

VII. MAGNET LABORATORY RESEARCH

Prof. F. Bitter
N. I. Adams III
J. Brossel

T. Erber
H. H. Plotkin
P. L. Sagalyn

J. R. Stanley
T. F. Wimett
A. W. Winston

A. NUCLEAR MAGNETIC RESONANCES

1. Field Homogeneity of the Barrel-Type Electromagnet

The program for homogenizing the field in the barrel-type magnet at 14,500 gauss has been continued. A series of eighteen field plots has been made, using flat steel shims extending to the full diameter of the pole faces (11 inches) with different inside diameters and thicknesses. For each arrangement of shims, plots were made along each of three orthogonal axes. Results so far obtained are similar to those obtained earlier (Quarterly Progress Report, p. 30, April 15, 1951) with six-inch rings.

The nuclear resonance probe used for examining the field consisted of a small oil sample (less than ten microliters). This sample was contained in a tuned coil which was connected to the grid of a 60-Mc amplifier through a half-wave coaxial line. No null or bridge circuit was used. The radio frequency was introduced at the grid terminals through a high impedance. The r-f oscillator was frequency-modulated at 60 cps and the modulating voltage was applied through a phase shifter to the horizontal plates of an oscilloscope to provide a linear sweep for the usual oscilloscope presentation. As the probe is moved from point to point, a change in field appears as a corresponding displacement of the resonance signal on the oscilloscope trace. With this method of observation, field plots were easily made with a precision of two or three parts in a million.

N. I. Adams III, T. F. Wimett

B. DOUBLE RESONANCE EXPERIMENTS

1. Nuclear Orientation in Mercury Vapor

An apparatus has been set up to produce nuclear orientation in mercury vapor by illumination with circularly polarized light, as has been suggested by A. Kastler (Journal de Physique et le Radium, 11, 255, 1950). The double resonance method is being used for detection, involving a change of polarization in the optical resonance radiation produced by r-f resonance between the nuclear Zeeman sublevels of the 1S_0 ground state.

F. Bitter, J. Brossel, A. W. Winston

2. The 3P_1 Level of Hg^{201}

As we pointed out in the Quarterly Progress Report, July 15, 1951, the nuclear moments are considerably decoupled from the electronic moments even in the low fields

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used. All expected resonances have been observed.

For the $F = 3/2$ levels the transition $\Delta m 1/2 \rightarrow 3/2$ is completely resolved from the transition $\Delta m -1/2 \rightarrow -3/2$ at 144 Mc/sec. The relative intensity of these lines is not that expected on the basis of the Majorana formula. This is not surprising in view of the fact that the Majorana formula assumes no decoupling.

A precise measurement of the gyromagnetic ratio for the even isotopes in the 3P_1 state is under way, but not for the odd isotopes, because the partial decoupling removes much of the significance of such observations.

A paper is being prepared for publication dealing with all measurements made (see Quarterly Progress Reports, October 15, 1950, January 15, April 15 and July 15, 1951) and with the theoretical analysis contained in Technical Report No. 176.

J. Brossel, F. Bitter

3. Effects in Sodium

A resonance has been observed, but the signal-to-noise ratio was poor, and the apparatus has been completely rebuilt in order to improve it.

P. L. Sagalyn

C. MAGNETIC PROPERTIES OF SOLIDS

1. The Rare Earths

Apparatus is being constructed for measuring the static magnetization of paramagnetic materials over wide ranges of field and temperature. The method to be used consists of moving the sample within a uniform magnetic field in such a way as to induce a signal in a pickup circuit from which the magnetization may be determined. In preliminary work on a rough model, magnetization curves were drawn for MnO , MnO_2 , and $FeCl_2 \cdot 4H_2O$ at room temperature and in small fields of about 10 oersteds. It was also used to plot hysteresis loops for an iron sample in small fields. This equipment will be used first for an investigation of the magnetic properties of cerium and neodymium.

H. H. Plotkin

2. Diamagnetism of Metals in Weak Fields

A device has been constructed for measuring the diamagnetic susceptibility of metals in fields below 1000 gauss. The sample is hung from one arm of a torsion balance, and is subjected to a field with a controllable gradient. Measurements are to be made from room temperature down to liquid helium temperatures. The purpose of the investigation is to examine in detail the magnetic transition in superconductors and to find out how metals behave in fields sufficiently weak so that the $v \times B$ forces

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produce orbits large compared to the dimensions of the sample used. This is of particular interest in view of some detailed predictions by Dingle of the Mond Laboratory, Cambridge, England. An advance copy of his thesis showing most of the results obtained was kindly loaned to us by Dr. D. Schoenberg of the Mond Laboratory.

J. R. Stanley, F. Bitter

D. ZEEMAN EFFECT IN ATOMIC HYDROGEN

The investigation of the Zeeman effect in fields up to 80,000 gauss is continuing under greatly improved conditions. Lines of the Balmer series involving transitions from $n = 6$ to 10 have been photographed.

T. Erber