NEW INFORMATION ON THE PHYSICS OF RUBIDIUM GAS CELLS ∤

P. L. Bender, Joint Institute for Lab. Astrophysics *
V. W. Cohen, Brookhaven National Laboratory

It has recently been found that the Rb^{87} hyperfine transition line width and frequency shift due to collisions can have a contribution from the transient formation of weakly bound rubidium-buffer gas molecules. Evidence for the formation of Rb-Kr molecules was obtained [1-3] at the Ecole Normale Superieure by observing Zeeman transitions at different magnetic fields. The molecules appear to be formed by three-body collisions, and then destroyed easily by two-body collisions.

For the Rb^{87} hyperfine transition, transient molecule formation causes a shift in the hyperfine frequency during the molecular lifetime. It can be shown that this gives an extra contribution to the width which is roughly independent of pressure over a wide range. Hyperfine line widths for helium and neon give no evidence of such a contribution, but line widths for argon, nitrogen, and methane do [4-5]. The clearest case is for argon, where the extra width is roughly 25 Hz. A non-linear frequency shift with buffer gas density is expected at low density and appears to be present. The minimum linewidths obtained for He, Ne, Ar, N_2, and CH_4, extrapolated to zero light intensity and microwave power, were 11, 7, 33, 17, and 28 Hz.

Some comments will also be made on the two commonly suggested possible causes of drift in Rb^{87} frequency standards: (1) change in the light intensity or spectral distribution, and (2) change in the collisional frequency shift.

1. M. Aymar, M.A. Bouchiat, and J. Brossel, Phys. Letters 24A, 753 (1967)
2. M. A. Bouchiat, J. Brossel, and L.Pottier, Phys. Rev. Letters 19, 817 (1969)
3. C.C.Bouchiat, M.A. Bouchiat, and L.C.L. Pottier, Phys. Rev. 181, 144 (1969)
4. P. L. Bender and V. W. Cohen, VI ICPEAC Book of Abstracts, M.I.T. (1969)pp.720-722
5. P. L. Bender and V. W. Cohen, to be published.

∤ This work was supported by the National Bureau of Standards and the Atomic Energy Commission.

* of the National Bureau of Standards and University of Colorado