VII. MAGNET LABORATORY RESEARCH

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A. NUCLEAR MAGNETIC RESONANCES

1. Nuclear Resonances in Gases

A high pressure sample container has been built and tested at pressures up to 10,000 psi, and associated equipment has been assembled for observing gas resonances at high pressures.

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2. The Deuteron-Proton Moment Ratio

In the process of observing proton resonance-absorption lines two milligauss in width, it was found that the time stability of the thousand-gauss field in the battery-driven Helmholtz coils was inadequate. Ordinarily because of the long relaxation times associated with such narrow lines, it is necessary to sweep the field extremely slowly, and it is only for very short periods that the thermal field drifts do not completely overcome the slow sweep. In order to eliminate this problem, an automatic field stabilizer has been developed. It contains two control elements: a current shunt which measures total current, and a derivative control consisting of auxiliary coils mounted inside the Helmholtz coils. The amplifier for the feedback system employs a galvanometer with photocell pickup and was suggested by Mr. Harold Enge and Professor Buechner who loaned some of the equipment used in the amplifier.

Preliminary tests on the automatic control indicate maximum drifts of, at the most, one part in a million over a period of several minutes.

T. F. Wimett

B. DOUBLE RESONANCE EXPERIMENTS

1. Hyperfine Structure of the $3P_{3/2}$ State of Sodium

A considerable amount of data has been taken in which the deflection due to the rf field is measured as a function of the steady field. The hyperfine structure of the $3P_{3/2}$ state of sodium consists of four levels with total angular momentum F equal to 3, 2, 1, or 0. At large dc fields (20-35 gauss) resonance curves of the type expected were obtained. The positions of the maxima of these curves can be correlated reasonably well with $F = 2 \rightarrow F = 1$ transitions. The signals in weak magnetic fields are smaller, and the interpretation of the data is not clear. There is some indication of a maximum deflection at zero field for rf frequencies in the neighborhood of the theoretical $F = 2 \rightarrow F = 3$ separation. Curves of rf deflection vs frequency in zero field are now

being taken. From the position of the maximum of such a curve, we hope to obtain the $F = 2 \rightarrow F = 3$ separation unambiguously.

<div align="right">P. L. Sagalyn</div>

C. MAGNETIC PROPERTIES OF SOLIDS

1. Ferromagnetic Materials

The equipment described in the Quarterly Progress Report, October 15, 1951, is being used to investigate the approach to saturation in iron, nickel, and cobalt in fields up to 50,000 gauss. Preliminary runs have been made in fields up to 45,000 gauss. The method used, involving the induction of a signal in a detector coil due to the motion of the magnetized sample, shows several advantages over conventional methods for measuring magnetization. It is mechanically more stable and convenient than force balance and does not require a known magnetic field gradient, since the sample is always in a static homogeneous field. Measurements are made by balancing for a null against a signal from a similar detector coil, produced by a known current in a dummy coil which moves with the sample. Thus, linearity in the detecting apparatus is not required. The use of a narrow band amplifier at the frequency of the oscillating sample permits the elimination of a good deal of the background noise due to field fluctuations, mechanical vibrations, thermal noise, stray field pickup and so on.

Absolute measurements of magnetization become possible, if the shape of the sample is accurately known. If the dummy coil is then formed into the same shape, or if the field around the dummy coil can be calculated, then a comparison of signals from dummy coil and sample may be interpreted to yield the absolute magnetization of the sample. Accurate control of sample shape is also important in treating materials at high magnetizations. Unless samples are ellipsoidal, the magnetization will not be uniform and the curves will be difficult to interpret. The limits of accuracy imposed by these problems will be considered quantitatively.

Present indications are that accuracies of the order of 1 percent certainly should be obtainable. Work is continuing on refinement of the apparatus for use on the paramagnetic rare earth metals.

<div align="right">H. H. Plotkin</div>

2. Diamagnetism of Metals in Weak Fields

Preliminary observations with a crudely constructed apparatus indicate that the susceptibility of a metal such as copper can be measured to within 10 percent in fields of the order of 1000 gauss. Efforts are being made to improve this.

<div align="right">J. R. Stanley</div>