LOW TEMPERATURE LINESHAPE OF HYDROGEN DEUTERIDE

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Hydrogen deuteride, HD, is the simplest and most abundant deuterium-bearing molecule in the universe. It has been detected in numerous astronomical sources, and is a primary target of SOFIA. Imaging instruments utilize relatively broad frequency windows to detect the faint FIR emission or absorption of this molecule, but high spectral resolution instruments such as GREAT will resolve the velocity structure of HD in the ISM as well as expose pressure-broadened profiles in planetary atmospheres. The only previous Doppler resolved FIR work on HD was done with a TuFIR spectrometer[1] utilizing a room temperature sample at relatively high pressure. The development of a 2.5-2.7 THz multiplier chain at JPL has enabled us to examine the lineshape of $J = 1 \leftarrow 0$ HD in detail under extreme environmental conditions in a cryogenically cooled absorption chamber. The low temperatures achieved, near 18 K, allow a maximal absorption coefficient for this very weak dipole, and therefore low pressures can be investigated with high fidelity. At the lowest pressures the linewidth is directly determined by Doppler broadening. However, increased pressures of HD or parahydrogen initially cause motional narrowing, allowing sub-Doppler line measurements. At modestly higher pressures the pressure broadening profile dominates. A significant lineshift is observed at elevated pressures of HD, and the best center frequency is thus determined from a linear regression of the pressure dependence of this quantity. The rest frequency of 2674986.094(25) MHz determined is nearly an order of magnitude more accurate than the previous measurement[1] of 2674986.66(15) MHz, and within one standard deviation of a purely *ab initio*[2] value, 2674986.134(240) MHz.

[1] Evenson, K. M., *et al.* 1988, Astroph. J., 330, L135
[2] Pachuki, K. & Komasa, J. 2010, Phys. Chem. Chem. Phys., 12, 9188.