

High Resolution Spectroscopy of Molecular Ions: Development of an Instrument
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We are interested in obtaining high resolution spectra of molecular ions at low temperatures, in order to enable spectroscopic searches for these molecules in the interstellar medium. While such spectroscopy yields benchmarks for theoretical calculations, and absolute values of the spectroscopic fingerprints of these molecules, it is difficult to perform, chiefly because it is difficult to produce large quantities of ions. The only robust way of making high quantities of ions, the plasma discharge, produces a small concentration (10^{-6}) of ions compared to the neutral molecules, and produces ions with high rotational and translational temperatures, leading to reduced sensitivity and a broadened absorption features. Therefore supersonically cooling a plasma discharge to produce a fast ion beam is desired because the fast ion beam reduces the line width, and the supersonic cooling reduces the rotational and translational temperature of the molecules. The ion beam can then be spatially separated from the background neutrals with ion optics, and then studied with cavity ringdown spectroscopy. Because coupling cavity ringdown spectroscopy with a fast ion beam produces a mass specific Doppler shift in the frequency positions, one can positively assign spectroscopic lines to a specific ion, thereby reducing the assignment complexity. Progress on the development of our instrument will be presented.