ON A POSSIBLE DETERMINATION OF THE SIGN OF MUON POLARIZATION

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A determination of the polarization sign of μ mesons produced in the π-μ decay would decide the validity of the conservation law of leptons. In this connection it seems to us that the following possibility for the experimental determination of the polarization sign is of interest.

Longitudinally polarized μ mesons from the decay process are sent into a transverse magnetic field. The anomalous magnetic moment of the meson will cause its spin to rotate somewhat faster than its momentum. After a certain number of revolutions the meson will be transversely polarized. The necessary number of revolutions for the spin to turn away from the momentum by $\pi/2$ may be estimated as follows. The angle of "deviation" of the spin from the momentum is $\psi' = 2\pi n(\epsilon/m)\Delta\mu/\mu$, where $\Delta\mu/\mu$ is the relative anomalous moment of the μ meson and ϵ is its energy. To lowest order $\Delta\mu/\mu = \alpha/2\pi = 1.15 \times 10^{-3}$.[1] Hence for mesons with energy $\epsilon/m = 1.7$ the value of $n_{\pi/2} \approx 125$ is obtained.

The sign of the transverse polarization may be determined, for example, by measuring the asymmetry in Coulomb scattering of the meson.[2] The asymmetry in the scattering of polarized particles has a rather sharp maximum for velocities of the order of $\beta^2 \approx 2/3$ (for scattering through an angle $\pi/2$).[1] Consequently mesons of appropriate energy should be selected for the experiment. Since at such high energies the scattering cross section becomes very small for large angles one should use a scatterer with high Z and of substantial thickness (although not so thick as to stop the mesons altogether).

Let us estimate the intensity of the scattered mesons and the degree of asymmetry in the scattering. Assuming scattering into a solid angle ~ 1 we find (for $Z = 80$ and for a kinetic energy of the meson of 80 Mev) for the number of scatterings through $\pi/2$ per g/cm^2 of the substance: $\nu \approx 1.5 \times 10^{-5}$. Further, in a field $H \approx 10 \times 10^3$ oe the time spent by the mesons in the system will be $\approx 1.5 \times 10^{-6}$ sec. At $\epsilon/m \approx 1.7$ approximately half of the mesons that entered the system will traverse it (assuming no losses in the system). Assuming $\sim 10^4$ mesons incident on the system per sec and using 15 g/cm^2 for the thickness of the scatterer we obtain for the meson intensity $I \sim 1\ \text{sec}^{-1}$.

The degree of asymmetry $a(\theta)$ is determined by the expression

$$I(\theta)/I(-\theta) = (1 + Pa)/(1 - Pa),$$

where P is the degree of polarization of the initial meson beam. For $\theta = \pi/2$, a_{max} has a value of $\approx \frac{1}{4}$. Apparently it is not difficult to obtain $P > 0.5$, so that the ratio of intensities is $\gtrsim 1.3$.

The proposed experiment may easily be combined with an experiment designed to measure the size of the anomalous magnetic moment μ.

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[1] A. I. Akhiezer and V. B. Berestetskiĭ, Квантовая электродинамика (Quantum Electrodynamics) Teortekhizdat, 1953 (Trans. by U.S. Dept. Comm.).

[2] H. A. Tolhoek, Usp. Fiz. Nauk **63**, 4 (1957).

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QUADRUPOLE MOMENT OF Er^{168}

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GROMOV et al.[1] and Jacob et al.[2] identified the 80-kev level of Er^{198}, produced by K capture in Tu^{168}, as the first level of the rotational band. A measurement of the lifetime of this level permits determination of the quadrupole moment and the deformation parameter of Er^{168}, using the equations of the generalized model of the nucleus.[3]

We used a weak source of Tu^{168} (T = 85 days), obtained in a deep splitting reaction by prolonged exposure of tantalum to 660-Mev protons in the synchrocyclotron of the Joint Institute for Nuclear Research.