Deuterium Fractionation in the Earliest Stages of High-Mass Star Formation

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High-mass stars release a huge amount of energy to interstellar space by outflows, UV radiation, stellar winds and supernovae, so that high-mass stars play important roles in evolution of galaxies. Understanding high-mass star formation is one of the most important issues for astronomy. For the purpose, it is crucial to understand the initial conditions, because expected initial conditions are different among the current proposed models of high-mass star formation (turbulent core accretion model and competitive accretion model). To investigate the initial conditions of high-mass star formation, we focus on the deuterium fractionation of molecules.

Recently, we conducted a molecular line survey, including DNC J=1-0 and $HN^{13}C$ J=1-0, toward the candidates of high-mass starless clumps, which were recently identified by Herschel observations (Traficante et al. 2015), by using the Nobeyama Radio Observatory 45 m telescope. Then, we found that there is diversity of DNC/HNC ratio among the observed sources, although the temperature of the sources is as low as about 10 K. By comparing the observational results with the chemical model calculation results, we suggest that the diversity of DNC/HNC ratio could be due to the diversity of the formation timescale of dense cores.

In addition, we investigate how the chemical composition of hot cores depends on the initial physical conditions. We compared the chemical composition of the hot core in the Infrared dark cloud G34.43+00.24 MM3 (T. Sakai et al. 2013) with that of the other hot cores. Then, we found that the D_2CO/CH_3OH abundance ratio of the G34.43+00.24 MM3 hot core is higher than that of the Orion KL hot core. We suggest that the difference in D_2CO/CH_3OH ratio is due to the difference in the initial conditions (i.e. timescale of cold starless phase). We also discuss how the abundances of complex organic molecules in hot cores depend on the initial physical conditions.

References

[1] Traficante et al. 2015, MNRAS, 451, 3089.
[2] T. Sakai et al. 2013, ApJ, 775, L31.