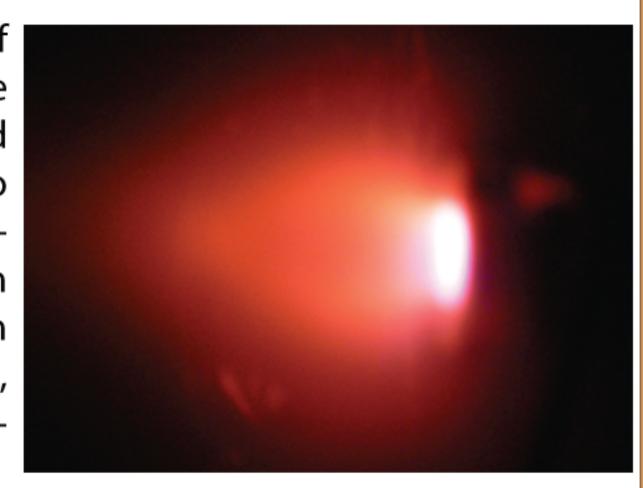
A Continuous Supersonic Expansion Discharge Source for the Production of Cold Molecular Ions

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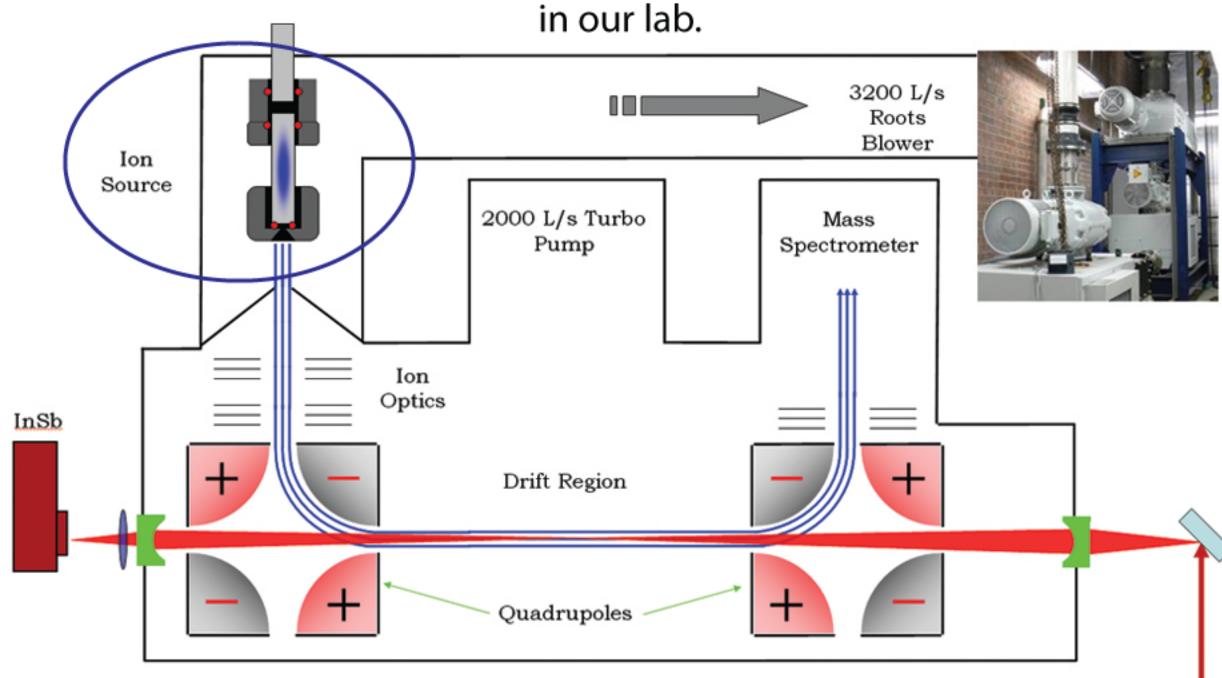
What is a Supersonic Expansion?

A supersonic expansion is a jet of molecules traveling faster than the local speed of sound. This is achieved when gas at high pressure passes into a low-pressure region through an orifice whose diameter is greater than the mean free path of the gas. When coupled with an electrical discharge, ions can be produced and accelerated into a supersonic expansion.



Motivation

Our goal is to perform high-resolution spectroscopy of astrochemically important, cold molecular ions using the SCRIBES instrument being developed



Sensitive, Cooled, Resolved Ion BEam Spectroscopy

For more information on SCRIBES, see P07- "High-Resolution Spectroscopy of Molecular Ions: Development of an Instrument."

Acknowledgements & References

Beijerinck, H. C. W. et al. Chem. Phys. **1985**, 96, 153-173. Birza, P. et al. Chem. Phys. **2002**, 283, 119-124. Campargue, R. J. Phys. Chem. **1984**, 88, 4466-4474. Verbraak, H. et al. Chem. Phys. Lett. **2007**, 442, 145-149.





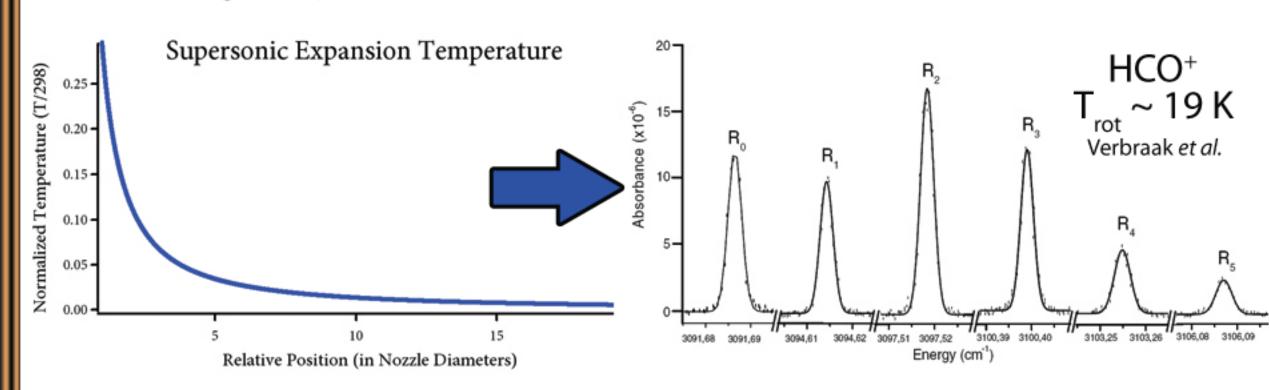




Advantages of a Continuous Supersonic Expansion Discharge Source

Astrochemically Relevant Environment

Ions produced under supersonic expansion conditions are **rotationally cold**, having temperatures close to those found in the interstellar medium.



Unlike other "matrix-isolated" techniques, the ions in the expansion are in the gas phase, eliminating spectral shifts due to matrix effects.

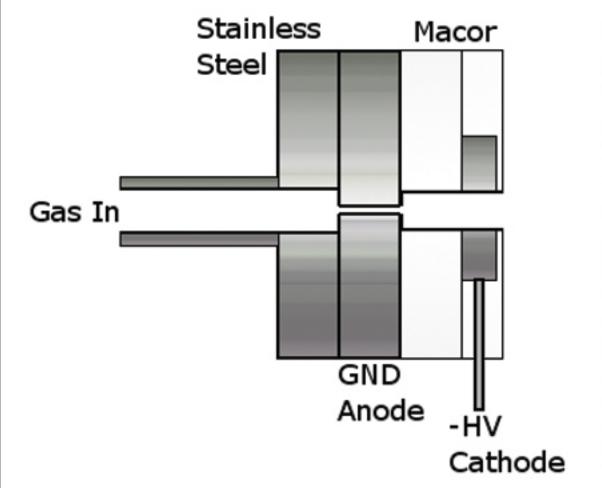
Continuous vs. Pulsed Operation

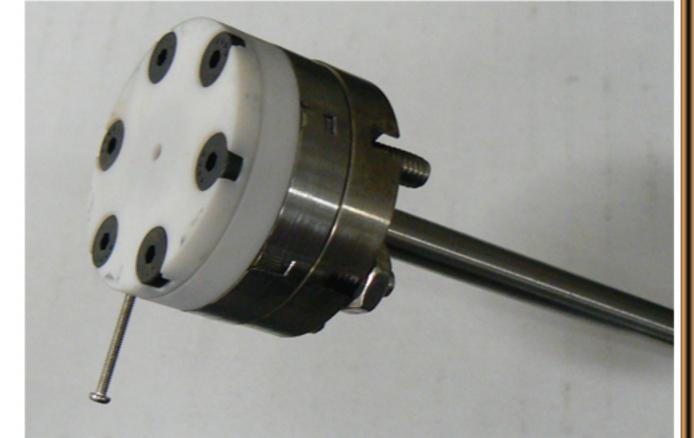


A continuous supersonic expansion discharge source can be interfaced with the SCRIBES experiment. SCRIBES promises **narrow linewidths** due to kinematic compression, facilitating the acquistion of spectra with the **high precision** necessary for performing combination differences analyses.

SCRIBES will also be interfaced with an **optical frequency comb**, allowing transition frequencies to be measured with unparalleled accuracy.

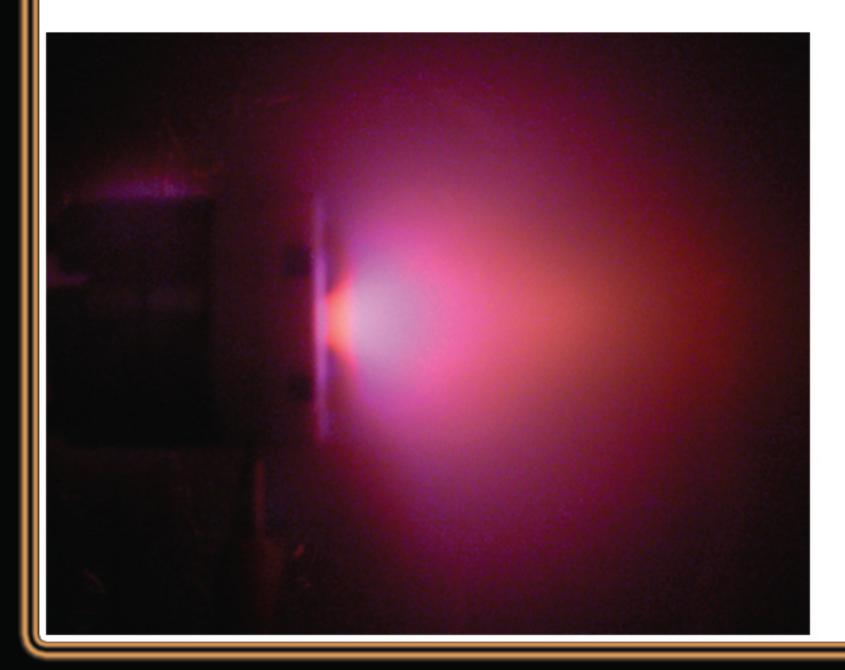
Source Design





The design is based around a conflat flange with a 100 micron-1mm pinhole coupled to a macor insulator assembly containing the discharge electrode with an exit aperture of 0.1-2.5 mm. The design is **modular** and **self-aligning**, allowing for easy swapping of components in order to fine-tune source performance

Source Operation



Typical Conditions

Discharge Voltage: -500 V

Discharge Current: 6 mA

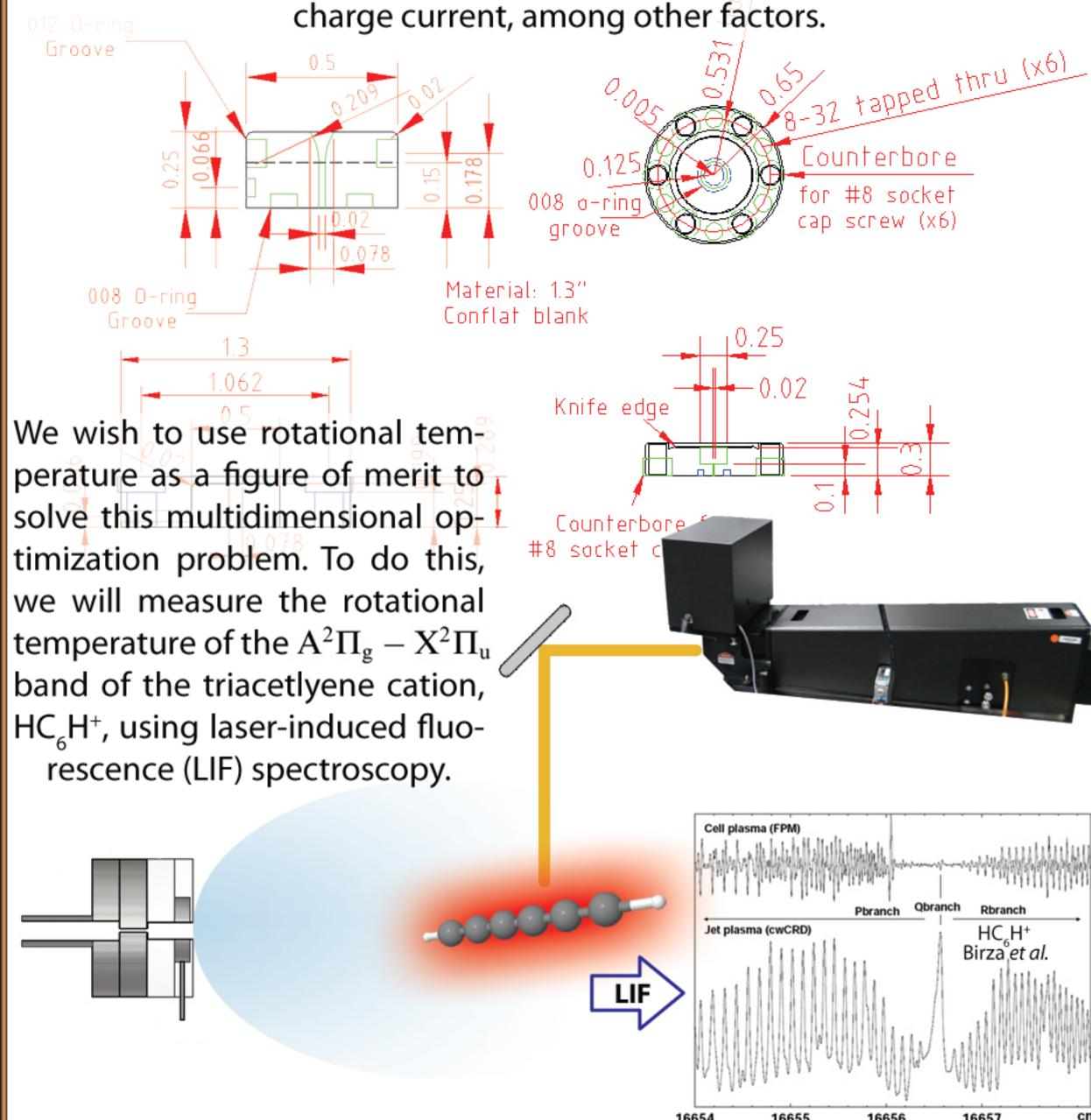
Feed Gas: Nitrogen

Feed Pressure: 1 atm

Lifetime: 24 hours

Design Optimization

The source performance is dependent upon the source geometry, materials choice, sealing mechanism, interior dimensions, discharge voltage, and discharge charge current, among other factors.



By monitoring the rotational temperature of the triacetylene cation as various source parameters are changed, we will be able to tune the performance of the source to produce ions suitable for spectroscopy