RECENT PROGRESS IN ULTRA-HIGH RESOLUTION SPECTROSCOPY OF MOLECULAR IODINE

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We present new results concerning both Raman spectroscopy of the $X^1\Sigma_{0^+g}(v=0, J=13)$ hyperfine states and saturation spectroscopy of rovibronic hyperfine transitions $X \rightarrow B$ at 501,7 nm. The observed structures are a few kHz wide and are of interest for metrological applications.

Stimulated resonant Raman spectroscopy of I_2 in the state $X^1\Sigma_{0^+g}(v=0, J=13)$

Stimulated resonance Raman spectroscopy gives rise to extremely narrow resonances because of the long lifetime of the hyperfine levels in the ground electronic state. Our experiment is carried out within sealed low pressure cells using two copropagating laser beams with a frequency detuning equal to the frequency interval between two hyperfine levels (a few hundred MHz). The two beams are generated from the same laser at 514,5 nm (with acousto-optic frequency shifters) in order to eliminate the influence of the laser frequency jitter. We have determined six hyperfine splittings in the ground state of I_2 with 0,2 kHz accuracy[1] . The width of the narrowest resonance is 8 kHz (HWHM). A detailed quantitative theoretical study of the line shape[2] shows a reduced curvature shift and the possibility to reach subkilohertz resonances using the dominant contribution of slow molecules at low laser power as in saturation spectroscopy[3,4]. Therefore, we expect to improve significantly our resolution, essentially through a better control of the residual broadening by foreign gases in the iodine cell.

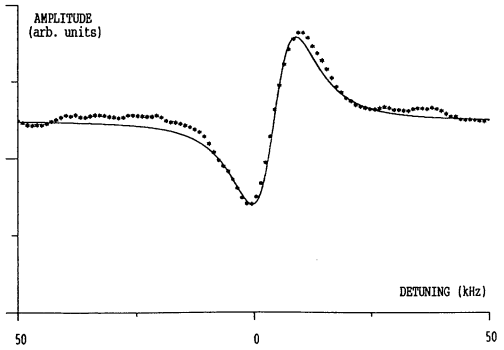

Figure 1 : The narrowest SRR resonance recorded (iodine pressure ≈ 0,2 mtorr, power of the laser beams ≈ 4 mW, beam diameter 2 cm, time constant 3 s, accumulation of nine 150 s sweeps). The solid line is a Lorentzian first-derivative with a half-width ≈ 8 kHz.

Saturated absorption spectroscopy of I_2 at 501,7 nm

Some of the five $X \rightarrow B$ transitions lying around $\lambda = 501,7$ nm (Ar^+ laser excitation) are of particular interest for laser stabilization, owing to the increase of the lifetime of the $B^3\Pi_{0^+u}$ states near the dissociation limit[5] . We firstly studied the 62-0 R(26) transitions by saturated absorption techniques, first in cell then in a supersonic beam. In the cell, we have observed narrow resonances (HWHM = 50 kHz). With the molecular beam, the signal obtained in a preliminary experiment is shown in figure 2. The width of the resonance is 28 kHz (HWHM). Using these transitions and multiple beam excitation, we expect to resolve the recoil splitting and to improve our molecular interferometry experiments[6] .

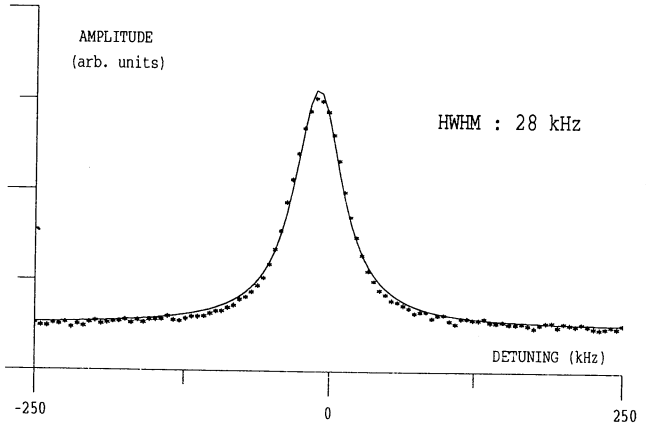

Figure 2 : The narrowest saturation resonance obtained in the supersonic I_2 beam (laser beam power ≈ 0,2 mW, beam diameter 1 cm, integration time constant 0,3 s, accumulation of four 10 s sweeps). The solid line is a Lorentzian with a half-width ≈ 28 kHz.

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