Observations of a hot molecular core in a nearby low metallicity galaxy

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Because cosmic metallicity is increasing in time with the evolution of our universe, interstellar chemistry in low metallicity environments is crucial to understand chemical processes in the past universe. Hot molecular cores are one of the early stages of high-mass star formation and they are one of the key astronomical objects to investigate complex gas-grain chemistry in dense interstellar medium. Gaseous molecules and atoms are frozen onto dust grains and experience grain surface chemistry in cold molecular clouds. As the core is heated by star-formation activities, reactions among heavy species become active on grain surfaces to form larger molecules, and various molecular species are released into the gas-phase in a warm and dense hot core region.

The Large Magellanic Cloud (LMC) is an excellent target to study chemistry in different metallicity environments thanks to its proximity (~50 kpc) and low metallicity (about one third of the solar neighborhood). However, observations of hot cores have been limited to Galactic sources due to lack of spatial resolution and sensitivity of radio telescopes.

Here we report the first detection of a hot molecular core outside our Galaxy based on radio observations with ALMA toward a high-mass young stellar object (YSO) in the LMC (Shimonishi et al. 2016, submitted). Molecular emission lines of CO, $C^{17}O$, HCO^+, $H^{13}CO^+$, H_2CO, NO, SiO, H_2CS, ^{33}SO, $^{32}SO_2$, $^{34}SO_2$, and $^{33}SO_2$ are detected from a compact region (~0.1 pc) associated with a high-mass YSO, ST11. The temperature of molecular gas is estimated to be higher than 100 K based on rotation diagram analysis of SO_2 and $^{34}SO_2$ lines. The compact source size, warm gas temperature, high density, and rich molecular lines around a high-mass protostar suggest that ST11 is associated with a hot molecular core.

We find that the molecular abundances of the LMC hot core are significantly different from those of Galactic hot cores. The abundances of CH_3OH, H_2CO, and HNCO are remarkably lower compared with Galactic hot cores by at least 1--3 orders of magnitude. In contrast, it is interesting that NO shows the higher abundance in ST11 than in Galactic counterparts despite the notably low abundance of elemental nitrogen in the LMC. We suggest that these abundances are characterized by the deficiency of molecules whose formation requires the hydrogenation of CO on grain surfaces. The observed characteristic chemical compositions of the LMC hot core are consistent with warm ice chemistry, which is suggested in previous infrared observations of ices in the LMC (Shimonishi et al. 2016).

In this presentation, we discuss physical and chemical characteristics of a hot molecular core in the LMC, particularly focusing on importance of grain surface chemistry on chemical processing in metal-poor environments.