A SUB-DOPPLER RESOLUTION DOUBLE RESONANCE MOLECULAR BEAM INFRARED SPECTROMETER OPERATING AT ∼2eV: INVESTIGATION OF HCN AND HCCH

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A molecular beam spectrometer capable of achieving sub-doppler resolution around 2 eV (18000 cm^{-1}) of vibrational excitation has recently been built in our laboratory. Two high finesse resonant power-buildup cavities are used to excite the molecules using a sequential double resonance technique. A $v = 0 \rightarrow 2$ transition is first saturated using a 1.5 μm color center laser. Downstream, a fraction of the molecules is further excited to the $v = 6$ level upon interacting with a chopped Ti:Al_2O_3 laser. The energy absorbed by the molecules is detected on a cryogenically cooled bolometer via phase sensitive detection. A resolution of approximately 15 MHz, corresponding to three parts in 10^8 and scan speeds of up to several reciprocal centimeters per hour were obtained, with signal-to-noise ratios in excess of 100. The performance of the spectrometer is demonstrated by probing a rotational in the v=6 manifold of the CH stretch chromophore of HCN.

We also report the spectra of the v=6 CH stretch excitation for $^{12}C_2H_2$, where a total of 13 transitions in the (006+) band have been recorded. Despite the low density of states (a few per cm^{-1}), two J states are split into two components. Analysis of the coupling coefficients indicates that different perturbers are responsible for each of the splittings, which means that the perturbing states rapidly tune into and out of resonance.