# USE OF LASER-SATURATED ABSORPTION OF METHANE FOR LASER FREQUENCY STABILIZATION*

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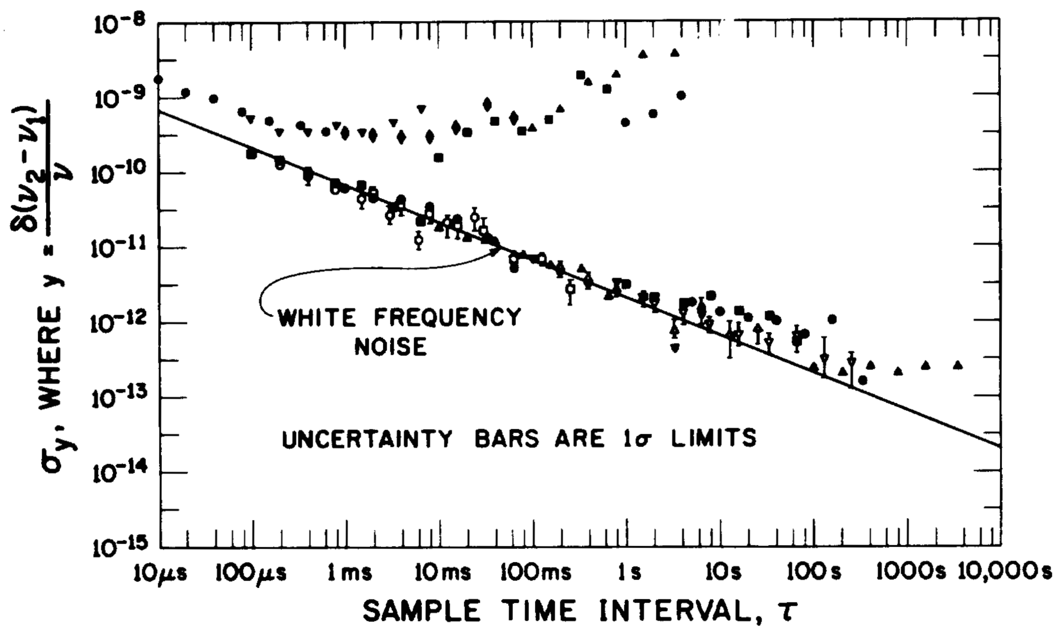
Using laser saturation of molecular absorption, we have obtained at 3.39 μ an emission feature in laser power centered on a methane vibration-rotation line [P(7) line of the $\nu_3$ band].[1,2] We report here the results of using this feature to stabilize laser frequency. The width of this very sharp Lorentzian line is determined by collisional and interaction time effects. Methane collisional self-broadening is measured to be 8.1 ± 0.3 kHz/m Torr, and an upper limit for the exceptionally low self-induced pressure shift is 75 ± 150 Hz/m Torr. We have obtained widths as narrow as 150 kHz halfwidth at half-maximum intensity, i.e. $\Delta\nu_{1/2}/\nu \approx 1\times10^{-9}$. Of this, about 100 kHz is due to time of flight across the laser beam; the remainder is due to power broadening. The asymmetry previously observed[2] in power broadening has been reduced to a negligible level. Beat frequency measurements between two independent, dissimilar methane stabilized lasers show that we have stabilized laser frequency to line center with a reproducibility of better than ± $1\times10^{-11}$. An analysis of the frequency noise **spectrum is given in the figure.**

*Supported in part by NASA, Advanced Development Division, Goddard Space Flight Center, Greenbelt, Md. and in part by the National Bureau of Standards, of which the authors are staff members.

†of the University of Colorado and the National Bureau of Standards.

1. J. L. Hall, IEEE J. Quantum Electron. QE-4, 638 (1968).

2. R. L. Barger and J. L. Hall, Phys. Rev. Letters 22, 4 (1969).




**Frequency fluctuations versus sample time interval of (a) Beat between two free running He-Ne lasers (upper set of measurement points). (b) Beat between two He-Ne lasers, each independently controlled by a methane absorption cell. (Lower set of measurement points).**

**Plotted is the Allan variance.* Number of samples N = 2; ratio of dead time plus sample time to sample time r = 1; bandwidth B ≻ 1 MHz.**

***D. Allan, Proc. IEEE 54, p. 221 (1966).**