

## VIII. ATOMIC BEAM RESEARCH

Prof. J. R. Zacharias  
Dr. J. G. King  
B. B. Aubrey

S. J. Buchsbaum  
D. S. Edmonds, Jr.  
R. D. Haun, Jr.  
J. H. Holloway

C. L. Schwartz  
H. H. Stroke  
R. Weiss

### RESEARCH OBJECTIVES

The present interests of the atomic beam laboratory are:

1. To exploit the inherent high precision of the atomic beam method. Experimental work is being continued to utilize this accuracy in a primary frequency standard. An apparatus which has a theoretical frequency precision of one part in  $10^{12}$  is under construction. Another possible application of this work is a better understanding of the hyperfine structure interaction.

2. To investigate the structure of nuclei through a study of the static properties of their ground states. In particular, measurements of the spins, magnetic dipole, electric quadrupole, and magnetic octupole interaction are being carried out on certain nuclei. Information concerning the distribution of nuclear magnetism is also obtained from a study of the hyperfine structure anomaly in various isotopes, and some experimental work along these lines has been completed.

#### A. ELECTRON MULTIPLIERS

To detect the beam of atoms in an atomic beam experiment, it is necessary to use either an electron multiplier or an FP 54 electrometer tube. The multipliers used heretofore consisted of 15 copper-beryllium plates with a difference of potential of 200 volts between successive stages. However, because activated copper-beryllium becomes contaminated when exposed to air for periods longer than about 4 hours, it was decided to try to replace the copper-beryllium with silver-magnesium, which, when activated, is supposed to remain uncontaminated even after exposure to air for long periods of time. Before using these silver-magnesium multipliers in an actual experiment it is necessary to measure their efficiency and to study their operating characteristics. These measurements are being carried out.

B. B. Aubrey

#### B. PRECISION MEASUREMENTS OF THE HYPERFINE LEVELS OF $\text{Cs}^{133}$

This work is part of our current program of precision measurements in cesium. It consists of the remeasurement of the transitions between the levels into which the ground electronic state of  $\text{Cs}^{133}$  is split by the action of both nuclear and external magnetic fields. Higher precision than has previously been obtained is now available through the use of better frequency sources for frequencies around 10,000 Mc/sec and through the use of Ramsey's method (1) of inducing transitions by the insertion of the radiofrequency field at two points, one at the beginning and one at the end of the transition region.

The apparatus used in this experiment is well suited to this work because it has a long homogeneous magnet (C-field) and hence makes available a long transition region.

## (VIII. ATOMIC BEAM RESEARCH)

Work has been centered on modifications of the vacuum system and construction of a directional oven of a multichannel type. Both are now complete. The oven has been successfully placed in operation. The system for inserting the required frequencies at the two points at the ends of the transition region in the proper relative phase is being designed.

D. S. Edmonds, Jr.

### References

1. N. F. Ramsey, Phys. Rev. 78, 695 (1950).

### C. STARK EFFECT ON HYPERFINE STRUCTURE

The cesium atomic frequency standard (see the Quarterly Progress Report, Oct. 15, 1954, page 30) has been modified so that both beams of atoms can be observed simultaneously. Provision has been made for the application of a strong dc electric field in the observation region between the two Ramsey rf regions in the left beam. The other beam still operates as described in the Quarterly Progress Report, October 15, 1954 (that is, as a frequency standard). By measuring the difference in resonance frequencies for the two beams as a function of the electric field, the Stark effect on hyperfine structure will be measured. Although the main effect will arise from the atomic electrons, it is hoped that it may prove possible to obtain information regarding the interaction of the nucleus with the external field. If the nuclear effect proves to be detectable, the experiment will provide an upper limit for the "induced" electric dipole moment of the nucleus and experimental knowledge of the degeneracy of the nuclear ground state.

R. D. Haun, Jr.

### D. STUDY OF THE HYPERFINE STRUCTURE OF THE $^2P_{1/2}$ STATE IN Ga<sup>69</sup> AND Ga<sup>71</sup>

This study will complete our program of analysis on the stable gallium isotopes. Our specific objective this time is the investigation of the Bohr-Weisskopf effect in the  $^2P_{1/2}$  state. Before the  $^2P_{1/2}$  state could be studied, a fairly complete overhaul of the existing apparatus was necessary because of the magnetic deflecting fields and the transition frequencies required. The redesign was completed and construction is in progress.

J. H. Holloway

### E. HYPERFINE STRUCTURE OF HALOGENS

Equipment is being prepared to measure the hyperfine structure of the long-lived ( $10^7$  years) iodine isotope I<sup>129</sup>. A 5-mg sample of this isotope has been obtained from

(VIII. ATOMIC BEAM RESEARCH)

Oak Ridge. The development of the following items is under way:

1. recirculating, directive, microwave-arc atom source;
2. electron multipliers and mass spectrometers for high-resolution, negative ion detection;
3. 10-cycle flop modulators and detectors;
4. rf sources consisting of klystrons for preliminary measurements and cavity-triode oscillators for final measurements;
5. automatic data recording (100 kc/sec/min, tentative speed) and frequency indexing.

Because of the smallness and rarity of the  $I^{129}$  sample, a relatively large amount of time and thought is being devoted to apparatus details with the hope of making it possible to obtain all the data within a few days, thus minimizing the risk of losing the sample.

J. G. King