X. ATOMIC BEAMS*

Prof. J. R. Zacharias
Prof. J. G. King
Prof. C. L. Searle
Dr. R. F. C. Vessot
H. H. Brown, Jr.
G. W. Stroke
R. Weiss

RESEARCH OBJECTIVES

The distributions of electric charge and magnetism in an atomic nucleus are usually described in terms of multipole moments limited in number by the magnitude of the nuclear angular momentum. In this laboratory, atomic-beam techniques are used to determine such electric and magnetic moments. In addition, information about the radial distribution of nuclear magnetism can be obtained in cases in which more than one isotope is available. These techniques lend themselves to such precision that they were used in this laboratory for the development of the most accurate atomic clock. In turn, these clocks are being used to make studies on the nature of time itself. Precision apparatus is under construction to observe not only the dependence of atomic time on gravitational potential but also the epochal dependence of nuclear, gravitational, and atomic time. Similar studies are being made on the velocity of light.

J. G. King, J. R. Zacharias

A. HYPERFINE STRUCTURE OF BROMINE

Since the Quarterly Progress Report of January 15, 1958 (p. 56), three of the six required klystrons have been phase-locked to a crystal standard. Great difficulty was experienced in obtaining the required vacuum in the vacuum envelope. Recently, some liquid-air traps and a diffusion pump were added to the apparatus, and we have succeeded in reaching the required pressure, although it is doubtful whether the extra traps and pump helped.

A bromine beam has been observed, but it was not of the required shape. Data taken indicate that the source may be too broad. This broadening might be the result of scattering in the oven chamber. Another possibility is that the bromine sits down on the oven chamber aperture, and then is re-emitted. A liquid-air baffle cooked in the oven chamber is being considered.

H. H. Brown, Jr., J. G. King

B. CESIUM MASER

The apparatus has been completed and measurements of beam intensities made with the use of a hot wave detector indicate that from 10^9 to 10^{10} particles per second are available in the desired state.

---

*This research was supported in part by Purchase Order DDL-B222 with Lincoln Laboratory, which is supported by the Department of the Army, the Department of the Navy, and the Department of the Air Force under Contract AF19(122)-458 with M.I.T.

Measurements of the vacuum-system pumping speed show that a pressure in the helium cavity of 10^{-2} mm Hg at 4° K results in a pressure of 5×10^{-6} mm Hg in the upper can. The lower system can be held to a pressure of better than 5×10^{-8} while these conditions are maintained.

Runs in which liquid helium was used for cavity cooling were made in an effort to find the cesium signal. Cavity pressure was varied from 10^{-2} to 10^{-4} mm Hg and stimulator power was varied 40 db. No signal has been obtained thus far. Recent measurements of receiver noise figure show that a vast improvement is necessary, and work will continue in this direction.

R. F. C. Vessot