PROGRESS AND RECENT DEVELOPMENTS IN SENSITIVE, COOLED, RESOLVED ION BEAM SPECTROSCOPY (SCRIBES)

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Molecular ions play key roles in many phenomena of chemical interest, from combustion to interstellar chemistry. To better understand the physical and chemical behavior of the ions in such processes, information on their structure, energies, and quantum states must be obtained. High resolution spectroscopy is an effective tool in this endeavor, especially in the investigation of molecular ions of interstellar interest, as spectroscopy is the only tool available to probe the interstellar medium. This technique, however, can be very difficult when applied to molecular ions, due to spectral congestion with neutral species and the low density of ions produced. To circumvent these problems, we are developing a unique way of conducting high resolution spectroscopy on molecular ions called Sensitive, Cooled, Resolved, Ion BEam Spectroscopy (SCRIBES). This technique features ion-neutral discrimination, narrow spectral linewidths from kinematic compression, high signal from cavity-enhanced spectroscopic techniques, and mass sensitivity from Doppler analysis and time-of-flight (TOF) mass spectrometry. The system can also be upgraded with a supersonic expansion ion source to study rotationally cooled molecular ions.

Recent modifications to and insights from the instrument will be presented and discussed. These include exploring different electrode configurations of the presently used cold cathode source, which has led to clarifications into molecular collisions of the gaseous sample before extraction into the ion beam. Mass spectral data of hydrogen samples clearly show the difference between ion extraction by anode and extraction by cathode. Other items to be presented include implementation of highly sensitive spectroscopic techniques, such as Noise Immune Cavity Enhanced Optical Heterodyne Molecular Spectroscopy (NICE-OHMS).