COMB-REFERENCED COHERENT RAMAN SPECTROSCOPY ON PURE H_2

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H_2 is a benchmark system for testing quantum electrodynamics and physics beyond the standard model via highly accurate measurements of transition frequencies, which has been the subject of many works during the past decades[b,c,d]. However, retrieving the unperturbed transition frequencies requires to measure spectra at very low pressure, where the low density combined with weak quadrupole transition moments makes it challenging to achieve high signal-to-noise ratios. An alternative approach is to model very precisely the transition profiles at higher pressure in order to correct for the strong Dicke narrowing and speed-dependent collisional effects which distort the absorption profiles.

We present a new approach to measure H_2 transition frequencies in the fundamental rovibrational band with high accuracy and signal-to-noise ratio. The approach uses an optical frequency comb to calibrate the frequency spacing between a cw pump and a cw Stokes beams that interact with H_2 in a multipass cell by stimulated Raman scattering. Specifically, we focus on the Q(1) transition of the 1-0 band of pure H_2 at $4155.25\mathrm{cm}^{-1}$. The pump laser emits at 737.8 nm and is kept fixed while the Stokes laser is swept over $0.3\mathrm{cm}^{-1}$around 1064 nm. The wavelength of the Stokes laser is referenced to a local oscillator, which in turn is locked to an optical frequency comb along with the pump laser. The frequency comb is obtained using an Er:fiber amplified femtosecond laser with stabilized repetition rate and offset frequency to a reference Rb standard. The profiles measured at various pressures, spanning from 0.1 to 5 atm, are fitted using Hartmann-Tran profiles. The retrieved parameters are compared to $ab\text{-}initio$ values based on H_2-H_2 quantum scattering calculations.

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