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Molecular Line Observations of Chemically Young Dark Cloud Cores

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Abstract. In order to understand initial conditions of low-mass star formation, it is essential to study dark cloud cores in the early evolutionary stage. For the purpose of this, we carried out mapping observations with various molecular lines in quiescent starless cores L1521E, L1521B, and L1495B (Hirota et al. 2002, 2004), which are known to be rich in carbon-chain molecules like the cyanopolyyne peak of TMC-1 and hence, called "carbon-chain-producing regions" (Suzuki et al. 1992). The important results of our studies are as follows; (1) there exist compact dense cores traced by the $H^{13}CO^+$, $HN^{13}C$, CCS, C_3S, and HC_3N lines, and their distributions have a single peak at the same position; (2) the distribution of CCS in these cores are different from those in well-studied starless cores such as L1544, where the distribution of CCS shows a shell-like structure; (3) although the H_2 densities are as high as 10^5 cm^{-3} at the peak position of these cores, the spectral lines of NH_3 and N_2H^+ are found to be very faint, indicating the low NH_3 and N_2H^+ abundances; (4) abundances of carbon-chain molecules in these cores are systematically higher than those in the other dark cloud cores, and especially the abundances of sulfur-bearing carbon-chain molecules C_nS are comparable to those in cyanopolyyne peak of TMC-1; (5) longer carbon-chain molecules such as HC_5N and C_4H are more abundant in TMC-1 than in L1521E, L1521B, and L1495B while those of sulfur-bearing molecules such as $C^{34}S$, CCS, and C_3S are comparable; (6)the deuterium fractionation ratios of DNC/HNC and DCO^+/HCO^+ are systematically lower in L1521E, L1521B, and L1495B than in the other dark cores (Hirota et al. 2001, 2003); (7)there exist neither *IRAS* point sources, evidence of molecular outflows, nor signature of infall motions in these cores. All these characteristic features suggest that L1521E, L1521B, and L1495B would be in the early stage of dynamical and chemical evolution, and the depletion factor of heavy atoms are possibly lower than in other evolved cores (e.g. Tafalla & Santiago 2004; Crapsi et al. 2005).

Although detailed studies on carbon-chain-producing regions are important for understanding of chemical and physical evolution of dense cores, only four carbon-chain-producing regions were identified in Taurus Molecular Cloud. In order to search for other carbon-chain-producing regions other than in Taurus Molecular Cloud, we carried out a survey of CCS, HC_3N, and HC_5N toward 31 dark cloud cores. As a result, we detected a possible candidate for another carbon-chain-producing region L492. According to our follow-up observations of various molecular lines toward L492, we found that the abundances of carbon-chain molecules such as CCS, C_3S, HC_3N, HC_5N, and HC_7N are comparable to those in TMC-1, L1521E, L1521B, and L1495B. In addition, the deuterium fractionation of DNC/HNC and DCO^+/HCO^+ are also comparable to those in TMC-1, L1521E, L1521B, and L1495B, and are significantly smaller than that in the evolved prestellar cores such as L1544 (e.g. Crapsi et al. 2005). On the other hand, the NH_3 and N_2H^+ lines are also detected and their abundances are systematically higher than those in TMC-1, L1521E, L1521B, and L1495B. Our mapping observations reveal that the central hole of molecular distributions, which were reported for CCS and $C^{34}S$ in L1544, are not significant in L492, except for the 7_6-6_5 line of CCS, indicating that the depletion factor of molecules are not very high in L492. The molecular abundances and distributions in L492 suggest that chemical evolutionary stage of L492 is younger than L1544 and is comparable to or slightly older than

TMC-1, L1521E, L1521B, and L1495B. However, L492 is dynamically more evolved than TMC-1, L1521E, L1521B, and L1495B, and rather close to be in dynamically collapsing like L1544 (Lee et al. 1999; Crapsi et al. 2005). Therefore, it is probable that chemical and dynamical evolutionary timescale is different from source to source (e.g. Taurus and Aquila lift).

Keywords. ISM: abundances, ISM: clouds, ISM: individual (L1521E, L1521B, L1495B, L492), ISM: molecules

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References

Crapsi, A., Caselli, P., Walmsley, C. M., Myers, P. C., Tafalla, M., Lee, C. W., & Bourke, T. L. 2005, ApJ, 619, 379

Hirota, T., Ikeda, M., & Yamamoto, S. 2001, ApJ, 547, 814

Hirota, T., Ikeda, M., & Yamamoto, S. 2003, ApJ, 594, 859

Hirota, T., Ito, T., & Yamamoto, S. 2002, ApJ, 565, 359

Hirota, T., Maezawa, H., & Yamamoto, S. 2004, ApJ, 617, 399

Lee, C. W., Myers, P. C., & Tafalla, M. 1999, ApJ, 526, 788

Suzuki, H., Yamamoto, S., Ohishi, M., Kaifu, N., Ishikawa, S., Hirahara, Y., & Takano, S. 1992, ApJ, 392, 551

Tafalla, M. & Santiago, J. 2004, A&A, 414, L53