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TITLE: Investigating Molecular Inheritance of Carbon in Star-forming Regions along a Galactic Gradient

ABSTRACT BODY:

Abstract Body: Observations of CO isotopologues taken at high spectral resolution toward young stellar objects (YSOs) are valuable tools for investigating protoplanetary chemical reservoirs, and enable robust comparisons between YSOs and solar system material (meteorites and the Sun). Investigating a range of YSO environments also helps parameterize variations in the distribution and evolution of carbon-based molecules, furthering an understanding of prebiotic chemistry. We have begun a wide survey of massive YSOs using Keck-NIRSPEC at high spectral resolution (R=25,000). Fundamental and first-overtone near-IR CO rovibrational absorption spectra have thus far been obtained toward 14 massive, luminous YSOs at Galactocentric radii (R_{GC}) ranging from ~4.5 to 9.7 kpc. From these data we can obtain precise [^{12}CO]/[^{13}CO] gas-phase abundance ratios along a Galactic gradient, and [^{12}CO]/[^{13}CO]$_{Gas}$ can be further evaluated against published [$^{12}CO_2$]/[$^{13}CO_2$]$_{Ice}$ and [^{12}CO]/[^{13}CO]$_{Ice}$; because all observations are in absorption, a robust study of molecular inheritance is possible by virtue of comparing ^{12}C/^{13}C along the same lines-of-sight. Initial results for cold CO gas at R_{GC} ~ 6.1 kpc and 9.4 kpc reveal [^{12}C^{16}O]/[^{13}C^{16}O] of 59+/−8 and 74+/−3, respectively, roughly following an expected ^{12}C/^{13}C Galactic gradient. Thus far, we find [^{12}CO]/[^{13}CO] in the cold CO gas to be lower than [$^{12}CO_2$]/[$^{13}CO_2$]$_{Ice}$, suggesting that CO_2 may not originate from CO reservoirs as often assumed. While very high-resolution observations of CO gas toward low-mass YSOs observed with VLT-CRIRES show significant heterogeneity in [^{12}CO]/[^{13}CO] at R_{GC} ~ 8 kpc, this dispersion is not found for the massive YSOs. Both the low-mass and massive YSOs have higher [^{12}CO]/[^{13}CO] in warm vs. cold gas, and both show signatures suggesting possible interplay between CO ice and gas reservoirs. Overall, our results indicate that carbon isotopic evolution in massive YSO environments may follow different paths compared to low-mass YSOs, and assumptions used in determining carbon-based molecular pathways should be considered in concert with robust observations of a range of YSO environments.

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