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ENERGY DEPENDENCE OF $\mu^+ - e^+$ DECAY ASYMMETRY

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The energy dependence of the asymmetry of electrons originating in the decay of polarized μ mesons was studied with a set of scintillation counters biased against bremsstrahlung. The measurements were carried out for electron energies above 20 Mev. The observations are in a quantitative agreement (within a few percent) with the two-component neutrino theory. The experiments indicate that the degree of polarization of the μ meson beam is 0.81 ± 0.11.

INTRODUCTION

THE hypothesis of parity nonconservation in weak interactions[1] has led[2] to a special variant of the neutrino theory, called the two-component or longitudinal neutrino theory. The attractiveness of such a theory makes it desirable to conduct experiments to decide whether the theory is correct or not.

A study of the spectrum of electrons produced in the decay of polarized μ meson at various angles offers such an opportunity. It is, however, necessary to note that such an investigation can, in principle, only disprove the two-component neutrino theory, but cannot provide a final proof of its validity. In other words, a four-component neutrino theory can, for an appropriate choice of the coupling constants,[3] give a spectrum similar to that predicted by the two-component theory, namely

$$f(E,\theta) = 2E^2\{(3-2E) + \lambda(2E-1)\cos\theta\}. \qquad (1)$$

Here $f(E, \theta)$ denotes the electron energy-distribution function, θ is the angle between the electron momentum and the μ-meson spin, E is the ratio of the electron energy to the maximum energy possible, and λ is a parameter that depends on the coupling constants.

Parity nonconservation in $\pi - \mu - e$ decay was discovered in the classical experiments of Garwin, Lederman, and Weinrich[4] who showed, using electronic methods of particle detection, that μ-meson beams from an internal target of a synchrocyclotron are polarized to a large degree, and that the angular distribution of electrons in $\mu - e$ decay is of the form $1 + a \cos\theta$. It follows from the above that the two-component neutrino theory predicts a definite dependence of the factor a on the electron energy.

The energy dependence of the factor a found in reference 4 is weaker than that given by Eq. (1). The energy of the electrons was estimated in these experiments by determining the penetrating power of electrons passing through a graphite absorber. Taking it into account that the arrangement of counters in reference 4 was such that the bremsstrahlung radiation of the electrons could be re-