MID-INFRARED NICE-OHMS SPECTROMETER FOR THE STUDY OF COLD MOLECULAR IONS

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Molecular ions are involved in the chemistry of many interesting systems, such as the atmosphere, combustion reactions, and the interstellar medium. Challenging aspects of studying molecular ions spectroscopically include producing ions in enough abundance and, for large or fluxional ions, overcoming the problem of quantum dilution at high vibrational and rotational temperature. Furthermore, highly precise transition frequencies are needed to answer many questions involving molecular ions, such as the presence of specific candidate ions in the interstellar medium. To address these challenges, we have constructed a mid-infrared spectrometer that uses a difference frequency generation (DFG) light source to probe cooled molecular ions produced in a continuous supersonic expansion discharge source. The cooling of the ions achieved through supersonic expansion mitigates the problem of quantum dilution. High sensitivity to detect the 10^{12} ions per cm^3 produced is accomplished through the use of noise-immune cavity-enhanced optical heterodyne molecular spectroscopy (NICE-OHMS) as a detection technique. Finally, an optical frequency comb is used to measure the transition frequencies of molecular ions precisely. This talk will present the current status of the instrument and preliminary studies to optimize and characterize its performance. Initial studies of room temperature methane allowed us to verify the use of NICE-OHMS for inferring rotational temperature of a molecular sample through Boltzmann plot analysis. Spectroscopy of H_3^+ and HN_2^+ extended this temperature verification to molecular ions. Future work on H_2CO^+, with the goal of determining its rovibrational transitions to a precision on the order of 1 MHz to aid in astronomical detection, will also be presented.