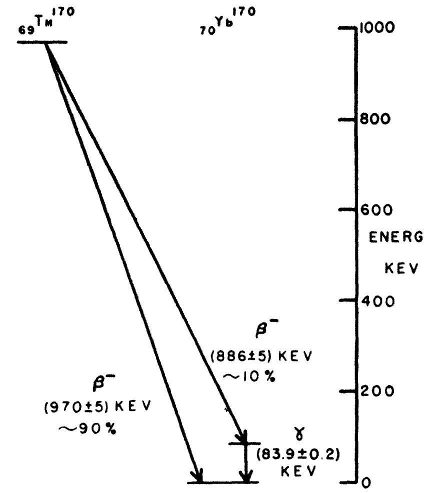

FIG. 2. Tentative decay scheme for Tm^{170}.

above the straight line at energies less than 240 kev is assumed to be due to scattering within the source.

A second source of 0.1 mg/cm² on a 0.5 mg/cm² aluminum backing was used to check the efficacy of the method of grounding the first source. The locations of the conversion lines and the end point agreed, within the accuracy of calibration, with those obtained with the first source. The effects of scattering in the source were slightly decreased in the thinner source.

The energy of the gamma-ray was computed from the K, L, and M conversion lines on the beta-spectrum at 22.6, 73.5, and 81.2 kev respectively as well as from the L and M photo-electron lines using a 15.3 mg/cm² lead radiator. A search for other gamma-rays[4] using a 40-mc source with lead and uranium radiators yielded a negative result.

The significant result obtained from the coincidence experiments was the very low ratio of beta-gamma-coincidences to beta-rays. A brass-cathode gamma-counter and a 2.1 mg/cm² mica end-window beta-counter were used in conjunction with a coincidence mixer of 0.45-microsecond resolving time. An aluminum absorber, 16 mg/cm², was placed before the beta-counter to avoid registering coincidences between conversion electrons and x-rays.

For the simple decay scheme previously proposed,[2,3] the ratio of the beta-gamma-coincidence rate, $N_{\beta\gamma}$, to the beta-counting rate should be equal to ϵ_γ, the efficiency of the gamma-counter in the experimental geometry. For the decay scheme depicted in Fig. 2 this ratio will be $N_2(1-\alpha)/(N_1+N_2)\epsilon_\gamma$, where N_1 refers to beta-particles in the group going to the ground state, N_2 to the lower energy group and α is the ratio of converted gamma-rays to N_2. The value of ϵ_γ for 84-kev gamma-rays was measured by calibrating the coincidence apparatus with Co^{60} gamma-rays and by referring to a semi-empirical efficiency curve for a similar counter.[5] The result was $\epsilon_\gamma=(2.9\pm0.2)\times10^{-4}$. The average of the two experimental values obtained for the ratio $N_{\beta\gamma}/N_\beta$ is $(3.05\pm1.0)\times10^{-6}$. The inference is that the factor $N_2(1-\alpha)/(N_1+N_2)$ is of the order 0.01. The Kurie plot analysis of the beta-spectrum leads to a value of approximately 0.1 for the ratio $N_2/(N_1+N_2)$. Thus $\alpha\cong0.9$.

The conversion coefficients were also measured from the ratios of the height of the lines above the continuum to the area corresponding to the group N_2. The line heights were corrected approximately for window absorption after a method described by Witcher,[6] using Nylon absorbers before the counter window. The results are $\alpha_K=0.08$, $\alpha_L=0.55$, and $\alpha_M=0.17$ so that $\alpha=0.80$.

The low beta-gamma-coincidence rate obtained here is in fair agreement with that obtained by Ketelle[7] who states that the gamma rays are in coincidence with not more than 10 percent of the beta-rays.

The result would be consistent with the simple decay scheme only if the gamma-ray were converted more than 90 percent whereas the experimental value would be about 8 percent referred to the simple scheme. A decay scheme which is consistent with all of the present results is given in Fig. 2.

The resolving power of the coincidence-absorption method used by Graham and Tomlin[3] is probably too low to distinguish between the two proposed decay schemes.

The author wishes to express his appreciotion to Professor J. S. Foster, for his help and advice throughout this work and to Dr. D. G. Douglas for valuable discussions and assistance.

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Erratum: Altitude Dependence of Penetrating Particles Slowed Down After Traversing 15 Cm of Lead

[Phys. Rev. **76**, 851 (1949)]

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THE numbers per hour of mesons (M) and of X-particles (X) stopped in the absorber must be multiplied by the factor 1.6×10^{-7} (not 1.1×10^{-7} as stated in the paper) in order to obtain the corresponding absolute numbers per sec., g, sterad. The ordinate of Fig. 1 must be multiplied, accordingly, by (1.6/1.1).

The "true anticoincidences" at 30,000 feet, in the fourth line of Table I, are 925±30 per hour (not 985±30).

Magnetic Multipole Internal Conversion

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September 30, 1949

IN a previous letter[1] on the calculation of magnetic internal conversion coefficients in the Pauli approximation curves of the ratio of the coefficients in the K shell to those in the L shell

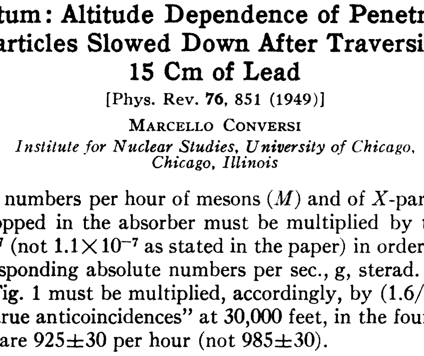

FIG. 1. Curves for N_K/N_L as a function of Z^2/E. Solid line, magnetic multipole; broken line, electric multipole.

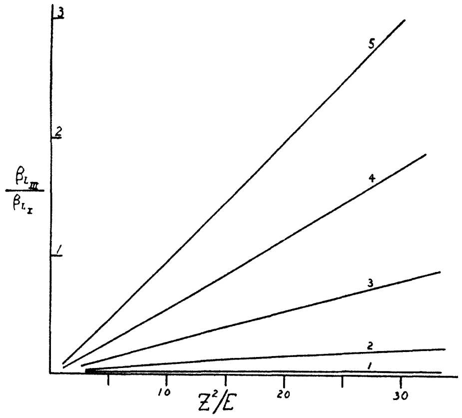

FIG. 2. Curves for the ratio of the magnetic internal coefficient for the L_{III} sub-shell to those for the L_I sub-shell as a function of Z^2/E.

versus Z^2/E for $Z=35$ and E, the gamma-ray energy in kev, were given for multipole orders $l=1$, 2, 3. The calculations have been extended to cover multipole orders 4 and 5. Figure 1 shows the complete set of curves. For the sake of comparison, the curves of Hebb and Nelson[2] for the electric multipole conversion ratios are included.

In Fig. 2 the ratio of the magnetic internal conversion coefficients for the L_{III} sub-shell to those for the L_I sub-shell has been plotted against Z^2/E for $Z=35$. Since, in this approximate theory, the magnetic internal conversion for the L_{II} sub-shell is less than 5 percent of that for the L_I sub-shell, these curves provide an additional method for determining the type of magnetic multipole radiation.

The curves of Figs. 1 and 2 are valid for low Z and low gamma-ray energy. However, the exact calculations of Rose and his co-workers[3] show that, in the K shell, the approximate method gives very poor results for the internal conversion coefficients for Z as low as 40 and energies as low as 150 kev. Of course, if one is concerned with lower values of Z, say about 25, and smaller gamma-ray energies, better agreement of approximate with exact calculations may be expected. In any case it is possible that the ratios given by the approximate method may be better than the values of the internal conversion coefficients. This point will be settled when the exact calculations for the L shell are completed. Until then the curves should be used with extreme caution.

* Deceased.
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A New Gyromagnetic Effect

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THE existence of this effect was suggested to one of us by Professor Albert Einstein a number of years ago. Not long afterward the quantitative theory was developed, and experiments instituted to test its validity. Circumstances, however, made it necessary to stop the work temporarily before it was completed, and only recently has its continuance become practicable, with the same magnetic materials and much the same experimental procedure, but with great improvements in many particulars.

A long circular cylinder of the substance under investigation is magnetized along its axis to intensity of magnetization J_z near saturation, so that the moments of all the magnetic elements point essentially in the same direction, Z.

In a direction X, normal to Z, a small magnetic intensity with frequency f, much below the resonance frequency, is applied. When the rod is absent the intensity in the space it is to occupy is

$$H_x = H_{ox}\sin 2\pi ft.$$

This causes the intensity of magnetization (always practically parallel and equal to J_z) to oscillate through the small angle θ in the plane XZ, thus producing a small intensity of magnetization J_x, synchronous with H_x and proportional thereto. The angle θ is given by the relation

$$\theta = J_x/J_z.$$

The rotation of the elements gives rise to a gyromagnetic intensity in the rod in the direction Y (normal to X and Z) such that[1]

$$H_y = \rho d\theta/dt$$

where ρ is the gyromagnetic ratio.

If the rod is infinite in length, there results an intensity of magnetization in the direction Y given by the formula

$$J_y = \rho f/2\pi\cdot[(\mu-1)/(\mu+1)]^2(H_{ox}\cos 2\pi ft)/(J_z)$$

where μ is the transverse permeability of the material.

From this formula, after correction for end effects due to the finite length of the cylinder, and after direct measurements of J_z and the other quantities involved, the quantity ρ can be calculated. It is assumed that, as is the case of the actual experiments, eddy currents are negligible.

In this way, for compressed Permalloy powder (from the Bell Telephone Laboratories), at frequencies of 22 kc and 30 kc, and in longitudinal fields varying in strength from 0 to 2700 gausses, it has been found that the (corrected) formula is satisfied throughout the region of approximate saturation when

$$\rho = (1.01\pm 0.06)m/e.$$

The formula does not, of course, hold in the region between $J_z=0$ and approximate saturation. As would be expected, J_y is zero when J_z is zero; and it increases to a maximum somewhat before approximate saturation is reached. It then follows the formula into the strongest fields.

In view of the magnitude of the experimental error, there is no certain disagreement between these results, obtained with very intense fields, and the results obtained from the Barnett effect, with rotation frequencies equivalent to exceedingly minute magnetic intensities, and from the Einstein-de Haas effect, with weak and moderate intensities. This value is about 1.05 m/e.[2]

Experiments have also been made on compressed iron powder (from the Bell Telephone Laboratories), but the fields obtainable have not been sufficiently intense to produce approximate saturation. The observable early part of the curve between J_y and J_z closely resembles that for Permalloy, and the part nearest saturation suggests a value of ρ approximately equal to $(1.06\pm 0.10)m/e$. The standard value of ρ for iron is $1.03m/e$.[2]

We expect to publish soon a much more nearly complete account of this work.

For important assistance we are indebted to the Carnegie Institution of Washington, the National Research Council and the U. S. Navy, ONR. The experimental work has been done in the Norman Bridge Laboratory of the Institute.

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