Because of non-uniform crystallization, the source thickness appeared to be greater than 18.5 mg/cm² at some points. Both by measurement with an end-window counter, and from a calculation using a published value of the beta-ray decay constant, the strength of the sample was found to be about 0.002 μC.

Figure 1 shows the beta-ray intensity distribution plotted against momentum in gauss-cm. The curve has a maximum of 11.8 counts per minute against a background of 18.3 per minute. A Fermi plot taken from the experimental points is shown in Fig. 2. This is linear above 450 kev, and gives an end-point energy of 1.40±0.03 Mev. Calibration was taken from the Fermi plot of P^{32} beta-rays measured under identical conditions except for source thickness. An upper energy limit of 1.71 Mev[10] was assumed for the phosphorus beta-rays. The annihilation quantum photoelectron line, previously mentioned, gave the same calibration figure within 1 percent.

The theoretical intensity distribution for K^{40}, corresponding to a Fermi plot linear over the entire range, is indicated in Fig. 1 by a dashed line. The point at 1130 gauss-cm (103 kev) is probably low because of absorption in the 3-mg/cm² counter window. The area under the experimental curve shows an excess of about 4 percent over the theoretical distribution.

The Fermi plot for P^{32} was also linear down to 500 kev and had a deviation of about the same shape and magnitude as in Fig. 2 for K^{40}. This would indicate that in both cases the excess of low energy electrons is mainly due to scattering which is difficult to eliminate under conditions of large solid angle and low resolution. It is therefore probable that the true K^{40} beta-ray Fermi plot would follow a straight line to considerably lower energies than observed here.

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Microwave Magnetic Resonance Absorption in a Nickel Salt near 1.25 Cm

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MAGNETIC resonance absorption at a frequency of 24,446 mc/sec. was observed in a crystal of nickel fluosilicate ($NiSiF_6 \cdot 6H_2O$) at room temperature as a function of the static magnetic field applied in directions parallel and perpendicular to the optic axis. The microwave technique enables a direct determination of values of the ground state splitting δ and splitting factor g, quantities previously inferred[1] from measurements of Becquerel and van den Handel[2] on the magneto-optic effect in this salt, and also from susceptibility measurements on other nickel salts.[3]

Our results are plotted in Fig. 1. For $H \parallel$ axis, we find $\delta = 0.52$ cm^{-1}, $g = 2.36$; for $H \perp$ axis, $\delta = 0.49$ cm^{-1} and $g = 2.29$. The differences between these values are probably within the over-all experimental error. These values, which are for room temperature, may be compared with $g = 2.252$ and $\delta = 0.301$ cm^{-1} at liquid He temperatures, as calculated by Becquerel and Opechowski[1] from the measured Verdet constant. Schlapp and Penney[3] show that $g = 2(1 - 2\lambda/5qD)$, where λ is the spin-orbit coupling constant and is equal to -335 cm^{-1} from spectroscopic data for the Ni^{++} ion; qD is the cubic field constant. Microwave measurements recently reported by the Oxford group[4] give $\delta = 0.32$ cm^{-1} at 195°K, 0.17 cm^{-1} at 90°K, and 0.12 cm^{-1} at 20°K.

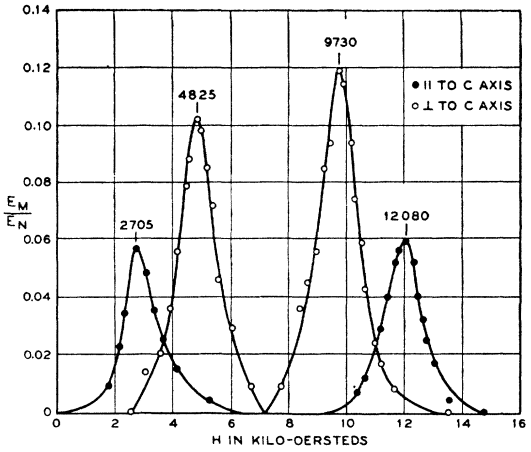

FIG. 1. Magnetic resonance absorption in $NiSiF_6 \cdot 6H_2O$ at 24,446 mc/sec. Vertical axis is ratio of (magnetic energy loss in sample) to (total non-magnetic energy loss in cavity and sample). Results are shown for two crystal orientations, parallel and perpendicular to the static field.

The free Ni^{++} ions is in a ^3F state; in the cubic electric field of the surrounding octahedron of water molecules, the non-degenerate orbital level Γ_2 is lowest. The threefold spin degeneracy of the ground level is partly lifted by the combined action of spin-orbit coupling and a small trigonal component of the crystal field. The relation between field strength and absorption frequency may be understood approximately by a "symbolic" method; namely, by considering the behavior of a level with $L = 1$ in a cylindrical electric potential ($V = A[x^2 + y^2 - 2z^2]$) and in a magnetic field H. We thus treat only three states, instead of the 21 states of the complete problem; the validity of this procedure is a consequence of group theory.

For $H \parallel$ axis, the three eigenvalues are $E_1 = g\mu_B H$; $E_2 = -g\mu_B H$; $E_3 = \delta$; and the allowed transitions satisfy $g\mu_B H_{\parallel} = h\eta \pm \delta$. For $H \perp$ axis, $E_1 = 0$; $E_{2,3} = (\delta/2) \mp [(\delta/2)^2 + (g\mu_B H)^2]^{\frac{1}{2}}$, which in the limit of $g\mu_B H \gg \delta$ gives $g\mu_B H = h\nu \pm \delta/2$.

We wish to thank Dr. Conyers Herring for a profitable discussion, and F. R. Merritt and J. Andrus for valuable experimental assistance.

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The Decay of Co^{55}

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THE decay of Co^{55} (18.2 hr.) has been studied by means of a large double focusing spectrometer[1] and by coincidence experiments. Samples were prepared by deuteron bombardment of iron. The cobalt was separated chemically. Small corrections for the radiations of the longer lived cobalt isotopes were made where necessary. The positron spectrum was found to be complex. There are two components[2] with maximum energies of 1.50 Mev and 1.01 Mev and about equal abundance. Another softer component of low abundance is possible. The

secondary electron spectrum produced by the γ-rays in a thin lead converter shows three nuclear gamma-rays of energies 0.477 Mev, 0.935 Mev, and 1.41 Mev. By comparing the number of photoelectrons due to these with those due to the annihilation radiation, we estimate the abundances of these three gamma-rays (in order of increasing energy) to be 0.3, 1.4, and 0.3 per positron. The negative electron spectrum consists of four internal conversion lines. Three of these correspond to the above gamma-rays and the intensities of the lines are about 7.4×10^{-4}, 5.4×10^{-4}, and 3.5×10^{-5} conversion electron per positron, in order of increasing energy. In addition, a conversion line was found corresponding to a 0.095-Mev γ-ray. The intensity of this line is about 1×10^{-3} electron per positron. Coincidences between gamma-rays and positrons of definite energies (selected in a magnetic-lens spectrometer designed for coincidence experiments[3]) were measured using copper-walled and gold-walled G-M counters. The combined results of the experiments lead us to conclude that the main decay scheme of Co^{55} is as shown in Fig. 1. The two positron

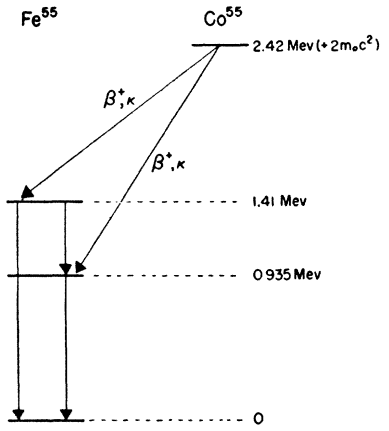

FIG. 1. Decay scheme of Co^{55}.

transitions are of approximately equal intensity. The same is true for the 0.477-Mev and 1.41-Mev gamma-rays. If our estimate of the intensities of the several gamma-rays compared with the number of positrons is correct, orbital electron capture is considerably more probable than expected theoretically for allowed transitions, particularly in the case of the transition to the 0.935-Mev level. The significance of the 0.095-Mev gamma-ray is not yet understood, but its intensity must be quite low. A more complete report on these experiments will be submitted for publication in the Arkiv for Matematik Astronomi och Fysik.

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Electron-Neutrino Correlation in Heavy Elements*

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THE electron-neutrino correlation for both allowed and first forbidden transitions has been discussed by Hamilton.[1] For allowed transitions the correlation function is

$$F(\theta)=1+n\beta\cos\theta, \quad (1)$$

where θ is the angle between electron and neutrino directions, $\beta=v/c$ and $n=-1$ for scalar and pseudoscalar, $\frac{1}{3}$ for tensor $(G-T)$, $-\frac{1}{3}$ for axial vector and 1 for polar vector (Fermi) interactions. Since (1) assumes plane wave electrons ($Z=0$) it is of interest to consider the effect of the Coulomb field[2] in order to determine whether or not the consequent change in the factor n may be as large as a factor 3. In the following we consider only allowed transitions.

For this purpose the following approximative calculation has been performed. A Dirac plane wave corresponding to a z-component of spin equal to $\frac{1}{2}$ can be expanded in terms of a representation in which j^2 and j_z, where j is the total angular momentum, are diagonal. This gives

$$\psi_{\frac{1}{2}}^{(0)}(\theta,\phi)=\text{const.}\sum_{l,m} i^l(2l+1)^{-\frac{1}{2}}Y_l^{m*}(\theta,\phi)\times[(l-m)^{\frac{1}{2}}u_{lm}^{(-)}-(l+m+1)^{\frac{1}{2}}u_{lm}^{(+)}], \quad (2)$$

where θ, ϕ are the polar and azimuth angles of the direction of motion of the electron, Y_l^m a normalized spherical harmonic and $u^{(\pm)}$ are spherical free particle wave functions for $j=l\pm\frac{1}{2}$. The superscript (0) indicates $Z=0$. For z-component of spin equal to $-\frac{1}{2}$ the corresponding expansion can be obtained from (2) by applying the usual operator which converts $\psi_{\frac{1}{2}}^{(0)}$ to $\psi_{-\frac{1}{2}}^{(0)}$. Of course, in (2) we can set $\theta=0$ and therefore $m=0$. We now use the same unitary transformation for the Coulomb field. That is, the wave functions used for the electron are given by (2) with $u_{lm}^{(\pm)}$ identified with solutions for the Dirac Coulomb field in the representation j^2, j_z diagonal. This approximation can be justified if the effect of the Coulomb field is small.

For allowed transitions we need only the terms $j=\frac{1}{2}$, $l=0$, 1 corresponding to $s_{\frac{1}{2}}$ and $p_{\frac{1}{2}}$ electrons. The correlation function then has the form (1) with n replaced by nf where f, which is independent of the type of interaction, is given by

$$f=\tfrac{1}{3}[1+2(1-\alpha^2Z^2)^{\frac{1}{2}}](1+\alpha^2Z^2/p^2)^{\frac{1}{2}}. \quad (3)$$

In (3) α is the fine structure constant and p is the electron momentum in units mc. Averaging (3) over a typical energy distribution for allowed transitions we find that even for an element as heavy as Pb, the value of $\langle\beta f\rangle_{Av}$ differs from $\langle\beta\rangle_{Av}$ by about 20 percent. Therefore one may safely disregard effects of the Coulomb field in comparing theory and experiment for the purpose of distinguishing between the various forms of the beta-interaction.

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A Possible Experimental Verification of the Statistics of He^3

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IN principle it is possible to determine whether He^4 obeys Fermi-Dirac or Bose-Einstein statistics by measuring the second virial coefficient B. J. de Boer,[1] and Massey and Buckingham[2] have calculated B starting from a field of force determined by measurements at high temperatures. It turns out that the $BT^{\frac{1}{2}}$ curve (T: temperature) as a function of temperature shows a maximum at about 0.8°K if He^4 obeys Bose-Einstein statistics but that there is no such maximum if He^4 should obey Fermi-Dirac statistics. A difference between