

Abundance Anomaly of the ^{13}C Isotopic Species of $\text{c-C}_3\text{H}_2$

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It has been reported that the $^{12}\text{C}/^{13}\text{C}$ ratios of several carbon-chain molecules in cold clouds are significantly higher than the interstellar elemental $^{12}\text{C}/^{13}\text{C}$ ratio of 60-70 [1]. For example, the $[\text{CCS}]/[^{13}\text{CCS}]$ ratio is reported to be 230 ± 130 [2], and the $[\text{CCH}]/[^{13}\text{CCH}]$ ratio is reported to be higher than 250 [3] in the cold starless core TMC-1 (Cyanopolyne Peak; CP). In addition, two or more ^{13}C species of a single molecular species have different abundances. For Instance, Takano et al. [4] found that the relative abundance ratio of H^{13}CCCN , HC^{13}CCN , and HCC^{13}CN is 1.0 : 1.0 : 1.4 in TMC-1 (CP).

We recently found the similar anomaly for $\text{c-C}_3\text{H}_2$ toward low-mass star-forming region L1527. Many lines of $\text{c-C}_3\text{H}_2$ and its ^{13}C species detected in the spectral line surveys with the NRO 45 m and the IRAM 30 m telescopes enable us to derive the $^{12}\text{C}/^{13}\text{C}$ ratios for the two ^{13}C species accurately.

For $\text{c-C}_3\text{H}_2$, attempting to fit these lines by one rotational temperature and one column density was not successful. We found systematic residuals in the fit. Then, we employ the two component model, assuming inner warm and outer cold regions. We calculated the $^{12}\text{C}/^{13}\text{C}$ ratio and found a systematic difference of the anomaly between them; the anomaly is mitigated in the inner region. This is the first indication of the variation of the $^{12}\text{C}/^{13}\text{C}$ ratio along star formation. This result suggests that the anomaly can be used as a new diagnostic tool for physical and chemical evolution of protostellar cores.

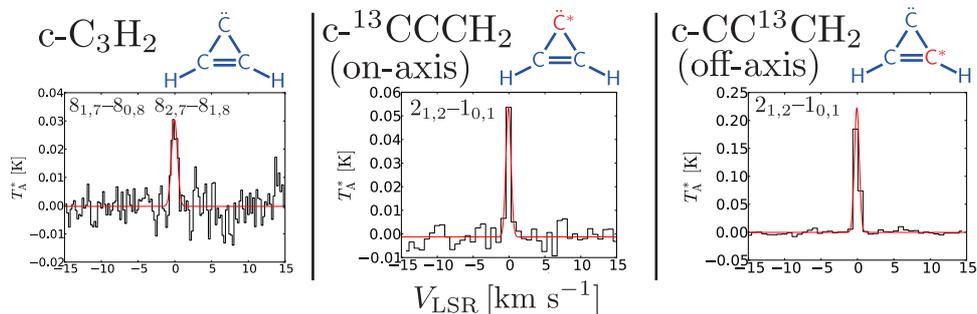


Figure 1: Spectral lines of $\text{c-C}_3\text{H}_2$ and its ^{13}C species observed toward L1527.

References

- [1] Lucas, R. & Liszt, H. 1998, A&A, 337, 246.
- [2] Sakai, N. et al, 2007, ApJ, 663, 1174.
- [3] Sakai, N. et al. 2010, A&A, 512, A31.
- [4] Takano, S. et al. 1998, ApJ, 329, 1159.