FREQUENCY COMB-REFERENCED MEASUREMENTS OF PRESSURE BROADENING FOR REMOTE SENSING

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The extraction of species profiles from atmospheric or remote planetary sensing requires accurate and precise laboratory measurements of spectral line properties. As satellite and ground-based observations become ever more sensitive and precise, the demands of laboratory measurements increase concomitantly. For example, recent calls for atmospheric species calibration at the 0.01% level mean that much existing laboratory-based data are not adequate for the task, and more precise spectroscopic techniques are being developed. In this talk, I describe a new spectrometer based on an extended cavity diode laser whose output is locked to a frequency comb has been used to measure pressure and line shape variation in rotational lines of the $\nu_1 + \nu_3$ combination band of acetylene as a function of collision partner and temperature. To check the accuracy of the spectrometer P(11) of this band was measured to be at 195 739.649 5135(80) GHz in agreement with published data. Broadening, shift and narrowing parameters for the $\nu_1 + \nu_3$ band were determined at a series of temperatures between 125 and 296 K with pressures varying between less than one Torr up to more than 800 Torr. At 296 K, and assuming a hard-collision model, we find, we find 0.146317(27), 0.047271(104), and –0.0070819(22) for the acetylene self-broadening, narrowing and shift, in units of cm^{-1}/atm, and 0.081129(35), 0.022940(74), and –0.0088913(25) respectively, for the nitrogen broadening parameters. The uncertainties are expressed as one standard deviation (in parenthesis) in units of the last digit reported. These parameters are 2-3 orders of magnitude more precise than those reported in any previous measurements. Analyses of the experimental data using multiple collisional lineshape models show that speed-dependent effects need to be taken into account to model the data over the full temperature and pressure range. Simpler models cannot adequately reproduce the observations.