

## V. MOLECULAR BEAM RESEARCH

Prof. J. R. Zacharias	J. T. Eisinger	L. Mower
Prof. B. T. Feld	V. Jaccarino	W. B. Pohlman
R. T. Daly, Jr.	J. G. King	H. Stroke

### A. THE THIRD ATOMIC BEAM APPARATUS

The third apparatus is now being used for experiments designed to give a direct measurement of the nuclear magnetic moment ( $\mu_n$ ) of certain alkali isotopes. The moments of  $\text{Na}^{22}$  and  $\text{K}^{40}$ , for instance, are now known only to the extent to which the Fermi-Segré formula for the evaluation of  $\mu_n$  from the measured value of the hfs separation  $\Delta\nu$  is applicable. The Fermi-Segré formula assumes a point dipole interaction between  $\mu_n$  and the magnetic field due to the orbital electrons. For isotopes (1) and (2) of the same elements which have the same spin, this assumption will not seriously impair the validity of

$$\frac{\mu_n^{(1)}}{\mu_n^{(2)}} = \frac{\Delta\nu^{(1)}}{\Delta\nu^{(2)}} \quad (1)$$

but if the spin of (1) differs from that of (2), an error in  $\mu_n$  as calculated by use of Eq. 1 can be expected. This has been shown to be true for  $\text{Rb}^{85}$  and  $\text{Rb}^{87}$  (spin 5/2 and 7/2). The purpose of the work now in progress is to look for a similar effect in the isotopes  $\text{Na}^{22}$  and  $\text{K}^{40}$ .

The method employed is the measurement of the  $\mu_n \cdot H$  interaction of atoms in a beam ( $H$  is the external magnetic field). This interaction is detected by measuring the difference in frequency between two transitions differing by  $2\mu_n \cdot H/h$ . Since these transitions are between states whose effective moments in the field  $H$  are essentially equal, they can be observed only in a zero-moment-flop-out experiment. Flop-out at the calculated frequencies has been observed but not yet at fields high enough to give a value for  $\mu_n$ . This work is being done on  $\text{Rb}^{85}$  in order to perfect the technique before the more difficult but also more interesting  $\text{K}^{40}$  investigation is undertaken.

The success of the method outlined above depends on the use of very stable r-f oscillators and an accurate measurement of the magnetic field  $H$ . R. Daly is working on the design of suitable oscillators.  $H$  can be obtained accurately by measuring the frequency of a field-dependent transition if the halfwidth of such a resonance is sufficiently small. A homogeneous magnet which will be long enough to give narrow resonances has been built and is being wound. It will replace the short C magnet now in use in the third apparatus.

J. T. Eisinger

## B. DETECTION OF ATOMIC HYDROGEN

In order to detect beams of atomic hydrogen, the possibility of producing negative hydrogen ions at the surface of a metal is being investigated. If a surface of work function lower than the electron affinity of H atoms (0.76 eV) could be produced,  $H^-$  ions should be readily obtained. Cs on  $Cs_2O$  on  $Ag_2O$  surfaces obtained by breaking red-sensitive photocells in vacuum have been tried, as well as Ba - SrO, tungsten and thoriated tungsten surfaces, all with negative results. In the case of surfaces with work functions higher than the electron affinity of H it was hoped that by applying sufficiently high fields (greater than  $10^6$  volts/cm at the surface) the barrier might be attenuated sufficiently to allow  $H^-$  ions to tunnel out; on the other hand, surfaces of Cs on  $Cs_2O$  on  $Ag_2O$ , when heated to the vicinity of  $150^\circ C$ , are reported to exhibit work functions as low as 0.65 eV.  $H^-$  ions, if formed, should then emerge in a fashion analogous to the formation of, for example,  $K^+$  ions in a surface ionization detector.

It is not yet certain whether the failure to observe  $H^-$  ions with the low work function surfaces might not be due to pollution of the surface by electronegative impurities. Experiments are being planned which, it is hoped, will allow some definite statement to be made concerning the probability of  $H^-$  ion formation and consequently the feasibility of using the process in an H atom detector.

J. G. King