Observational Constraints for Pre-Solar Grains: Carbon and Nitrogen Isotope Ratios in Dying Stars

L.M. ZIURYS,[1,2] D.R. SCHMIDT[1] N.J. WOOLF[3], AND T.J. ZEGA[3]

[1] Department of Astronomy, University of Arizona, Tucson, AZ 85721 (lziurys@email.arizona.edu, nwoolf@email.arizona.edu, dschmidt@email.arizona.edu),
[2]Department of Chemistry and Biochemistry, University of Arizona, Tucson, AZ 85719
[3]Lunar and Planetary Lab, University of Arizona, Tucson, AZ 85721 (tzega@lpl.arizona.edu)

Isotopic studies of pre-solar SiC grains, particularly the $^{12}C/^{13}C$ and $^{14}N/^{15}N$ ratios, suggest that their origins cluster into several distinct classes, including Asymptotic Giant Branch (AGB) stars, J-type stars, novae, and supernovae. These classifications are based primarily on models of nucleosynthesis. In order to provide astronomical benchmarks for the origins of presolar SiC grains, we have been measuring $^{12}C/^{13}C$ and $^{14}N/^{15}N$ ratios in circumstellar envelopes of AGB and J-type stars, planetary nebulae, and supernovae remnants. These ratios have been obtained from millimeter observations of isotopically-substituted gas-phase molecules, obtained with radio telescopes. The high spectral resolution (1 part in 10^6) of radio astronomy enables a wide frequency separation between related isotopic species, making ratio determinations optimal. Molecules used for these isotopic diagnostics include CN, CO, HCN, HCO^+, and HNC. The $^{12}C/^{13}C$ and $^{14}N/^{15}N$ ratios obtained for the ordinary C-rich AGB stars are identical to those found in mainstream SiC grains, while those determined for J-type stars fall in the A + B sub-population. However, certain objects exhibit very low $^{12}C/^{13}C$ and $^{14}N/^{15}N$ ratios, classifying them as sources of novae grains. These sources are clearly not novae. Implications of these measurements will be discussed.