**Motivation**

With the recent science tests of the Herschel, ALMA, and SOFIA observatories, there are new opportunities for advancing our understanding of astrochemical processes, via observations in the THz frequency range. However, there is a lack of spectroscopic data for many species in this frequency range due to the limitations for high-resolution, high-sensitivity spectral techniques in this THz Gap.

Much of the chemistry leading to complex organic molecules in interstellar environments is believed to proceed through highly reactive, spectroscopically complex transient intermediates.

These molecules are difficult to produce in large quantities and have complex spectra at high temperatures, necessitating a high-resolution, high-sensitivity spectroscopic technique. We are building a cavity ringdown spectrometer coupled with a supersonic expansion to overcome these challenges.

**Current Benchtop Cavity Setup**

- High reflectivity dielectric mirrors are not available for the THz regime. Instead, we use wire-grid polarizers, turned 90° from typical use, to achieve reflectivity >99%.
- A microwave synthesizer + VDI multiplier chain produces tunable THz radiation from 50 GHz – 1 THz.
- Mode-matching optics collimate the THz radiation, and couple it into the cavity through the first polarizer.
- The off-axis cavity is formed by a gold wire-grid polarizer placed on a translation stage, a gold off-axis paraboloid, and a tungsten wire-grid polarizer.
- Radiation is detected by the InSb HEB detector and the signal is recorded by a high speed digitizer.

**Experimental Design**

![Benchtop CRDS Setup](Image)

**Full Cavity Ringdown Setup**

- The cavity is incorporated into a vacuum chamber.
- A supersonic expansion source introduces the molecules into the cavity perpendicular to the beam path.
- Electric discharge or photolysis lamps may be incorporated into the supersonic source for the study of ions or radicals.
- One of the polarizers is mounted on a translation stage to dither the cavity in and out of resonance.
- When the cavity is in resonance with the radiation, power builds up, and the input radiation is triggered off to allow ringdown.
- The signal is detected by an InSb hot electron bolometer, digitized and sent to a computer for analysis.

**Future Work**

- Narrow cavity modes, increase pathlength and reflectivity
- Extend system to higher frequencies
- Incorporate cavity into vacuum chamber
- Test fully-integrated CRDS system on known interstellar molecules
- Incorporate discharge and photolysis sources in experimental setup
- Begin molecular spectroscopy on ions, reactive organic intermediates
- Extend to broadband spectral acquisition

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