Direct Optical Detection of Ramsey Fringes in a Supersonic Beam of SF_6

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Narrow (2.6 kHz HWHM) optical Ramsey fringes corresponding to an absorbed power as weak as 60 pWatt have been observed directly on the intensity of a CO_2 laser crossing a supersonic beam of SF_6. The interaction geometry comprises 4 purely travelling waves [1,2,3,5] generated by two large aperture high quality corner-cubes facing each other. Adjacent copropagating waves are separated by 4.5 cm.

The laser beam comes from a phase-locked waveguide CO_2 laser, whose spectral purity is of the order of 10 Hz over its 550 MHz tuning range around each CO_2 laser line [4].

A HgCdTe detector at 77 K receives the full laser beam after its 4 interactions with the molecular beam. The absorption signal is measured using phase sensitive detection at the 1.5 kHz molecular beam chopping frequency.

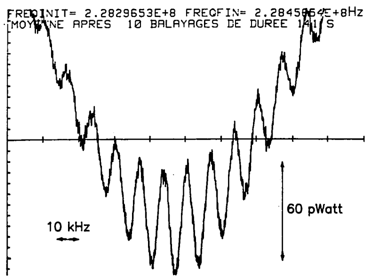

Fig. 1

SF_6 $\nu_3 P(4)F_1$ Ramsey fringes (10 sweeps of 141 s with a 0.1 s integration time). The central fringe amplitude is 26 % of the saturation dip, 8% of the Doppler-broadened background and 2×10^{-6} of the laser intensity

The signal-to-noise ratio ($\sim$ 30 for the fringes, $\sim$ 400 for the Doppler-broadened background, for 1 s integration time) is within a factor 3 of the shot-noise limit. The observed (30 ± 5) µW optimum laser power for the fringe signal ($\pi/2$ pulse) is in good agreement with the theoretical value (33 µW).

In conclusion, optical detection of Ramsey fringes is an attractive alternative to optothermal detection at 4 K in the infrared [1], especially since a molecular beam could be designed for an optimized optical depth which was not the case of our experiment.

References

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