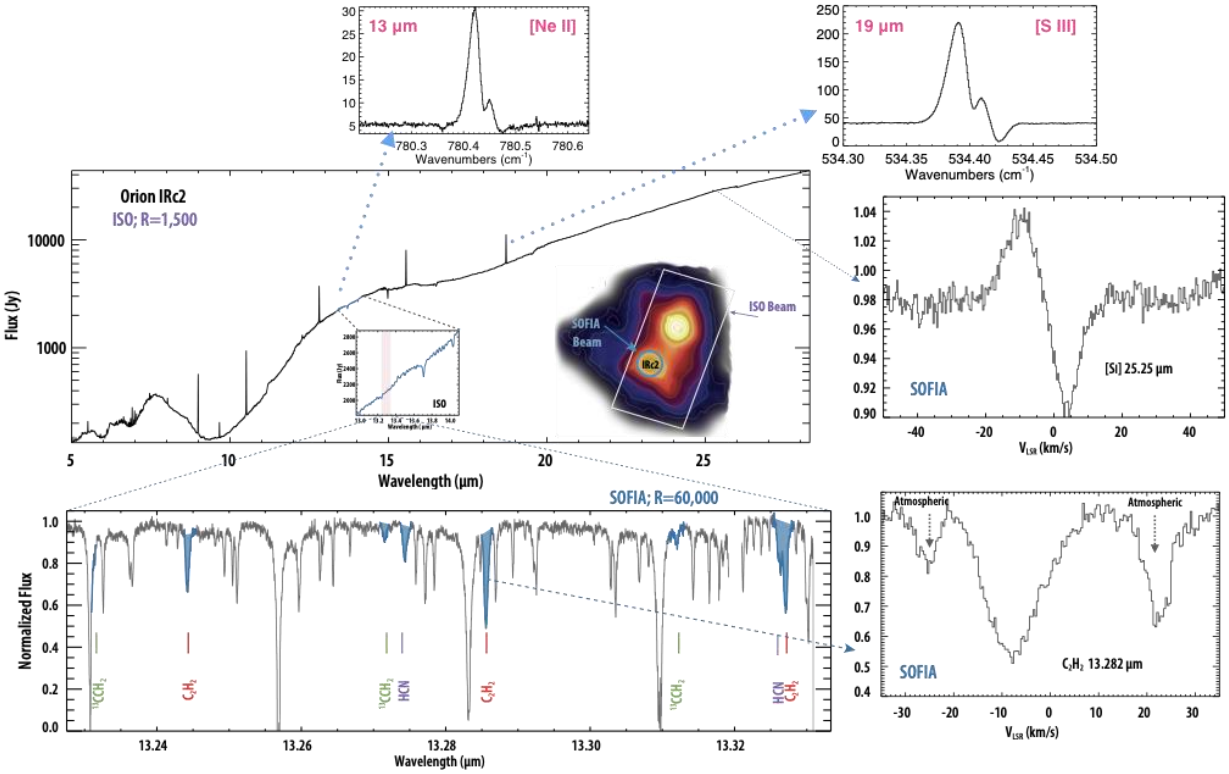
High-Resolution Mid-Infrared Molecular Line Survey of the Orion Hot Core

The basic building blocks of life are synthesized in space as part of the natural stellar evolutionary cycle, whereby elements ejected into the interstellar medium by dying stars are incorporated back into the dense clouds, which form the next generation of stars and planets. The formation of stars and planets are fundamental to the evolution of matter in the Universe as complex molecules are created and destroyed during this step. Understanding these processes will allow us to answer "What is the relation between the molecules we see in the ISM and the molecular inventory of Earth and the terrestrial planets in the Solar System?" Measuring and cataloging the inventory of organic molecules and understanding their evolution requires observations over a broad wavelength range (IR, MIR, FIR, (sub)mm, and radio) to cover all stages of this evolutionary cycle needed to link interstellar material to that delivered to planets.

High-resolution molecular line surveys provide chemical inventories for star forming regions and are essential for studying their chemistry, kinematics and physical conditions. Previous high spectral resolution surveys have been limited to radio, sub-mm and FIR wavelengths; however, Mid-infrared observations are the only way to study symmetric molecules that have no dipole moment and thus cannot be detected in the (sub)mm line surveys from ALMA. Past mid-infrared missions such as ISO and Spitzer had low to moderate resolving power that were only able to link broad features with particular molecular bands and could not resolve the individual rovibrational transitions. JWST will provide exceptional sensitivity in the MIR, but will also not have sufficient spectral resolution, which can lead to confusion in identifying the contribution from strong to moderate strength molecular species.

We present new results from an on-going high resolution (R ~ 60,000) line survey of the Orion hot core between 12.5 - 28.3 μm and 7 - 8 μm, using the EXES instrument on the SOFIA airborne observatory. SOFIA's higher-resolution and smaller beam compared to ISO allows us to spatially and spectrally isolate the emission towards the hot core. This survey will provide the best infrared measurements (to date) of molecular column densities and physical conditions, providing strong constraints on the current chemical network models for star forming regions. This survey will greatly enhance the inventory of resolved line features in the MIR, making it an invaluable reference to be used by the JWST and ALMA scientific communities.


13 μm
[Ne II]
780.3 780.4 780.5 780.6
Wavenumbers (cm-1)
19 μm
[S III]
534.30 534.35 534.40 534.45 534.50
Wavenumbers (cm-1)
Orion IRc2
ISO; R=1,500
Flux (Jy)
10000
1000
5 10 15 20 25
Wavelength (μm)
ISO
SOFIA Beam
ISO Beam
IRc2
SOFIA
[Si] 25.25 μm
VLSR (km/s)
SOFIA; R=60,000
Normalized Flux
1.0 0.8 0.6 0.4 0.2 0.0
13.24 13.26 13.28 13.30 13.32
Wavelength (μm)
13CCH2
C4H2
13CCH2
HCN
C4H2
13CCH2
HCN
C4H2
Atmospheric
Atmospheric
SOFIA
C3H3 13.282 μm
VLSR (km/s)