CIRCUMSTELLAR $^{12}C/^{13}C$ RATIOS DERIVED FROM MILLIMETER OBSERVATIONS OF CO AND CN: INSIGHT INTO NUCLEOSYNTHESIS ON THE GIANT BRANCHES

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A survey of the $^{12}C/^{13}C$ ratio towards circumstellar envelopes has been conducted at millimeter wavelengths using the telescopes of the Arizona Radio Observatory (ARO). These ratios were obtained for a sample of local AGB, Red Giant, and Supergiant stars from observations of the ^{12}C and ^{13}C isotopologues of CO and CN. The $1 \rightarrow 0$ transitions of both molecules were measured at 3 mm using the 12m telescope, while the $2 \rightarrow 1$ lines were obtained using the Submillimeter Telescope (SMT) at 1 mm. Ratios were established from CO using radiative transfer modeling, while the hyperfine structure was used to evaluate opacity effects in CN. For C-rich shells, the ratios fall in the range $^{12}C/^{13}C \sim$ 25-90, while the oxygen-rich AGB objects have values of 10-35. Ratios of $^{12}C/^{13}C \sim$ 3-14 are found for the Supergiant stars. A qualitative model has been constructed based on first and third dredge-up convective mixing that can reproduce the observed ratios. Substantial mixing of H-burning (i.e. CNO) products must occur to explain the ratios in the O-rich envelopes, while a wide range of $^{12}C/^{13}C$ values can be generated by only a few percent mixing of He-burning ashes in the carbon-rich case.