PROGRESS ON THE DEVELOPMENT OF AN INFRARED ION BEAM SPECTROMETER

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Velocity modulation has often been used to spectroscopically discriminate against neutrals in a plasma discharge for small molecular ions, however the increased temperature from the plasma makes spectroscopy on larger molecules difficult. While a supersonic expansion can reduce the rotational and vibrational temperatures of molecular ions created in a plasma discharge, there is no technique which can spectroscopically discriminate against the more abundant neutrals in the expansion. We are actively engaged in improving the "direct laser absorption spectroscopy in a fast ion beam" technique pioneered by Saykally's group[a]. Briefly, molecular ions will be produced in a supersonic expansion discharge source, accelerated, and then focused with electrostatic ion optics. The resulting fast ion beam will be turned 90° by an electrostatic quadrupole, allowed to drift through a field-free region, and then turned another 90°. The beam in the drift region will be spectroscopically probed in a collinear configuration using continuous-wave cavity ringdown spectroscopy (cw-CRDS), which will yield the advantages of a sensitive absorption measurement, a sub-Doppler linewidth, and a mass-dependent Doppler splitting. We will describe the development and commissioning of our instrument, which we call SCRIBES (Sensitive, Cooled, Resolved Ion BEam Spectroscopy).

We are characterizing the SCRIBES instrument by studying the 1-0 vibronic band of the N_2^+ $A^2\Pi_u$-$X^2\Sigma_g^+$ system, using ions produced in an uncooled cold cathode dc discharge source. We will report the linewidth and ion density found in the ion beam. In order to study the rovibrational structure of many molecular ions with SCRIBES, we will need a robust, widely tunable cw laser in the mid-infrared, that can cover the aliphatic and aromatic C-H, N-H, and O-H stretch regions. A difference frequency generation (DFG) system has been successfully produced using a periodically poled lithium niobate crystal pumped by cw-Ti:Sapph and Nd:YAG radiation. The infrared light has been successfully coupled to a high-finesse cavity to perform cw-CRDS. The construction and characterization of this cw-DFG laser system will be discussed.

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[a] J. V. Coe, J. C. Owrutsky, E. R. Keim, N. V. Agman, D. C. Hovde, and R. J. Saykally *J. Chem. Phys.* **90**, 3893 1989.