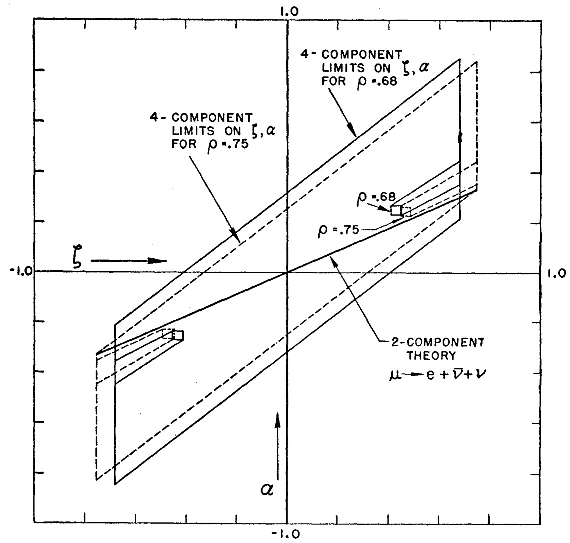

FIG. 2. Comparison of experimental values of α, ζ, with theoretical limits, from Larsen, Lubkin, and Tausner.[3] The direct empirical parameters α', ζ' for $\rho=0.68$, $\rho=0.75$ are represented by the little rectangles. The actual parameters α, ζ are larger in absolute value because of depolarization effects. The first quadrant applies if the μ's are polarized in the direction back to the parent π, the third quadrant if they are polarized opposite to this direction.

ratios of (7) are compared as a solid line with experiment in Fig. 1. The contribution of the distribution function uncertainty is indicated by the cross-hatching on the two-component curve. We judge the results to be a rather successful prediction of the two-component theory. Radiative corrections[8] amount to of the order of 1% in this method of analyzing the data. A more quantitative test of the two-component theory may be made by evaluating the additional parameters of the four-component theory. Larsen, Lubkin, and Tausner[3] find, instead of (6), the distribution

$$f(\theta,x)=Ax^2\{(1-x)+(2/9)\rho(4x-3)+[\alpha(1-x)+(2/9)\zeta(4x-3)]\cos\theta\}, \quad (8)$$

where α and ζ are the new parameters. The comparison with experiment is made in Fig. 2 which was prepared by these authors. Here too, resolution effects may account for the small deviation from two-component theory.

The data permit a determination of $a_0=\xi B$. Integration of (6) from $x=0$ to $x=1$ gives $f(\theta)=1-\frac{1}{3}a_0\cos\theta$. We find from (5)

$$\xi B=0.79\pm0.06. \quad (9)$$

In the two-component theory $|\xi|\leq 1$ and hence $B\gtrsim 0.80$. This is consistent with the two-component prediction that, in the decay $\pi\rightarrow\mu+\nu$, the muons are formed in a state of complete polarization. Independent of the two-component theory, the observation of $P/V>3$ (Fig. 1) and the restriction $|a|<1$ in (1) leads to $B\gtrsim 0.50$.

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† Also at the IBM Watson Scientific Laboratory.

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Determination of the Sign of the He^3 Nuclear Magnetic Moment*

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WE have made a direct comparison between the signs of the proton and the He^3 nuclear magnetic moments. The result is that the proton and He^3 have nuclear magnetic moments of opposite sign. Since the sign of the proton moment is known to be positive,[1] the He^3 moment is therefore negative as predicted[2] from the odd neutron configuration and previously inferred from optical hyperfine spectra data.[3]

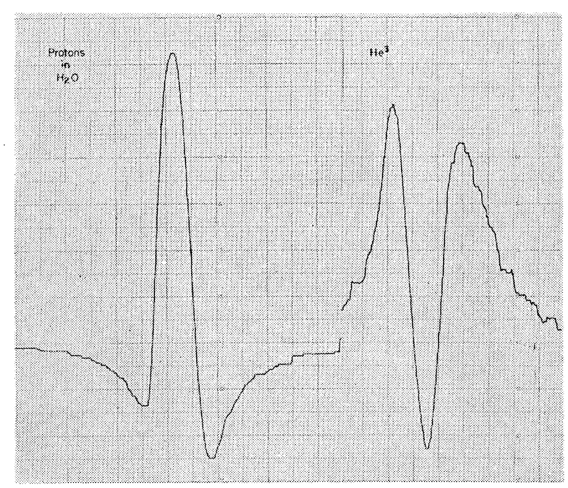

FIG. 1. Nuclear induction dispersion derivative signals of H^1 and He^3.

The comparison of the signs of the nuclear magnetic moments was carried out by the nuclear induction method[4] employing a Varian Associates V-4300 spcetrometer operating at a frequency of 40.0 Mc/sec. together with a 12-inch electromagnet.

The He^3, obtained from the decay of H^3, was contained in a thick-wall Pyrex tube of 10-mm inner diameter fitted with a valve assembly for filling and sealing. The tube contained He^3 at a partial pressure of approximately 10 atmospheres together with O_2 at a partial pressure of 10 atmospheres. The inclusion of the paramagnetic oxygen provides a mechanism for thermal relaxation of the He^3 and was suggested by the work of Anderson[5] in the original determination of the magnetogyric ratio of He^3. A one-millimeter capillary containing water with $0.05M$ $MnCl_2$ was taped to the outside of the He^3 sample tube. The dual sample was placed inside the receiver coil of the nuclear induction head.

The proton nuclear magnetic resonance was established at 9400 oersteds and the probe "paddles" adjusted to give a dispersion mode of presentation.[4] The customary low-frequency sine-wave field modulation and the phase-sensitive detection were employed. The derivative of the proton dispersion was then recorded. Without disturbing the nuclear induction probe, the static magnetic field was increased to 12 350 oersteds to bring the He^3 into resonance, and the derivative of the dispersion was again recorded.

For a fixed value of the leakage flux in a nuclear induction apparatus, the sign of the signal is determined by the sign of the nuclear magnetic moment. A comparison of the signs of two signals at a common value of leakage therefore yields comparative signs of the nuclear moments.

Figure 1 shows a recording of the derivative of the dispersion signals for both protons and He^3. The dispersion derivative was selected to preclude any ambiguity which might arise when the absorption derivative is recorded.

We are indebted to Mr. Victor P. Gede and Mr. Henry Otsuki for the preparation of the sample and the filling of the sample holder.

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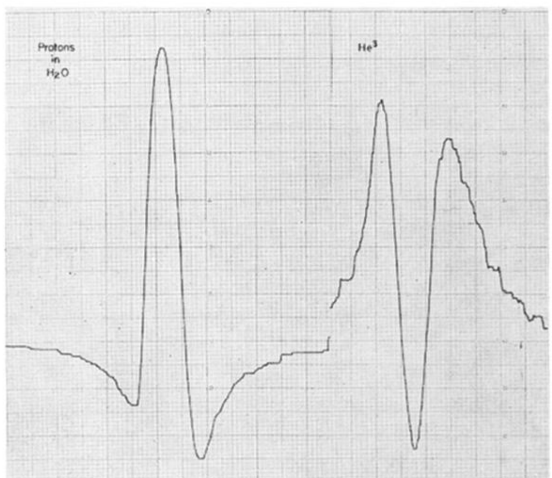

FIG. 1. Nuclear induction dispersion derivative signals of H^1 and He^3.