in mercury, the isotopes at masses 196 and 199. Since the 199 is 110 times as abundant as the 196 most of the neutron absorption in normal mercury is due to the isotope of mass 199.

TABLE I. Isotopic composition of neutron irradiated mercury.

Mass No.	% Abundance normal	% Abundance bombarded	Net change	Isotopic cross sections in 10^{-24} cm²	Contribution to total section in 10^{-24} cm²
196	0.155	0.120	-0.035 ± 0.002	3100	4.8
197	<0.001	<0.001	—	—	—
198	10.12	10.17	$+0.05\pm0.05$	—	—
199	17.01	13.78	-3.23 ± 0.07	2500	425
200	23.21	26.52	$+3.31\pm0.03$	<60	<15
201	13.15	13.11	-0.04 ± 0.07	<60	<8
202	29.66	29.63	-0.03 ± 0.15	<60	<18
203	<0.001	trace	+trace	—	—
204	6.69	6.68	-0.01 ± 0.03	<60	<4
205	<0.001	<0.001	—	—	—

In the cases of the isotope of mass 198, 200, 201, 202, and 204 it was possible only to assign upper limits to the cross sections. The upper limits in the Table I were deduced by assuming only $(n-\gamma)$ reactions. There are some indications at masses 199 and 201, however, that reactions other than $(n-\gamma)$'s took place; in particular $(n-2n)$'s. The occurrence of such a reaction in this sample was possible since there was a considerable flux of fast neutrons in the pile. A much heavier flux, or a different flux distribution, would be necessary to prove this point.

No peak was detected at mass 197 so that all the mercury 197 formed by $(n-\gamma)$ reaction on mercury 196 decayed by K capture to gold 197. Thus 35 micrograms of gold were formed from the 100 milligrams of mercury.

The weak peak at mass 203 was probably caused by a long-lived $(n-\gamma)$ induced activity in mercury as it was not observed in the normal sample. This is probably the 51-day β-activity known to exist in mercury.[2]

[1] Mark G. Inghram, Phys. Rev. **70**, 653 (1946).
[2] Glenn T. Seaborg, Rev. Mod. Phys. **16**, 1 (1944).

Fine Structure of H_α

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THE fine structure of H_α has been again examined with a Lummer plate and with a Fabry Pérot étalon. The source was a hydrogen discharge tube submerged in liquid air. Trials were made under various conditions of pressure and current density. The separation of the apparent doublet resulted in an average value of 0.310 ± 0.007 cm^{-1}. The results relative to a particular series of spectra have been examined with great care and compared with the results of Dirac's theory. The apparent doublet has been reconstructed by assigning to every theoretical component an intensity curve $\exp[-k(\nu-\nu_0)^2]$ and to k a value derived from the experimental curve.

The "reconstructed" doublet differs from the experimental one in regard to the intensities and to the distance between the two maxima, which for the "reconstructed" doublet has a value of 0.327 cm^{-1}. We have tried to establish whether these disagreements may be ascribed only to the fact that the experimental intensities of the components are not exactly in agreement with the values calculated by Dirac's theory. In order to fit well the reconstructed doublet to the experimental one without changing the separations of the components, we should triple the intensity of the third component, keeping for the others about the theoretical intensities. But such a change of intensity, affecting almost exclusively the third component, would disagree with Sommerfeld's and Unsöld's[1] suggestion according to which the deviations from the theoretical intensities are due to the fact that the $2S$ level is metastable.

The observed deviations of the separation between the two maxima of the experimental and reconstructed doublet can certainly not be attributed to the overlapping of lines of the molecular spectrum, as Drinkwater, Richardson, and Williams[2] suppose, because the intensity of the molecular spectrum near H_α under our experimental conditions was practically zero.

If in the experimental measurements a mysterious systematic error does not occur, we should conclude, in accord with C. R. Williams' observations,[3] that the separations between the components do not correspond exactly to the calculated ones on the basis of Dirac's theory. As Sommerfeld[4] has shown, using Dirac's theory also, the deviations from the coulombian field in the neighborhood of the nucleus cannot explain the deviation observed by C. R. Williams. However, it is not certain that the formalism of the quantum mechanics maintains its validity for problems involving distances of the order of the nuclear radius. Therefore, we may hope that, when a suitable formalism is found, the small observed deviations may be justified.

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[2] J. W. Drinkwater, O. Richardson, and W. E. Williams, Proc. Roy. Soc. London **A174**, 165 (1940).
[3] R. C. Williams, Phys. Rev. **54**, 558 (1938).
[4] A. Sommerfeld, Zeits. f. Physik **118**, 295 (1941).

A Microwave Spectrograph*

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WE have constructed a microwave spectrograph of the wave-guide absorption cell type[1] which appears to be somewhat more sensitive than others which have been described. The basic principle is the use of a radiofrequency Stark effect field[2] which modulates the absorption by the gas so that a radio receiver can be used for detection purposes. The apparatus consists of the usual $2K33$ K-band klystron oscillator tube, attenuator, a $5\frac{1}{2}$-foot length of K-band wave guide, and a crystal detector, the output of which goes to a narrow-band communication receiver. The amplified output of the receiver is displayed on an oscilloscope screen. The wave guide is fitted with a central electrode insulated from the walls in the form of a brass strip inserted parallel to the broad sides of the wave guide[3] and is made gas-tight with mica windows. An oscillator supplies

a radiofrequency voltage to this electrode. In addition a d.c. potential is applied to the same electrode. The radio receiver is tuned to the same frequency as the oscillator (80 Kc has been used), or alternately (and less effectively) to various overtones of this frequency. A sawtooth voltage at about 20 cycles per second is applied to the reflector grid of the klystron and also to the horizontal plates of the cathode-ray oscillograph in order to sweep the tube through a small frequency range.

When the frequency of the klystron passes through an absorption frequency of the gas, a small part of the microwave energy is modulated because of the varying absorption of the gas as the Stark effect components are moved back and forth in frequency by the alternating Stark effect field. A radiofrequency component then appears in the crystal output and is amplified by the radio receiver and displayed on the oscilloscope screen. The shape of the curve, which is displayed when a line is present, is a complicated function of the nature of the Stark effect of the particular molecule.

The minimum detectable absorption depends upon the nature of the Stark effect of the given substance. Even with the short wave guide used, the apparatus is able to display the $J=1$, $K=1$ line of the inversion spectrum of N^{15} ammonia present in its natural proportion of 0.3 of 1 percent in ordinary ammonia.

Dr. B. P. Dailey and Mr. Robert Karplus have contributed heavily to the success of this experiment. We also wish to thank Dr. Stuart P. Cooke for the assistance rendered by himself and by other members of the Microwave Research Group. Dr. A. G. Hill of the Research Laboratory of Electronics, Massachusetts Institute of Technology, very kindly aided us through loans of apparatus.

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[1] See for example, W. D. Hershberger, J. App. Physics **17**, 495 (1946), W. E. Good, Phys. Rev. **70**, 213 (1946), and C. H. Townes, Phys. Rev. **70**, 665 (1946). We are indebted to Dr. Hershberger for giving us a detailed description of his apparatus.

[2] A principle similar to this has been used in a different way by E. M. Purcell, H. C. Torrey, and R. V. Pound, Phys. Rev. **69**, 37 (1946), and by Arthur Roberts, Robert Beers, and A. G. Hill, Phys. Rev. **70**, 112 (1946).

[3] As described by T. W. Dakin, W. E. Good, and D. K. Coles, Phys. Rev. **70**, 560 (1946).

Conductivity of Sodium-Ammonia Solutions

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IN an earlier communication, two of us in collaboration with J. G. Daunt and M. Désirant[1] had reported failure to reproduce R. A. Ogg's observation[2] of superconductivity in solidified sodium-ammonia solutions. We had then worked under the assumption that the reported persistent currents had the same well-reproducible character as with established superconductors. When from a subsequent communication by Ogg[3] it became clear that the phenomena

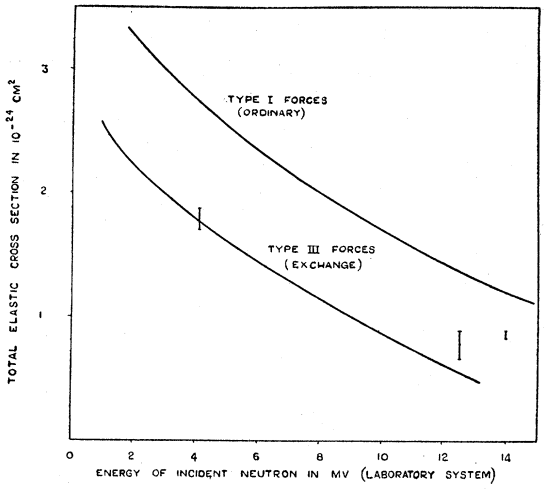

FIG. 1. Variation of resistance of a 2.1 percent ($\sim 1N$) sodium-ammonia solution.

observed by him were of a rare and transient nature, we had to admit the possibility that similar effects might have escaped our notice. In view of the importance of the possibility of superconductivity at relatively high temperatures, and also because of a confirmatory report by J. W. Hodgins,[4] a more extensive investigation of the electric, thermal, and magnetic properties of sodium-ammonia solutions was undertaken. While a full report of this work will be published elsewhere[5] a short statement of some of the conclusions reached may be of interest.

Resistivity measurements using a current-potential method were carried out on thin continuous layers of the frozen solution. In the case of $1N$ solutions, different behavior was in fact observed according to the speed with which the samples were frozen. As is shown in the accompanying figure, in general, rapid freezing yielded low resistance at low temperatures, slow freezing, high resistance. The figure illustrates the subsequent behavior on warming to higher temperatures with a very marked drop of resistivity at -114°C. In all cases, *finite conductivity* was observed throughout the experiments. As became evident from our thermal experiments, these results are readily explicable by the formation of a concentrated highly-conducting eutectic (m.p.: -114°C) (see also Ruff and Zedner[6]) which is readily supercooled.

Persistent current experiments were carried out with ring-shaped specimens similar to those used by Ogg[3] except that in all cases the formation of a continuous annulus was ensured. In the first experiments transient magnetic moments of the order described by Hodgins were indeed observed, but it was then detected that these were produced by the presence of iron objects in the laboratory or by very small vibrations of the search coil. Since the field to be detected only amounts to one-fiftieth of the vertical component of the earth's magnetic field, a slight tilting of the search coil would readily yield a false indication. Great care had therefore to be taken to avoid such disturbances and also others, as for instance would be produced by the dis-