1 gauss above 10°K; at about this temperature the width increased abruptly to 5.4 gauss and remained constant down to 1.55°K. At 1.55°K two side peaks with a separation of about 39.5 gauss began to appear, and at 1.4°K two additional humps with a separation of about 75.5 gauss. As the temperature was reduced further there was a marked decrease in the intensity of the central line with a corresponding increase in the side peak intensity. These results are in agreement with those of references 1 and 2. The observed fine structure at low temperatures can be explained by the magnetic dipole-dipole interaction of the two protons in the lowest level, provided one takes into consideration the splitting of the rotational level ($J=1$) of the *ortho*-molecules caused by the potential field of the neighboring molecules. The strength and symmetry property of the crystalline field which most likely depend on concentration of the *ortho*-molecules probably also give rise to the specific heat anomaly observed in *ortho-para* mixtures.[4]

Consequently, we performed experiments on solid hydrogen samples with different *ortho*-concentrations. In 11, 16, and 34 percent *ortho*-hydrogen the observed line widths at 4.2°K were 1.2, 1.6, and 3.3 gauss, respectively. Only the central line appeared with no fine structure down to 1.20°K. In 55 percent *ortho*-hydrogen, the circumstances were the same, but the line width at 4.2°K was 5.0 gauss and remained unchanged down to 1.19°K. In 67 percent *ortho*-hydrogen, the line was a simple one with a width of 5.6 gauss down to 4.2°K. At 1.33°K, however, the side peaks appeared. At 1.20°K the separations of these side peaks and two humps were 39.5 gauss and 75.5 gauss, respectively. In 70 percent *ortho*-hydrogen, the line was a simple one with a width of 5.1 gauss down to 4.2°K. The side peaks appeared at 1.43°K. At 1.24°K, in addition to the two side peaks of the separation of 39.5 gauss, two humps with a separation of 75.5 gauss appeared. The interesting result is that the temperature at which the fine structure appeared depends on *ortho*-concentration. This temperature shifted to lower temperatures with falling *ortho*-concentration. The line width of the center peak also depends on *ortho*-concentration, but the observed line width in high *ortho*-concentration was broader than that calculated by Van Vleck's formula assuming the intermolecular broadening of *ortho*-molecules with $I=1$. The experiments should be extended to lower temperatures for the samples in which no fine structure was observed above 1.2°K.

Recently, Hill and Ricketson[5] reported the existence of a λ-type specific heat anomaly and a sharp dependence of its critical temperature on *ortho*-concentration in solid hydrogen. In 74 percent *ortho*-hydrogen the specific heat maximum occurs at 1.6°K, while in 66 percent *ortho*-hydrogen it is shifted to 1.35°K. It is interesting to note that there is a coincidence between the observed λ-point of the specific heat anomaly and the temperature at which the side peaks begin to appear in our nuclear magnetic resonance experiments.

We also made experiments with solid normal D_2 near 4 Mc/sec. The results were in agreement with those of references 1 and 2. The line at 4.2°K was a simple one with a width of about 1.4 gauss. The fine structure resulting from the $J=1$ state of *para*-D_2 was not observed down to 1.19°K. Further experiments down to lower temperatures will be necessary to confirm this point.

A full account of this work will be published shortly.

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Spins and Hyperfine Splittings of Ag^{111} and Cu^{64}†

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(Received July 8, 1954)

FOLLOWING a suggestion by Professor Donald R. Hamilton, we have constructed an atomic beam magnetic resonance apparatus for the measurement of the spins and magnetic moments of radioactive nuclei in which the conventional A and B deflecting magnets[1] have been replaced by six-pole magnets similar to the focusing magnet constructed by Friedburg and Paul.[2] The A magnet acts as a converging lens for atoms having a negative strong field moment; the B magnet acts as a diverging lens for atoms having a positive strong field moment. By arranging the stops as shown schematically in Fig. 1, only atoms which have undergone a transition in the C field resulting in a change in the sign of the strong field moment can reach the detector. Each atom

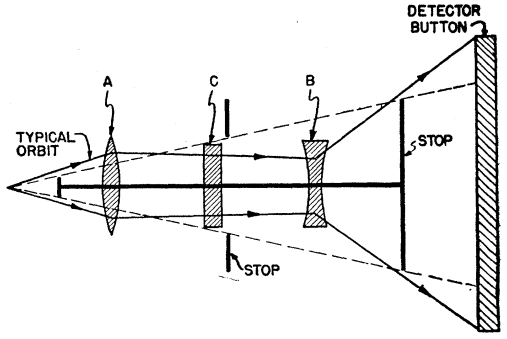

FIG. 1. Schematic of atom optics.

must cross the dotted line twice. Calculation showed that this arrangement of optics enabled us to compensate sufficiently for the chromatic aberration caused by the Maxwellian distribution, so that we were able to obtain an effective solid angle of $(5\times10^{-5})\ 4\pi$ steradians for flopped atoms reaching the detector from the oven and having a kinetic energy between 300°K and 1200°K.

A point on a resonance curve is taken by inserting a copper button in the position shown in Fig. 1. We collect for 5 min and then count for 5 min with a 2π Geiger counter. A typical resonance for Cu^{64} is shown in Fig. 2. The spin of Cu^{64} was found to be 1; a tentative

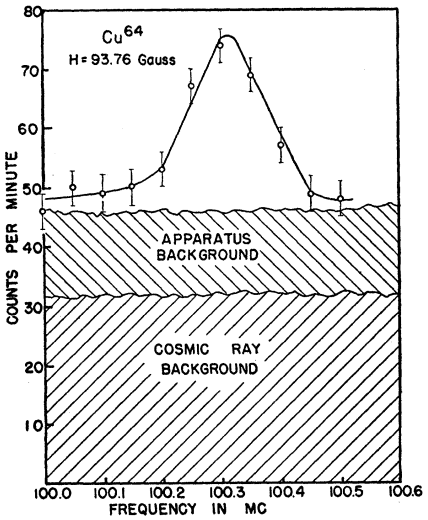

FIG. 2. Typical Cu^{64} resonance curve.

value for the hyperfine splitting is 1278±20 Mc/sec. Because of a dependence, which is not understood, of the line center upon the rf power level, at present we cannot say what the sign of the moment is. Using the hyperfine splitting of 0.195 cm^{-1} observed spectroscopically by Ritschl,[3] an average of the gyromagnetic ratios of Cu^{63} and Cu^{65},[4] and the Fermi-Segrè formula,[5] we obtain for the magnetic moment of Cu^{64},

$$|\mu| = 0.40 \pm 0.05 \text{ nm}.$$

A definitive interpretation must await the determination of the sign of the moment.

The spin of Ag^{111} is $\frac{1}{2}$; a tentative value of the hyperfine splitting is 2180±100 Mc/sec. Using the data of Wessel and Lew[6] on the hyperfine splitting of Ag^{107} and Ag^{109}, the nuclear magnetic moments measured by Sogo and Jeffries,[7] and the Fermi-Segrè formula, we obtain for the magnetic moment of Ag^{111}

$$|\mu| = 0.144 \pm 0.007 \text{ nm}.$$

This confirms the spin assignment of McGinnis,[8] and gives further evidence that the addition of two neutrons does not substantially change the nuclear state.

We are indebted to Professor Donald R. Hamilton for suggesting the possibility of constructing a focusing atomic beam apparatus and for his continued advice throughout the conduct of the experiment. We also wish to express our thanks to R. D. Petti and R. L. Christensen for their help in constructing the apparatus and taking data. A more complete report on the apparatus and further measurements now in progress will be submitted in the near future.

† This work was supported in part by the U. S. Atomic Energy Commission and the Higgins Scientific Trust Fund.

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Resonance Absorption of Gamma Radiation by O^{16} Nuclei

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(Received July 6, 1954)

RESONANCE absorption of gamma radiation was detected by Moon and Storruste[1] in the scattering of Hg^{198} radiation by the same nuclei. A high linear speed, mechanically attained, compensated for energy lost to recoil in emission and absorption. In this case, however, Doppler broadening due to thermal motion greatly exceeded the level width.

The occurrence of resonance absorption by individual levels in light nuclei has been inferred by Haslam *et al.*[2] from discontinuities in the slope of the betatron excitation curve for the reaction $O^{16}(\gamma,n)O^{15}$. Some uncertainty remains in this interpretation, however, owing to the energy spread in the betatron radiation.

This note reports preliminary experiments using gamma radiation from the reaction $Li^7(p,\gamma)Be^8$. The photonuclear reaction $O^{16}(\gamma,n)O^{15}$ was chosen for investigation because it has recently been the subject of a careful betatron study by Penfold and Spicer.[3]

The gamma radiation, produced by a 40-μa proton beam from the University of Melbourne 700-kv electrostatic generator striking thin lithium nitride targets, could be varied over a limited energy range by variation of proton energy. Only the highest energy component of this radiation (transitions to the ground state of Be^8) is above the photodisintegration threshold. The yield of this radiation exhibits the well-known resonance at 441 kev, above which it drops to a low but nearly constant level.

The oxygen irradiated was combined chemically in *p*-dioxane, in which was dissolved *p*-terphenyl to make a scintillating solution. O^{15} was detected by its positron