INDIRECT ROTATIONAL SPECTROSCOPY OF HCO^+

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Molecular ions play important roles in astrochemistry and their spectroscopy is of great interest to astronomers who try to detect these species in the interstellar medium and other astronomical environments. Only about 20 molecular ions have been detected in outer space to date, mainly due to the lack of laboratory data which is required to support astronomical observations. Not only is molecular ion spectroscopy inherently challenging, but so too is laboratory THz spectroscopy, which necessitates an alternative approach to acquiring these laboratory spectra. We demonstrate a method to indirectly measure the pure rotational spectra of molecular ions that is based on a combination differences analysis of rovibrational transitions that typically lie in the mid-infrared, where laboratory spectroscopy is less challenging.

As a proof of concept, we present mid-infrared spectroscopy of the ν_1 fundamental band of HCO^+, a well studied and astronomically relevant ion, using Optical Heterodyne Velocity Modulation Spectroscopy (OHVMS) in conjunction with an optical frequency comb for highly accurate and precise frequency calibration. Both P branch transitions out to P(10) and R branch transitions out to R(9) have been measured. From these data we performed a combination differences analysis to calculate the ground state rotational spectrum of HCO^+ and compare it to the directly measured rotational spectrum. Here the results of such an analysis will be presented as well as calculations for the v=1 vibrationally excited state rotational spectrum.