VI. MAGNET LABORATORY RESEARCH

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A. MAGNETO-OPTIC STUDIES OF Hg^{196} AND Hg^{197}

By previously described methods we have repeated observations on radioactive mercury prepared by bombarding gold with 15-Mev deuterons. Five new hyperfine structure lines have been observed, of which three have been identified with reasonable certainty. One of these is attributable to Hg^{196}, a stable isotope present to only 0.15 percent in natural mercury but much more abundant in the residues of the samples obtained from bombarded gold. The lines from even-even isotopes are readily identified by the fact that their Zeeman effect consists of a normal triplet whose center, or π-component, is undisplaced. The isotope shifts are compared in Fig. VI-1.

Two other lines have been identified from their g-factors as having F = 3/2 and 1/2. Since such lines would be expected for Hg^{197}, which is predicted and observed (1) to have a spin of 1/2, and since these lines disappeared at a rate, if not measurable, at

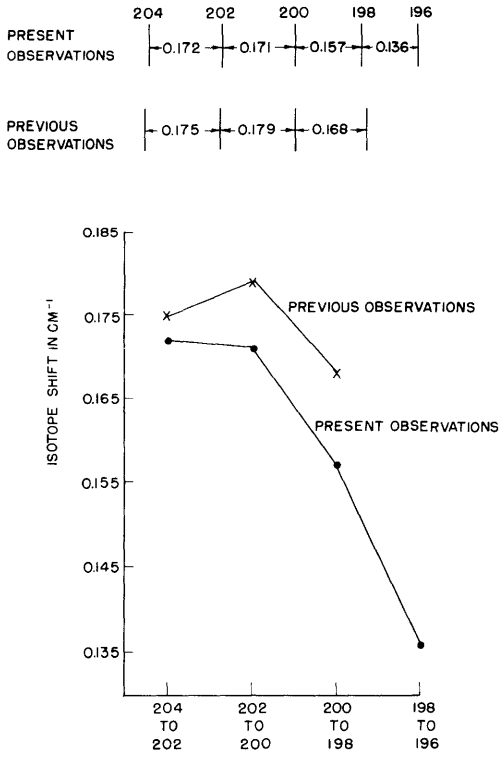

Fig. VI-1
Frequency separation of λ 2536 components in cm^{-1}.

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least not inconsistent with the 64-hour half-life of Hg^{197}, we have tentatively assigned these to the ground state of Hg^{197}. This leads to a magnetic moment for this isotope equal to that of Hg^{199} within a few percent, and to an isotope shift for the center of gravity of Hg^{199} to Hg^{197} slightly smaller than the 198 to 196 shift shown in Fig. VI-1.

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References

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B. NUCLEAR MAGNETIC RESONANCE IN GASES

In molecular gases, the width of the resonance is inversely proportional to the average frequency with which the molecule is reoriented. This is the kinetic collision frequency. Many gases are vapors at room temperature (that is, have a maximum pressure); thus they have a minimum linewidth. However, if we add other gases, the collision frequency may be increased, and the linewidth be reduced below the value set by vapor pressure. The purpose of the present measurements is to evaluate the effectiveness of various added gases and to compare this with estimates from kinetic theory.

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C. THE SELF-REVERSAL OF Na RESONANCE RADIATION

The question of self-reversal in the light source is of interest in connection with the recent work on sodium (1). The source used was an ordinary sodium laboratory arc. Since the lines from this arc are known to be self-reversed, a high-frequency discharge tube containing sodium metal was constructed. Spectrograms of the D line at 5890A are shown in Fig. VI-2. They were taken on a Spectroscopy Laboratory echelle, with a plate factor of approximately 0.5 A/mm. Varying intensity along the lines was produced by a step sector at the slit that had steps with exposure-time ratios of 2:1. The power input to the high-frequency exciting source, a QK-61 magnetron, was 25 watts. Note that the laboratory arc shows a reversal width of approximately 0.7A, while the discharge tube shows very little, if any. When operated at

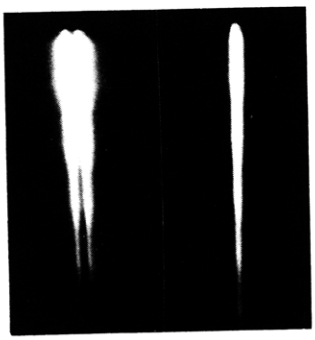

Fig. VI-2

Spectrograms of the D line of Na at 5890A: (a) laboratory arc; (b) high-frequency discharge.

twice the input power and with external heating, however, the tube showed nearly as much reversal as the arc. More quantitative measurements than these have not been made.

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References

1. P. L. Sagalyn, Doctoral Thesis, Department of Physics, M. I. T. (1952) (Phys. Rev. article in press).

D. THE ZEEMAN EFFECT OF MERCURY (λ = 4047A)*

Further work (1) on obtaining the emission spectrum of small amounts of mercury indicates that the 4047A line $\left({}^3P_0 - {}^3S_1\right)$ furnishes desired information concerning the splitting of the upper level. Spectrograms taken on the Spectroscopy Laboratory echelle show clearly separated hfs components, and it has proved possible to follow their

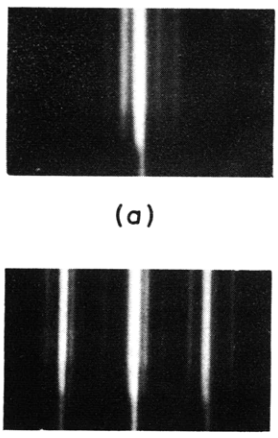

Fig. VI-3

Spectrograms of mercury at 4047A: (a) The central bright component is due to the even isotopes. The outer faint components are the hfs lines of the isotopes with an odd number of neutrons (zero field). (b) The three bright lines are the normal Zeeman triplet produced by the even isotopes. The splitting of the hyperfine structure is complicated (B $\approx$ 14, 000 gauss).

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splittings in magnetic fields up to approximately 14,000 gauss. These components and splittings are shown in Fig. VI-3.

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1. Quarterly Progress Report, Research Laboratory of Electronics, M. I. T., July 15, 1953, p. 32.

E. NUCLEAR RESONANCE STUDIES OF SOLIDS AND LIQUIDS

The interactions of nuclear multipole moments with their surroundings, occurring as perturbations on a strong coupling of the magnetic dipole moment with an external magnetic field, can be used as a means of studying the nuclear environment. The desired information is contained in the breadth and fine structure of radiofrequency resonance absorption lines in bulk matter. The work of this project can conveniently be divided into two parts.

1. The temperature dependence of splittings caused by nuclear dipole-dipole coupling in crystals will be investigated as a means of studying the conditions necessary for large-scale motions and polymorphic phase transitions. Closely related series of compounds among the ammonium halides, alkali borohydrides, and octohedral coordination complexes of cobalt, and the like, will be investigated to elucidate these matters, including the role of cooperative phenomena in phase transitions and the coupling of lattice disturbances with molecular activation leading to initiation of chemical reaction. The variable frequency regenerative spectrometer with homodyne detection to be used for these experiments has been largely assembled.

2. Studies will be made of electron distributions in molecules by the measurement of diamagnetic shifts in the Larmor frequency and of electron-coupled nuclear interactions. The general aim of this work is the correlation of these spectra with molecular structure, properties, and mode of chemical reactivity. Since extremely high resolution is required, studies are being made of the factors governing the homogeneity of magnetic fields. It is hoped that by means of special magnet design and flowing-sample techniques it will be possible to produce fields of very high effective local uniformity with considerably less labor and expense than have heretofore appeared necessary. A fixed-frequency spectrometer of the bridge type will be used under slow passage conditions.

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