THZ AND LONG PATH FOURIER TRANSFORM SPECTROSCOPY OF METHANOL; TORSIONALLY COUPLED HIGH-K LEVELS

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Methanol is nearly ubiquitous in the interstellar gas. The presence of both $a-$type and $b-$type dipole moments, asymmetry, and internal rotation assure that any small astronomical observation window will contain multiple methanol transitions. This often allows a great deal about the local physical conditions to be deduced, but only insofar as the spectra are characterized. The Herschel Space Observatory has detected numerous, clearly beam diluted, methanol transitions with quanta surpassing $J = 35$ in many regions. Unfortunately, observations of methanol often display strong non-thermal behavior whose modeling requires many additional levels to be included in a radiative transfer analysis. Additionally, the intensities of many more highly excited transitions are strongly dependent on the accuracy of the wave functions used in the calculation. We report a combined Fourier Transform Infrared and THz study targeting the high J and K transitions in the ground torsional manifold. Microwave accuracy energy levels have been derived to $J > 40$ and K as high as 20. These levels illuminate a number of strongly resonant torsional interactions that dominate the high K spectrum of the molecule. Comparison with levels calculated from the rho-axis method Hamiltonian suggest that the rho-axis method should be able to model $\mathrm{v}_t =$ 0, 1 and probably $\mathrm{v}_t = 2$ to experimental accuracy. The challenges in determining methanol wave functions to experimental accuracy will be discussed.