

Carbon Isotope Ratios in Molecular Clouds and Circumstellar Envelope from Millimeter

Observations of CN

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Observations of the $N=1 \rightarrow 0$ and $N=2 \rightarrow 1$ transitions of ^{12}CN and its ^{13}C isotopomer at 1.2 and 3 mm have been conducted towards both molecular clouds and the circumstellar envelopes of various types of stars, using the Kitt Peak 12 m antenna and the Sub-Millimeter Telescope (SMT) of the Arizona Radio Observatory. These observations have been used to establish $^{12}\text{C}/^{13}\text{C}$ ratios in these objects. CN is particularly useful in this regard, because its spectra exhibit substantial hyperfine structure, from which accurate opacities can be evaluated. Ratios have been determined towards W31, G29.9, G19.6, G49.2, G35.2, S156, and WB391, with $^{12}\text{C}/^{13}\text{C}$ values of 20.5, 62.8, 70.5, 47.8, 94.8, 77.6, and 134.5. In conjunction with past CN observations of Savage et al. (2002, ApJ, **578**, 211), these measurements suggest a $^{12}\text{C}/^{13}\text{C}$ gradient in the galaxy of $5.87D_{\text{GC}} + 15.2$. This gradient is close in value to that established from a grand average of these measurements, past CO and H_2CO observations. Towards carbon-rich AGB and post AGB stars (e.g. IRC+10216, CRL618, CRL2688, and IRC+40540), measurements suggest preliminary $^{12}\text{C}/^{13}\text{C}$ isotope ratios in the range of 20-76. Observations are currently being conducted towards Hydrogen-deficient, Supergiants, Li-rich, and typical Carbon stars. Ratios established in these objects will also be reported. This material is based upon work supported by the National Aeronautics and Space Administration through the NASA Astrobiology Institute under Cooperative Agreement No. CAN-02-OSS-02 issued through the Office of Space Science.