

## VII. MAGNET LABORATORY RESEARCH

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### A. NUCLEAR MAGNETIC RESONANCES

#### 1. The New Barrel-Type Electromagnet

The installation is now complete. The graphs in Fig. VII-1 summarize the characteristics of the new electromagnet for a power input up to 20 kw.

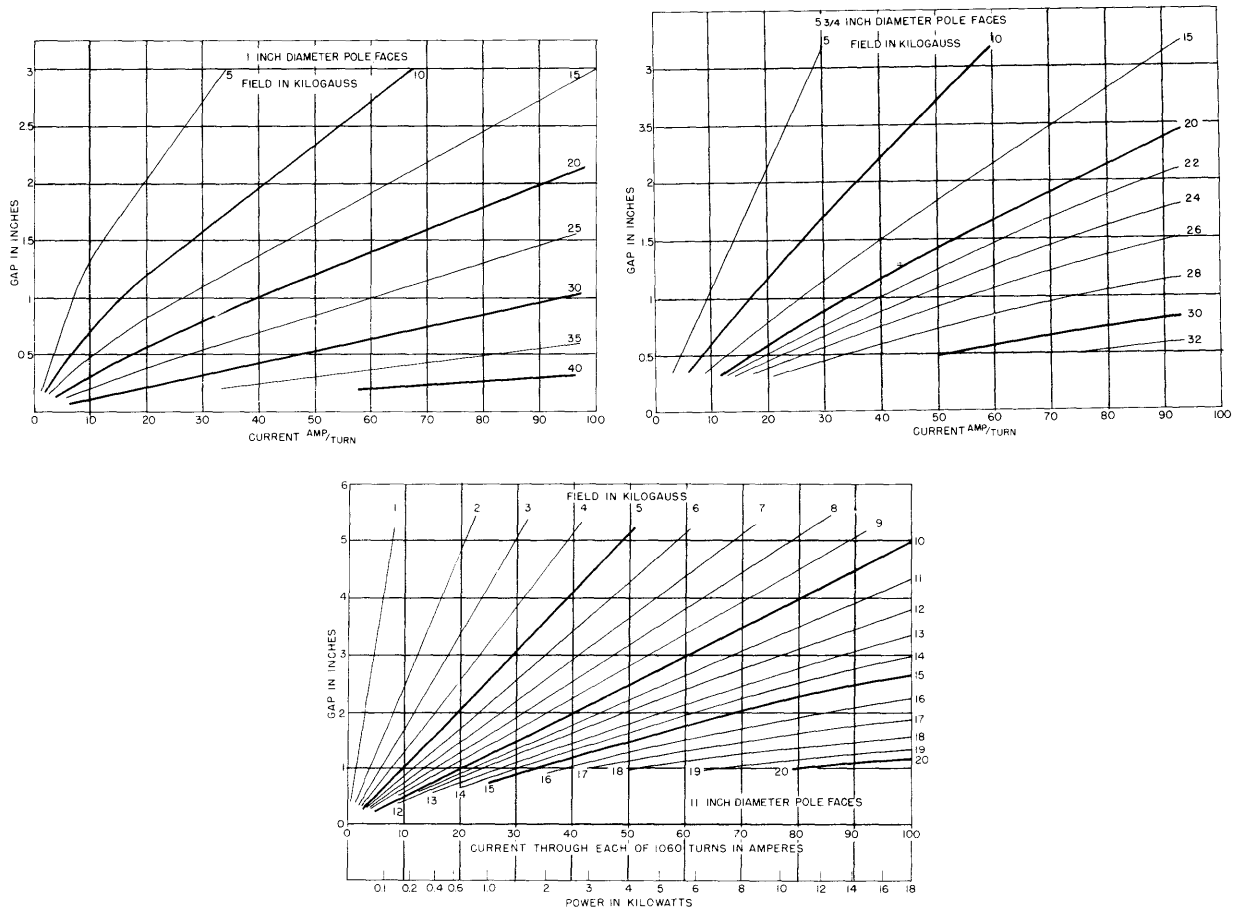


Fig. VII-1 Graphs showing fields obtainable with the new magnet.

F. Bitter

#### 2. Deuteron-Proton Moment Ratio

The deuteron resonance has been observed at a thousand gauss in the Helmholtz coils, using a fairly large sample of heavy water with added paramagnetic ions. The signal-to-noise ratio through the "lock-in" amplifier was of the order of fifteen-to-one, which was somewhat lower than expected. Work is therefore in progress to improve

## (VII. MAGNET LABORATORY RESEARCH)

this ratio which, it is believed, is not limited by the low-noise electrical circuits used but perhaps by excess paramagnetic ions. This signal-to-noise ratio may prove to be the limiting factor in this low-field measurement.

Radio frequency equipment is being revised and new circuits are being constructed by means of which both proton and deuteron driving frequencies will be generated from harmonics of a low-frequency, crystal-controlled oscillator. This simplifies the problem of determining the ratio of the two resonance frequencies and at the same time maintains the ratio of the driving frequencies practically fixed once they are adjusted. The latter is very important in a precision measurement as it allows for circuit adjustments, such as those affecting shapes, without constant rechecking of the frequency ratio.

T. F. Wimett

### B. DOUBLE RESONANCE EXPERIMENTS

#### 1. Effects in Mercury

The line shape of the resonance lines has been computed under varied conditions for the mercury atoms, Hg 199 and Hg 201, and even isotopes.

The cases concerned are

- a. No magnetic orientation in the ground state (case of a very short relaxation time, or of a constant supply of atoms entering the space where optical excitation takes place).
  - 1) The line shape has been obtained for resonances within a Zeeman pattern for each of the hfs levels of each isotope for  $\pi$  or  $\sigma^+$  optical excitation,  $\pi$  and  $\sigma$  detection, for all possible values of the r-f field.
  - 2) The intensity at resonance has been obtained for resonances between hfs levels of the odd isotopes for  $\pi$  and  $\sigma^+$  optical excitation and detection, for large values of the r-f field.  
The intensities obtained in that case are small.
- b. Magnetic orientation in the ground state.
  - 1) The intensities at resonance have been calculated in all the above cases for large values of the r-f field.
  - 2) The line shape has been obtained for very small values of the r-f field in the case of  $\pi$  excitation.

The above calculations assume broad line excitation and do not take into account the effect of collisions on the degree of polarization of the excited state (conditions easily met with in practice). The effect of magnetic orientation in the ground state is most pronounced with  $\sigma^+$  excitation, where whole patterns disappear and where some lines are considerably enhanced.

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## (VII. MAGNET LABORATORY RESEARCH)

### 2. Effects in the Alkalis

Computations were carried out to determine the feasibility of measuring the nuclear electric quadrupole moments of the alkalis by the double resonance method. (This involves measuring the hyperfine separations of the  $P_{3/2}$  level with sufficient accuracy to detect deviations from the interval rule.) Calculations were made of optical line intensities, radio-frequency line widths, and estimates were made of the deviations from the interval rule to be expected. The conclusion was reached that sodium and cesium were the two most favorable elements on which to begin research. Sodium will be close to the limit of resolution but cesium appears to be well within it.

A proton resonance circuit has been constructed which will enable us to check the field of our solenoid in the vicinity of 80 gauss.

P. L. Sagalyn

### C. MAGNETIC PROPERTIES OF SOLIDS

#### The Rare Earths

Previous experimental results as well as theoretical considerations lead one to expect that some of the rare earth elements may have very interesting and useful magnetic properties at low temperatures. A program is being initiated to investigate the rare earth metals at liquid helium temperatures. The Curie points of those that become ferromagnetic and their saturation magnetization are to be measured. A small sensitive electrodynamic balance has been built for the measurement of magnetic susceptibilities of very small samples by the Faraday method, and initial calibration curves have been obtained.

Preliminary investigations are to be carried out with one of the existing magnets in the M. I. T. Magnet Laboratory. For final measurements, Helmholtz coils capable of producing 30,000 gauss with independently controlled gradient coils are to be used. This magnet is being constructed under the supervision of Prof. A. R. Kaufmann.

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