

Abundant CH₃OH in the Cold Starless Core TMC-1

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Methanol (CH₃OH) is generally abundant in star-forming regions [1][2]. It is thought to be produced mainly on grain mantles, and is released into the gas phase by various star-formation activities. Since its abundance is apparently enhanced in the shocked region such as L1157B1 [3][4][5], CH₃OH is sometimes used as a shock tracer. However, CH₃OH is moderately abundant even in cold starless cores like Taurus Molecular Cloud-1 (TMC-1) ($T_k \sim 10$ K), although no heating sources are embedded there. Since evaporation temperature of CH₃OH is about 100 K, existence of CH₃OH in TMC-1 is puzzling. While the production pathway in the gas phase is proposed [6], it cannot explain the observed abundance of CH₃OH in TMC-1.

Recently, we have conducted high velocity-resolution observations of CH₃OH in TMC-1. We have found that the line shape of CH₃OH is much different from those of other carbon chain molecules toward TMC-1 (Cyanopolyne Peak; CP), which indicates different distribution of these two species in the core. We have also conducted mapping observations of CH₃OH ($J_k = 2_k - 1_k$), C³⁴S ($J = 2-1$) and C¹⁸O ($J = 2-1$) in the 150'' \times 150'' area around TMC-1 (CP), and revealed that the distribution of CH₃OH is anticorrelated with that of C³⁴S. This difference would be an important clue to understand the mechanism for production of CH₃OH in TMC-1.

We are considering two possible mechanisms for desorption of CH₃OH from grain mantles in starless cores. One is soft shock caused by collisions of small clumps inside the core and/or accretion motions of envelope materials onto the core, whereas the other is desorption by cosmic-ray induced UV. In any case, the distribution of CH₃OH would not follow the distribution of the dense gas (CS), being consistent with our observation. It therefore seems likely that the molecular composition in the gas phase would significantly be affected by non-thermal desorption processes of grain mantles in starless cores.

References

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