry of the electrons from the following $\mu-e$ decay. After this anisotropy was observed for the high-energy part of the electron spectrum by Garwin, Lederman, and Weinrich[3] for μ^+ mesons stopped in carbon, it seemed desirable to investigate the $\pi^+-\mu^+-e^+$ angular distribution integrated over the whole momentum spectrum for μ^+ mesons stopped in liquid hydrogen. It is likely that the most effective depolarizing effect on the stopping μ^+ mesons results from the capture and loss of electrons in the last fraction of its range. It is then plausible that the depolarization of the slowing μ^+ mesons might be least in substances with high ionization potentials and there may be less depolarization in hydrogen than in carbon.

One-hundred-Mev π^+ mesons, produced by bombarding a copper target with one-Bev protons in the Cosmotron, were selected by magnetic analysis and directed into a liquid hydrogen bubble chamber, 6 in. long, 2 in. deep, and 3 in. high. Appropriate absorber was placed in the beam so that the π mesons stopped in the chamber. According to Lee and Yang,[1] the μ mesons are polarized with their spin along the direction of emission from the stopped π mesons. Since the π mesons decay isotropically, the μ mesons are polarized at random with respect to any magnetic field in the

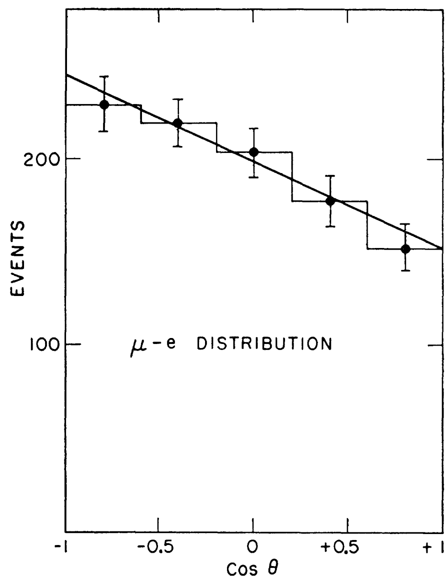

FIG. 1. The electron angular distribution from μ^+ decay. A least squares fit gives $dN/d\Omega \propto 1-(0.25\pm0.045)\cos\theta$. The errors represent standard deviations.

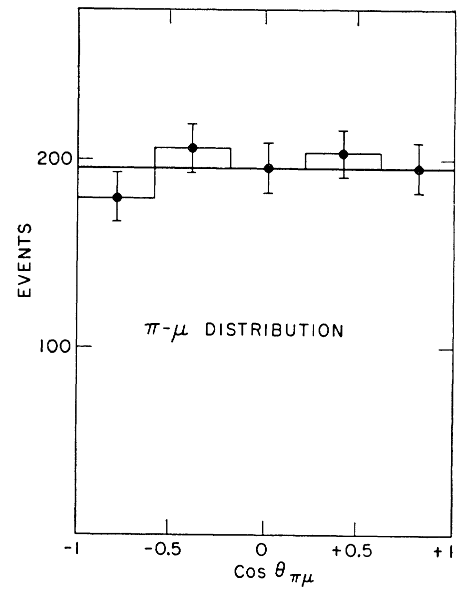

FIG. 2. The μ^+ angular distribution from π^+ decay. The distribution is evidently consistent with an isotropic decay. A least squares fit gives $dN/d\Omega \propto 1+(0.043\pm0.045)\cos\theta_{\pi\mu}$. [The errors represent standard deviations.]

chamber and their precession in the field will tend to destroy angular correlations. Therefore a degaussing coil was placed around the chamber which reduced the field in the chamber to less than 0.25 gauss.

Figure 1 shows the $\mu-e$ angular distributions derived from 980 events. A similar plot of the $\pi-\mu$ angles shown in Fig. 2 is consistent with the spherical symmetry to be expected from this decay. Since the μ range of about 1.1 cm is small compared with the dimensions of the chamber, and since the μ directions are isotropic, it seems unlikely that any scanning or measuring bias affects the measured distributions appreciably.

According to Lee and Yang[1] the measured values of the Michel parameter, ρ, indicate that the decay process is probably $\mu^+ \rightarrow e^+ + \nu + \bar{\nu}$. For a simple nonderivative coupling theory the normalized electron distribution was found by Lee and Yang to have the form

$$dN = 2x[(3x-2x^2)+\xi(x-2x^2)\cos\theta]dx d\Omega/4\pi, \quad (1)$$

where x is the ratio of the electron momentum to the maximum electron momentum, θ is the angle between the directions of emission of the μ and electron, and

$$\xi = (f_V f_A^* + f_A f_V^*)/(|f_V|^2 + |f_A|^2), \quad (2)$$

where f_V and f_A are the usual vector and axial vector coupling constants, respectively. Integrating over all x, we get

$$4\pi(dN/d\Omega) = 1 - \tfrac{1}{3}\xi\cos\theta. \quad (3)$$

Our value of 0.25 ± 0.045 for the coefficient of $\cos\theta$ leads to a value for ξ of 0.75 ± 0.14, if depolarization is negligible. If there is appreciable depolarization, ξ must be nearly equal to its maximum possible value of one.

Lee and Yang[4] have discussed gradient coupling terms though these are not important in nuclear beta decay. These can lead to values of the coefficient of $\cos\theta$ greater than $\frac{1}{3}$ for the integrated spectrum as well as a different energy dependence than indicated by Eq. (1). Our result does not require the introduction of a gradient coupling.

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† National Science Foundation Predoctoral Fellow.

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Odd-Odd Isotope Having Zero Spin*

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THE nuclear angular momenta of two neutron-deficient isotopes of gallium have been determined by the atomic-beam magnetic-resonance method. The results are that for 9.4-hr Ga^{66}, $I=0$, subject to the qualification below, and that for 78-hr Ga^{67}, $I=\frac{3}{2}$. The two isotopes are produced by alpha-particle bom-