Goldschmidt 2023 Abstract
https://doi.org/10.7185/gold2023.16030

Observations of CO in Massive Young Stellar Objects and Inheritance in Protoplanetary Reservoirs

RACHEL L SMITH[1] AND ADWIN BOOGERT[2]

[1]NC Museum of Natural Sciences
[2]University of Hawaii
Presenting Author: Rachel.smith@naturalsciences.org

Astronomical observations using high-resolution, near-infrared, rovibrational spectroscopy of carbon monoxide (CO) toward young stellar objects (YSOs) and the determination of precise carbon and oxygen isotope ratios enable a meaningful evaluation of protoplanetary chemistry in a wide range of YSO environments. These data are significant in exploring early nebular processes that likely affected prebiotic and protoplanetary reservoirs in the solar nebula, in particular related to CO self-shielding and molecular inheritance from the parent cloud to the disk. Here we present our results for massive YSOs (> 8 M_{Sun} and ~10^4 to 10^5 L_{Sun}) as part of our ongoing study using NASA's IRTF observatory and the high-resolution *iSHELL* spectrograph (M band, 4.7 µm: *R*~88,000; K band, 2.3 µm: *R*~78,000). Spectra were obtained with optically thin $^{13}C^{16}O$, $^{12}C^{18}O$, and $^{12}C^{17}O$ (M band), and $^{12}C^{16}O$ (K band). Spectral lines were fitted with Gaussians, and optical depths were derived using mean line widths from $^{12}C^{18}O$ or optically thin $^{12}C^{16}O$ lines. Rotational analyses were used to determine total isotopologue column densities and integrated gas temperatures. Repeated observational epochs capture potential short-term variability in CO isotopologue abundances, which we have found in $^{12}C/^{13}C$ in some YSO targets. One of our recent observations includes the binary, MonR2 IRS3 (A,B) [Fig. 1], which has an extensive CO forest enabling oxygen isotopic evaluation, and is a valuable comparison to the isolated YSO MonR2 IRS2 evolving from the same parent cloud. Our results for oxygen are shown in Fig. 2, with repeated epochs indicated symbolically for certain targets. Signatures of CO self-shielding are found in the isolated YSO, MonR2 IRS2, and MonR2 IRS3 (B). CO self-shielding signatures are also found in an isolated, massive YSO with ionizing winds and a potential disk, and mass-dependent signatures are found in an evolved YSO. Together, these results support inheritance of CO self-shielding from the cloud to the disk, with chemical processing as the YSO evolves. Molecular inheritance is also consistent with our findings of $^{12}C/^{13}C$ variability, and supports recent nebular models. Our results further show that binaries may not evolve along the same chemical pathways, which has implications for protoplanetary chemistry within multiple-star systems.