experiment than to go ahead with the 1% experiment with the 6-meter magnet, and we regard this as a much better investment of our time.

STATUS

The techniques of shimming, storage, vacuum, counting, and polarization analysis to be used in the 6-meter experiment have all been experimentally confirmed. At this moment, the shims have all been designed and measured, and one is proceeding to integral measurements of the orbits by means of α-particle tests. All these tests have been done before with the smaller magnet, and we hope to have g-2 to 1%.

ACKNOWLEDGMENT

We wish to thank Prof. G. Bernardini for his enthusiastic and continued support of this project from its inception, without which this work would have been impossible. We are greatly indebted to Prof. W. K. H. Panofsky for his many contributions during the fall of 1959 when he visited CERN and Prof. L. M. Lederman for his early work at CERN on this problem.

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MUON MASS AND CHARGE BY CRITICAL ABSORPTION OF MESIC X-RAYS

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(presented by L. M. Lederman)

The high precision currently available [1] in determinations of the muon magnetic moment has stimulated efforts to obtain the mass directly. This may be considered parallel but different from the (g—2) experiment. We report the first results of a study of the $3D$-$2P$ transition in μ-mesic phosphorus, a mesic x-ray known to have energy very close to the K-absorption edge of lead [2, 3, 4].

Thus a careful absorption measurement [3, 4] in Pb of the radiation from a μ^- stopped in phosphorus can yield an absorption coefficient μ, which may be compared to a recent remeasurement of μ as a function of x-ray energy [5]. If, as we observe, this mesic x-ray line falls on the rapidly rising part of the μ *vs* E curve, the energy of the x-ray may be determined to within 0.01%. Since this energy is directly proportional to the muon mass, with known proportionality constant [6], this experiment affords an extremely sensitive determination of the mass.

This experiment differs from those of references [3] and [4], in that a 90° " good " geometry is employed which substantially reduces corrections due to obliquity, fluorescent re-radiation by the Pb absorber, and Compton scattering in the phosphorus. We used a 3″ diameter, $\frac{1}{4}$″ thick NaI scintillation spectrometer crystal to detect the μ-mesic x-rays.

Six thicknesses of Pb absorber were used with each of two thicknesses (3 g/cm^2 and 1.5 g/cm^2) of phosphorus meson-stopping targets, to enable us to make corrections for Compton scattering in the latter. Calibrations were made with radioactive extended sources of Tl^{204} (71 keV) and Co^{57} (123 keV). The calibration spectra provided a check on the gaussian shape of the observations, on the resolution widths *vs* energy, on the fluorescent yield of the lead, and on the amplitude of the escape peak. In addition the resulting absorption coefficients were compared with the literature [7] to give a check on the obliquity factor (1.07) and the forward scattering from the lead which reaches the detector (effective attenuation coefficient of 0.4 cm^2/g), both of which are separately calculable.

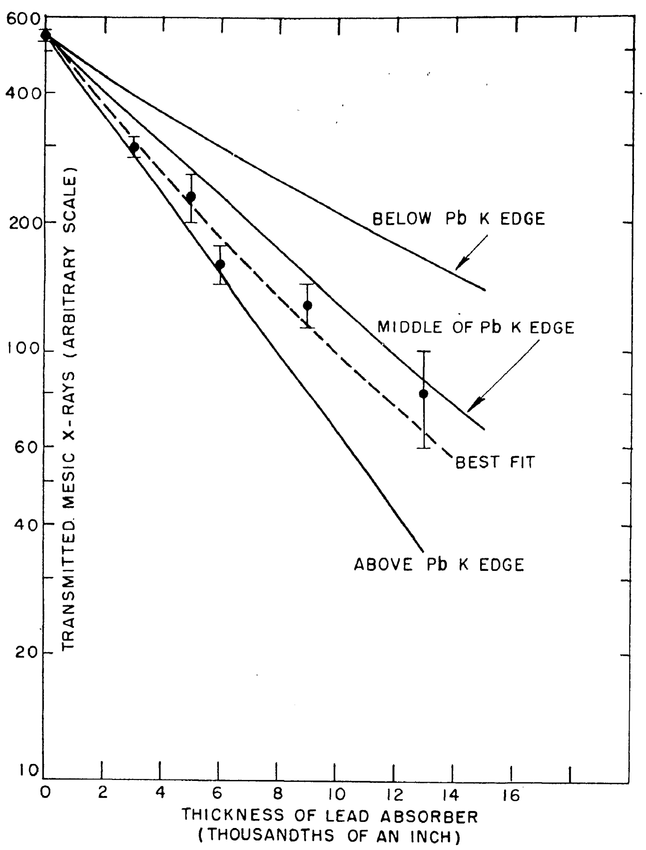

Fig. 1 Absorption by lead of $3D$-$2P$ line in μ-mesic phosphorus.

The individual spectra (at each thickness) are least-squares fitted to obtain the amplitude of the 88 keV $3D$-$2P$ peak. The resulting amplitudes are fitted to a complex absorption curve using the three components of the transition ($3D_{5/2}-2P_{3/2}$; $3D_{3/2}-2P_{3/2}$; $3D_{3/2}-2P_{1/2}$) in the ratio 9 : 1 : 5 respectively. A qualitative observation of the data sets the latter two below and above the absorption discontinuity. In Fig. 1 we plot the resulting absorption curve and best fit.

The mass absorption coefficient so obtained for the $3D_{5/2}-2P_{3/2}$ transition is 5.7 ± 0.9 cm^2/g.

According to Bearden's curve, the energy of this x-ray is 88.017^{+15}_{-10} eV. This implies:

$$m_\mu/m_e = 206.78^{+0.03}_{-0.02} .$$

If $g_\mu = 2(1+\alpha/2\pi)$, the result of the magnetic moment experiment requires that

$$m_\mu/m_e = 206.77\pm0.01 .$$

Thus this experiment, as does the similar work of the Chicago group, confirms the predictions of theory as to the second-order radiative correction to the muon magnetic moment.

Alternatively, the results may be construed as the best evidence to date of the equality of the muon and electron electric charge. In this case, it is assumed that the results of the $(g-2)$ experiment will yield a muon g-factor in agreement with quantum electrodynamical theory. Then this experiment measures the ratio of the quantity (me^2) of the muon to that of the electron; whereas the magnetic moment experiment measures the ratio of (e/m) of the muon to that of the proton. We assume the knowledge of such well-measured quantities as the Rydberg constant, the proton-electron mass ratio, and the proton g-factor. The product of the two results is thus a measure of $e_\mu^{\ 3}/e_e^{\ 2}e_p$. Given the equality of electron and proton charges, our conclusion is that e_μ/e_e is unity to within one part in 20,000. This may be viewed as determining the upper limit to the charge on the ν_μ in $\mu^+\rightarrow e^+ + \nu_\mu + \bar{\nu}_e$.

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GYROMAGNETIC RATIO OF FREE PROTONS AT 150 MeV

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I wish to report on some work carried out at Harwell by Manning and myself. As part of our program of work on *p-p* scattering, we intend to measure the Wolfenstein A parameter for which a longitudinally polarized beam is required. This is obtained most conveniently by passing a horizontally and transversely polarized beam through a bending magnet with a vertical magnetic field. On passing through the magnet, the magnetic moment precesses more rapidly than the orbital motion turns, and the relation between the two originally given by Mendlowitz and Case and based on Dirac theory is $\omega_s/\omega_L = 1+a\gamma$. This was also derived classically by Bargman et al. This relationship has not been tested experimentally, and it is of importance not only in the measurement of certain triple scattering parameters but also in the study of anomalous magnetic moments.

The measurement was carried out as shown in Fig. 1 and is based on a suggestion of Cassels some years ago. A vertically polarized proton beam, produced by scattering from a carbon target inside the cyclotron, was passed through a solenoid of such magnetic length that it converted the polarization to the horizontal. The polarization was either to the left or to the right depending upon the direction of the solenoid current. Any small longitudinal component would be unaltered.

The beam was then passed through a bending magnet giving a deflection of $\sim 43\frac{1}{2}°$, sufficient to precess the spin through roughly 90° with respect to the orbital motion, say through (90°-ϕ). The transverse components of polarization for ϕ small would be $P_T+P_V\phi$ and P_T-$P_V\phi$ for the two directions of solenoid current, where P_V is the vertical component of polarization on entering the solenoid, and P_T is the longitudinal component of polarization.

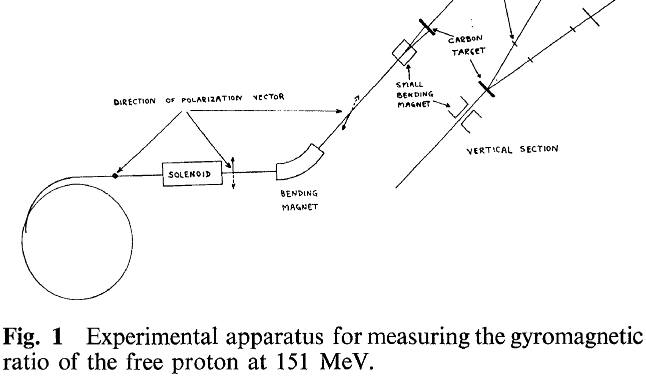

Fig. 1 Experimental apparatus for measuring the gyromagnetic ratio of the free proton at 151 MeV.

The beam was then focused by a quadrupole pair onto a scattering target of carbon, from which protons scattered up and down at $8\frac{1}{2}°$ were detected by two