HIGH RESOLUTION STUDIES OF THE ν_3 BAND OF METHYL FLUORIDE IN SOLID PARAHYDROGEN USING A QUANTUM CASCADE LASER

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The ν_3 band of CH_3F isolated in solid $para$-H_2 exhibits a clearly resolved series of lines due to clusters of CH_3F with residual $ortho$-H_2 molecules, CH_3F-($ortho$-$H_2)_N$, with $N = 0 \sim 12$.[a] We have examined this spectrum in detail using a quantum cascade laser source. Solid hydrogen crystals were formed by direct vapor phase deposition on a BaF_2 window at 2 K followed by annealing (4.6 K for 10 minutes) or "super-annealing" (7 K for 10 seconds). The cw laser (Hamamatsu Corp.) was a room temperature DFB device with output powers up to 30 mW and a tuning range of about 1042 - 1036 cm^{-1} for device temperatures of 0 - 37° C. This power level was easily strong enough to modify the sample by means of spectral hole-burning effects. It was therefore necessary to strongly attenuate the laser in order to record normal "static" spectra. But we also took advantage of the power to make interesting "dynamic" measurements in which a transition could be bleached away and forced to reappear in a new position. Line widths as narrow as 0.0065 cm^{-1} were observed and line profiles were Lorentzian. The $N = 0$ line at 1040.19 cm^{-1} was resolved into two closely-spaced ($\sim$0.008 cm^{-1}) components which we believe correspond to the $K = 0$ (A) and 1 (E) levels of CH_3F, arising from partially free a-axis rotation in the crystal.[b] Numerous extra satellite lines were observed around each main feature (N = 0, 1, 2, 3, 4) as well as some weak but sharp transitions almost mid-way between $N = 0$ and 1.

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[a] K. Yoshioka and D.T. Anderson, *J. Chem. Phys.* **119**, 4731 (2003).
[b] Y.-P. Lee, Y.-J. Wu, and J.T. Hougen, *J. Chem. Phys.* **129**, 104502 (2008).