Exploring Molecular Complexity in the Low-Metallicity ISM

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The Large Magellanic Cloud (LMC) provides a key laboratory for exploring the diversity of star formation and interstellar chemistry under subsolar metallicity conditions*. We here present the results of a hot core** survey toward 30 massive protostellar objects in the LMC using ALMA at 350 GHz [1]. Continuum imaging reveals 36 compact sources in total, among which line analyses identify 9 hot cores and 1 hot-core candidate. We detect CO, HCO^+, $H^{13}CO^+$, $HC^{15}N$, HC_3N, SiO, SO, SO^+, NS, SO_2, $^{34}SO_2$, $^{33}SO_2$, CH_3OH, $^{13}CH_3OH$, HCOOH, $HCOOCH_3$, CH_3OCH_3, C_2H_5OH, and hydrogen recombination lines from hot cores. All hot cores show stronger emission in a high-excitation SO line compared to non-hot-core sources, suggesting that its strong detection can serve as a useful hot-core tracer in the LMC. Chemical analysis reveals a spread of more than two orders of magnitude in CH_3OH abundances, with some sources deficient in complex organic molecules. In contrast, SO_2 is detected in all hot cores, and its abundance shows a good correlation with rotational temperature. The hot cores without CH_3OH detections are all located outside the LMC's bar region, where the metallicity is thought to be relatively low. These CH_3OH-poor hot cores also exhibit either high luminosity or active star formation in their surroundings. We speculate that a combination of locally low metallicity, active star formation in the vicinity, and high protostellar luminosity may jointly trigger the CH_3OH-poor hot core chemistry observed in some LMC protostars.

Note.
*Understanding the chemical evolution of the ISM in low-metallicity environments is important for unveiling the physical and chemical processes in past Galactic environments and in high-redshift galaxies, where the metallicity was significantly lower compared to the present-day solar neighborhood (see e.g., [2])

**Hot molecular cores are one of the early stages of star formation, and they play a key role in the chemical processing of interstellar molecules, especially for complex organic molecules.

References

[1] T. Shimonishi et al., submitted
[2] T. Shimonishi, 2025, to be published in the proceedings of the IAU Symposium 383, arXiv: 2411.04451