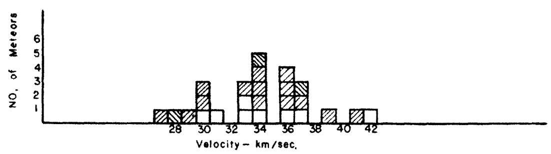

FIG. 3. Meteors whose direction, range, and velocity are correct to be Geminid shower meteors.

Meteors having azimuths and ranges satisfying the above requirement, and having velocities between 27 and 43 km/sec., were classified as possible Geminids. Their speeds are plotted in Fig. 3. The mean velocity was 34.8 km/sec. (standard deviation 3.7 km/sec.) which is in good agreement with the Geminid velocities of 34.7 km/sec. obtained photographically by Whipple,[3] and 34.4 km/sec. obtained using diffraction radar techniques by Ellyett and Davies.[4]

The work described in this letter was carried out by the Meteor Ionization Research group at Stanford University.

* This work sponsored jointly by the ONR and the U. S. Army Signal Corps.

[1] L. A. Manning, O. G. Villard, Jr., and A. M. Peterson, J. App. Phys. to be published.

[2] J. A. Pierce, Phys. Rev. 71, 88–92 (1947).

[3] F. L. Whipple, Proc. Am. Phil. Soc. 91, 189 (1947).

[4] C. D. Ellyett and J. G. Davies, Nature 161, 596 (1948).

Beta-Ray Spectrum of K^{40}

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March 7, 1949

THE mass 40 isotope of potassium is known to decay by beta-ray emission to Ca^{40}, and by electron capture to A^{40}, with a total half-life of about 4×10^8 years. A gamma-ray of 1.5 Mev is thought to be associated with the electron capture process, since beta-gamma-coincidences have not been found.[1] The maximum beta-ray energy has generally been observed to be 1.3–1.5 Mev[2–5] although a value of 1.7 Mev has been reported.[6]

Aside from the geological significance of the decay rates and energies, the nature of the beta-ray distribution is of considerable interest. A measurement has shown[7] the spin of the K^{40} nucleus to be four, while the "even-even" Ca^{40} is usually assumed to be zero. The long life and moderately high beta-ray energy are consistent with a large spin change. The shape of the spectrum should therefore correspond to a highly forbidden transition, and its determination might well afford a test of present theories.

Electron spectrometer measurements have been made difficult by the low specific activity of potassium, due in part to the natural K^{40} abundance of only 0.012 percent. Dželepow, Kopjova, and Vorobjov[4] used a six-section semicircular focusing spectrometer and measured the beta-ray distribution from sources of $K_2C_2O_4$, 69 mg/cm² thick. Their curve had an upper energy limit at 1.35 ± 0.05 Mev and was said to be of of the allowed shape.

The 100-fold enrichment of potassium in the K^{40} isotope to 1.2 percent has recently been achieved.[8] This communication reports the results of a lens spectrometer measurement of the beta-ray distribution from such an enriched sample.

The instrument used was recently constructed at this laboratory. It is a conventional magnetic lens spectrometer[9] designed for a variety of applications up to electron energies of 10 Mev. The four-section 850-lb. copper coil is water-cooled, and at the maximum energy setting dissipates 12 kw. A 10-in. i.d. brass vacuum chamber 48 in. long is normally used.

For the present application, relatively high solid angle was achieved by use of a 24-in. chamber lined on the inside with aluminum, and by employing only the outer two coil sections having a separation of 5.5 in. From an estimate of the electron trajectories, the solid angle appeared to be between 6 and 9 percent of 4π. A measurement of the photoelectron line produced in a 0.001-in. thick uranium foil by annihilation quanta gave a resolution figure of about 15 percent (full width at half maximum) under these conditions.

The source holder consisted of a Plexiglas cup having a cavity 1 in. deep and 1 in. in diameter, and with a sheet of mica 4 mg/cm² thick attached at the rim. 74 mg of enriched KCl were crystallized on a 4-cm² central area of the mica.

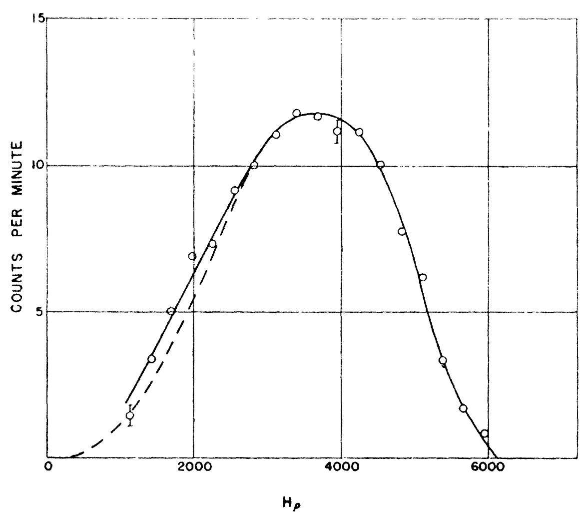

FIG. 1. Beta-ray intensity distribution from K^{40}. The dashed curve corresponds to a linear Fermi plot.

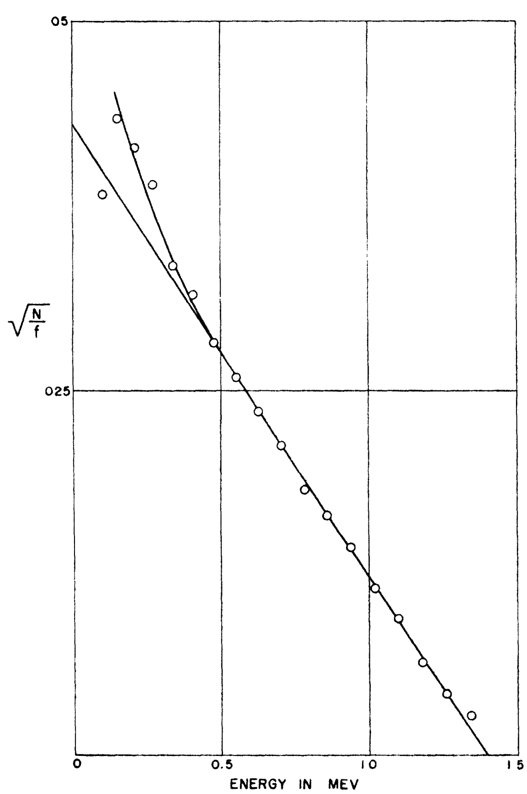

FIG. 2. Fermi plot of the K^{40} beta-ray spectrum.

Because of non-uniform crystallization, the source thickness appeared to be greater than 18.5 mg/cm^2 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$\pm$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/cm^2 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.

The author is indebted to Dr. L. B. Borst for arranging the loan of the material from the Stable Isotopes Division of the AEC and for mounting the source. Thanks are also due Dr. T. Lauritsen who made valuable suggestions for the use of the lens spectrometer in this application.

* Research carried out under contract with the AEC.

[1] Meyers, Schwachheim, and deSouza Santos, Phys. Rev. **71**, 908 (1947).
[2] O. Hirzel and H. Wäffler, Phys. Rev. **74**, 1553 (1948).
[3] W. J. Henderson, Phys. Rev. **71**, 323 (1947).
[4] Dželepow, Kopjova, and Vorobjov, Phys. Rev. **69**, 538 (1946).
[5] J. J. Floyd and L. B. Borst, Phys. Rev. **75**, 1106 (1949).
[6] S. Franchetti and M. Giovanozzi, Phys. Rev. **74**, 102 (1948).
[7] J. R. Zacharias, Phys. Rev. **60**, 168 (1941).
[8] Carbide and Carbon Chemicals Company, Oak Ridge, Tennessee.
[9] Deutsch, Elliott, and Evans, Rev. Sci. Inst. **15**, 178 (1944).
[10] K. Siegbahn, Phys. Rev. **70**, 127 (1946).

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

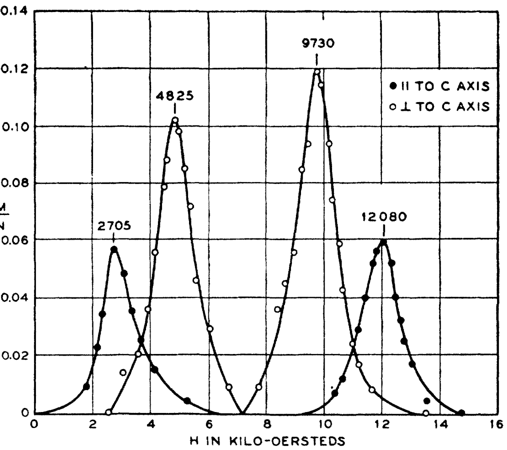

FIG. 1. Magnetic resonance absorption in $NiSiF_6 \cdot 6H_2O$ at 24,446 mc/sec. Vertical axis is ratio of (magnetic energy loss in sample) to (total non-magnetic energy loss in cavity and sample). Results are shown for two crystal orientations, parallel and perpendicular to the static field.

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.

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 $g\mu_B H_{||} = h\eta \pm \delta$. 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.

[1] J. Becquerel and W. Opechowski, Physica **6**, 1039–1056 (1939).
[2] J. Becquerel and J. van den Handel, Physica **6**, 1034–1038 (1939).
[3] R. Schlapp and W. G. Penney, Phys. Rev. **42**, 666–686 (1932).
[4] Bagguley, Bleaney, Griffiths, Penrose, and Plumpton, Proc. Phys. Soc. **61**, 551–561 (1948).

The Decay of Co^{55}

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March 14, 1949

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