VIII. ATOMIC BEAMS

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A. THE HYPERFINE STRUCTURE ANOMALY IN ATOMIC P-STATES

The theoretical analysis of the effect of s-electronic configuration interaction on the hyperfine structure of doublet states (1) has been applied to the study of the hfs anomaly in atomic p-states. Atomic beam measurements by Daly and Holloway (2) of this Laboratory on the $p_{3/2}$ states of $Ga^{69,\,71}$ and by Lurio and Prodell (3) on the $p_{1/2}$ states of these two isotopes, together with a new nuclear resonance measurement (4) of the moment ratio, confirm the theoretical prediction that there is a larger anomaly in the $p_{3/2}$ state than in the $p_{1/2}$ state of Ga. Unfortunately, one cannot yet interpret this data according to the Bohr-Weisskopf (5) theory since there are still other corrections to be made, and the exact magnitude of these is not yet known.

<div align="right">C. L. Schwartz</div>

References

1. C. L. Schwartz, Phys. Rev. 97, 380 (1955).
2. R. T. Daly, Jr., and J. H. Holloway, Phys. Rev. 96, 539 (1954).
3. A. Lurio and A. G. Prodell, Bull. Am. Phys. Soc. 30, No. 3, 13 (1955).
4. M. Rice and R. V. Pound (Physics Department, Harvard University), private communication.
5. A. Bohr and V. F. Weisskopf, Phys. Rev. 77, 94 (1950).

B. ELECTRIC POLARIZATION EFFECTS ON Cs^{133} HYPERFINE STRUCTURE

The shift in the resonance frequency of the $F = 4$ $m_F = 0$ to $F = 3$ $m_F = 0$ transition in Cs^{133} resulting from the application of a static electric field has been measured as a function of the electric field up to 2.3×10^4 volt/cm. The observed shift is given by $(dF)_{obs} = AE^2 + BE^4$, where E is the magnitude of the electric field gradient (volts/cm) and the experimentally determined values for A and B are

$$A = (2.4 \pm 0.1) \times 10^{-6} \frac{\text{cycles/sec}}{(\text{volt/cm})^2}$$

and

$$B = (0 \pm 2) \times 10^{-16} \frac{\text{cycles/sec}}{(\text{volt/cm})^4}$$

The electric field was roughly parallel to the static magnetic field in the observation region for this experiment.

Because of the method of measurement (that is, the Ramsey split rf field method with the electric field applied only between the two rf regions (1, 2)), further experiments will be necessary before the relationship between $(dF)_{obs}$ and the true frequency shift is known. These experiments are in progress.

The results obtained so far seem compatible with the assumption that the main reason for the frequency shift is the second-order Stark effect. In this effect the electric field "mixes" each of the $F = 3$ $m_F = 0$ and the $F = 4$ $m_F = 0$ levels with all of the higher lying levels. Since the higher hfs level ($F = 4$ $m_F = 0$) will be shifted more strongly than will the lower level ($F = 3$ $m_F = 0$), this mixing will appear as a small shift in the resonance frequency for transitions between the two levels. Since the perturbation appears only in second order, the shift will vary quadratically with the electric field.

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References

1. N. F. Ramsey, Phys. Rev. **78**, 695 (1950).
2. Quarterly Progress Report, Research Laboratory of Electronics, M.I.T., Jan. 15, 1955, p. 32.