Submillimeter-wave Investigations of "Space in a Bottle" – Spectroscopy and Collisions from 1 - 1000 K

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The non-equilibrium conditions of the interstellar medium produce a mixture of molecular species, distributions of populated states, and collisional processes which have been difficult to replicate and study in the laboratory. The most obvious manifestation of this interstellar non-equilibrium is the existence of gas phase molecules with translational temperatures far too low for them to have significant vapor pressure at equilibrium.

We have developed a quasi-equilibrium laboratory technique, Collisional Cooling, which makes possible an interstellar-like non-equilibrium in the laboratory. However, in Collisional Cooling, the pressure, translational temperature, and ionizing flux can be controlled and measured over the temperature range from 1 - 1000 K, making possible quantitative measurements of important astrophysical processes (Messer and De Lucia 1984; Pearson et al. 1995). Submillimeter spectroscopic techniques, including time-resolved double resonance for direct measurement of the rates of collisional processes for both neutrals and molecular ions, and a new Fast Scan Submillimeter Spectroscopic Technique (FASSST), will be discussed (Petkie et al., 1997). The latter system uses fast scanning and data acquisition to replace the more traditional phase-lock methodology and can record, at Doppler resolution and very high sensitivity, 100 GHz ($\approx 10^5$ resolution elements) of spectra in the submillimeter spectral region in a few seconds.

References:

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