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. NUCLEAR MAGNETIC RESONANCES

1. Field Stabilization

At the time of the Li^6 - Li^7 ratio measurements in this Laboratory it was found that in the barrel-type electromagnet field instability in time due to current fluctuations was so large that it practically precluded further refinement of field homogeneity. For this reason a nuclear resonance field stabilizer was needed. The r-f and a-f parts, supplying a signal in the form of phase changes on modulation, were constructed in this Laboratory. The circuits from this point to tubes controlling the current in auxiliary coils were designed and constructed by the Servomechanisms Laboratory. Experiments with preliminary r-f equipment have stabilized the field to within about 2 parts in 10^7 with respect to the frequency of a freely-running well-stabilized oscillator. The oscillator's principal frequency change is a very slow drift.

Further work on the r-f and a-f equipment to increase the signal-to-noise ratio and to decrease frequency drift is in progress. It is estimated that the limit on the field homogeneity practically attainable will be decreased by at least an order of magnitude.

N. I. Adams III

2. The Sign of Nuclear Magnetic Moments

A literature search was made to determine the nature of the evidence for the attributed sign of nuclear magnetic moments. The results of this survey are given in Table I.

An apparatus was constructed for measuring the sign of nuclear moments. This consisted of one of the usual nuclear induction circuits with two r-f coils at right angles to provide a rotating component of the r-f field. With this apparatus the spectroscopically determined positive sign for the nuclear moments of P^{31}, Cu^{63}, and Cu^{65} was verified.

Considerable time was spent in searching for a resonance of praseodymium ^{141}. Although the magnitude of the moment of Pr^{141} had been determined, using nuclear induction methods, a literature search disclosed only a statement to the effect that the work of White indicated a positive moment (W. H. Chambers, R. E. Sheriff, D. Williams: Phys. Rev. 78, 482, 1950). A private communication from D. Williams, received after repeated attempts at finding the resonance in question had failed, disclosed that his values were probably due to impurities.

Table I

Nucleus	Sign	Reference
H^{1}	plus	1
H^{2}	plus	1
Li^{6}	plus	2
Li^{7}	plus	3
Be^{9}	minus	3
B^{10}	plus	4
B^{11}	plus	4
C^{13}	plus	5
N^{14}	plus	6
N^{15}	minus	6
F^{19}	plus	2
Na^{22}	plus	7
Na^{23}	plus	3
Al^{27}	plus	8
P^{31}	plus	9
Cl^{35}	plus	6
Cl^{37}	plus	6
K^{39}	plus	3
K^{40}	minus	7
K^{41}	plus	16
Sc^{45}	plus	6
V^{51}	plus	6
Mn^{55}	plus	6
Co^{59}	plus	6
Cu^{63}	plus	10
Cu^{65}	plus	10
Rb^{85}	plus	11
Rb^{87}	plus	11
Mo^{95}	minus	6
Mo^{97}	minus	6
Cd^{111}	minus	12
Cd^{113}	minus	12
In^{113}	plus	6
In^{115}	plus	6
Sn^{115}	minus	13
Sn^{117}	minus	14
Sn^{119}	minus	14
Sb^{121}	plus	6
Sb^{123}	plus	6
Xe^{129}	minus	6
Cs^{133}	plus	3
Cs^{135}	plus	7
Cs^{137}	plus	7
Ba^{135}	plus	15
Ba^{137}	plus	15
Pt^{195}	plus	6
Hg^{199}	plus	6
Tl^{203}	plus	12
Tl^{205}	plus	12
Pb^{207}	plus	14
Bi^{209}	plus	6

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J. R. Stanley

B. DOUBLE RESONANCE EXPERIMENTS

1. Effects in Mercury

The measurements on Hg^{199} have been extended to the frequency of 50 Mc/sec. The background due to the wings of the lines of the even isotopes has prevented an accurate measurement of the lifetime of the ${}^3_{3/2}P_1$ level of Hg^{199}. The decoupling of I and J at the lower value of the field used is not appreciable in this case, and indeed a large decrease in the extrapolated value of the half-width at zero r-f amplitude has been observed, compared to the value at 150 Mc/sec.

The very large r-f amplitudes obtained at this frequency have made possible the observation of the Bloch-Siegert shift (F. Bloch, A. Siegert: Phys. Rev. 57, 522, 1940) due to the use of a linear r-f field instead of a rotating one. The shifts observed are in the right direction but apparently slightly larger than predicted by the formula. Further evidence is needed to settle this point beyond doubt.

A study of the resonances of Hg^{201} has been started. An enriched sample was used and the 2 resonances 3/2 and 5/2 have been observed. Even at frequencies as low as 50 Mc/sec in both cases the decoupling I J is so considerable that at low r-f amplitudes the different lines ($3/2 \rightarrow 1/2$, $1/2 \rightarrow -1/2$, etc.) should be resolved, as may be seen from inspection of Figs. VII-1, 2, and 3. The previous theory based on the Majorana

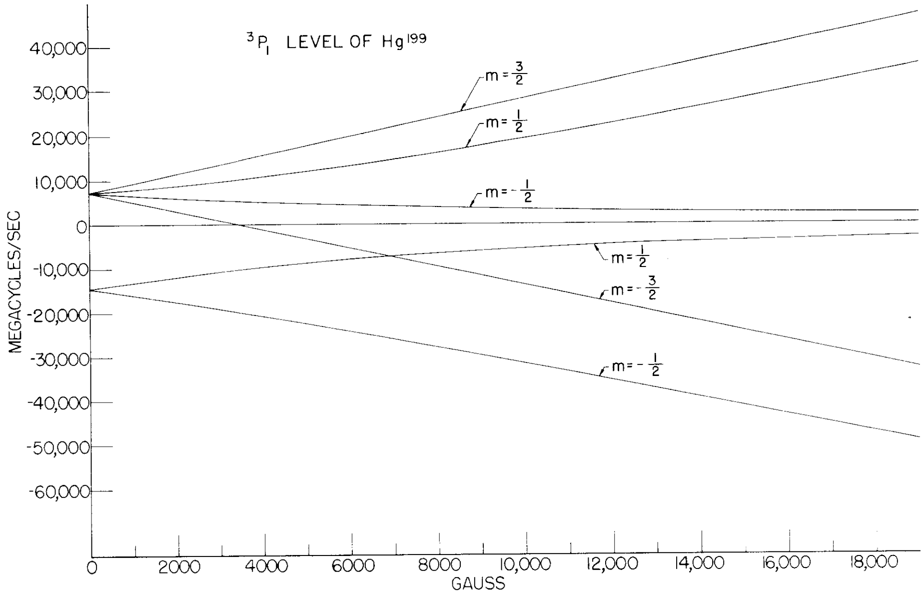

Fig. VII-1 Zeeman effect of the $^3P_1$ level of Hg^{199}.

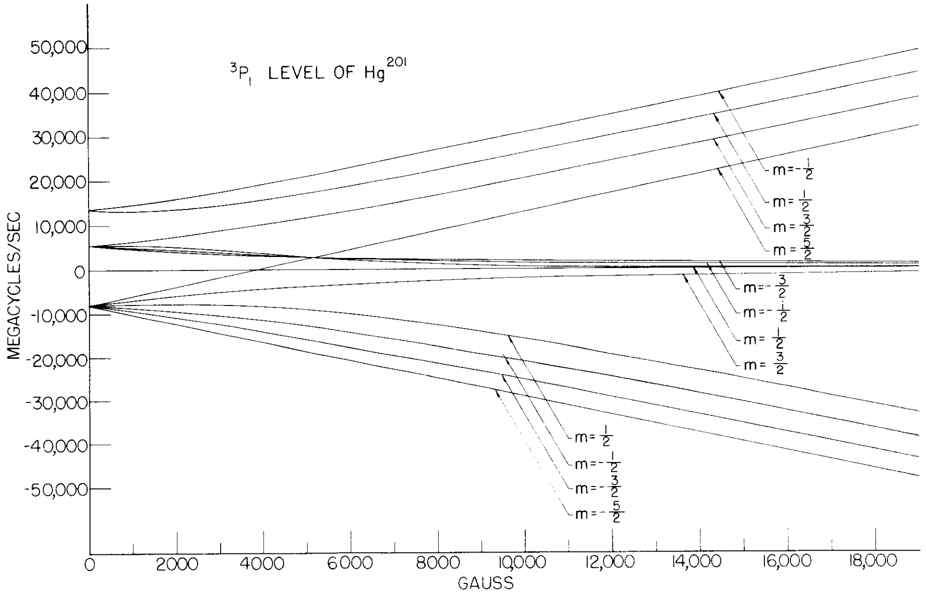

Fig. VII-2 Zeeman effect of the $^3P_1$ level of Hg^{201}

formula does not hold. Measurements are being prepared at 150 Mc/sec where at large r-f amplitudes the different Zeeman frequencies should be resolved. The transition probabilities are known for this case and it should be possible to compute the line shape.

J. Brossel

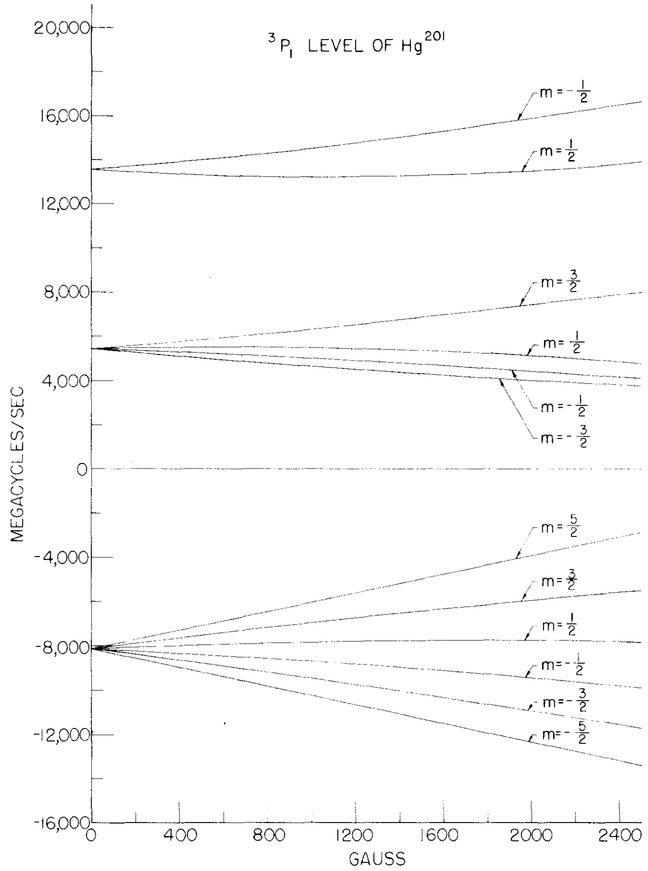

Fig. VII-3 Zeeman effect of the $^3P_1$ level of Hg^{201}.

C. MAGNETIC PROPERTIES OF SOLIDS

1. The Rare Earths

Considerable work is being done on cleaning the water-cooling system of the magnets to be used.

H. H. Plotkin

2. Adiabatic Demagnetization – see sec. IV, A.

D. ZEEMAN EFFECT IN ATOMIC HYDROGEN

The quadratic Zeeman effect in the H_δ(n = 6) and H_ϵ (n = 7) lines of the Balmer series was observed in a field of 80,000 gauss. Having established the feasibility of such measurements, a more detailed investigation is planned for this summer.

T. Erber