Spectral Line Survey toward Spiral Arm in Nearby Galaxy M51

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For a thorough understanding of the galactic star formation history, one of the key issues is formation and evolution of giant molecular clouds (GMCs) and giant molecular associations (GMAs), because they are intermediate structure connecting the galactic structure and individual star formation. We are going to investigate the evolutionary history and the physical states of GMCs on the basis of their chemical compositions. As the first step, we have conducted an unbiased spectral line survey toward a spiral arm in M51 to grasp the averaged chemical composition of GMCs.

M51 (d = 8.4 Mpc) is a well-studied nearby galaxies for star formation and gas dynamics (*e.g.* Koda et al. 2009), because it has a prominent spiral arm and a plenty of molecular gas in a disk. The observed frequency ranges are 83-116 GHz and 130-146 GHz (Figure 1). We detected 17 molecular species (c-C_3H_2, CCH, HNCO, HCN, $H^{13}CN$, HCO^+, HNC, N_2H^+, CH_3OH, CS, $C^{34}S$, SO, $C^{18}O$, ^{13}CO, CN, $C^{17}O$ and ^{12}CO) in the 3 mm band, and 4 molecular species (HNCO, H_2CO, CH_3OH and CS) in the 2 mm band. It is remarkable that CCH, HNCO, CH_3OH, N_2H^+, CN, and H_2CO, which are unfamiliar in observations of extra-galaxies except for those toward the nuclear region of the starburst galaxies and AGNs, are detected in the spiral arm region. The spectrum pattern is much different from that found in massive star forming regions like Orion KL (*e.g.* Tercero et al. 2011), indicating that the observed chemical composition cannot simply be interpreted in terms of the sum of contributions from embedded star forming cores. We will present the chemical compositions of M51 and comparisons them with other galactic and extra-galactic sources.

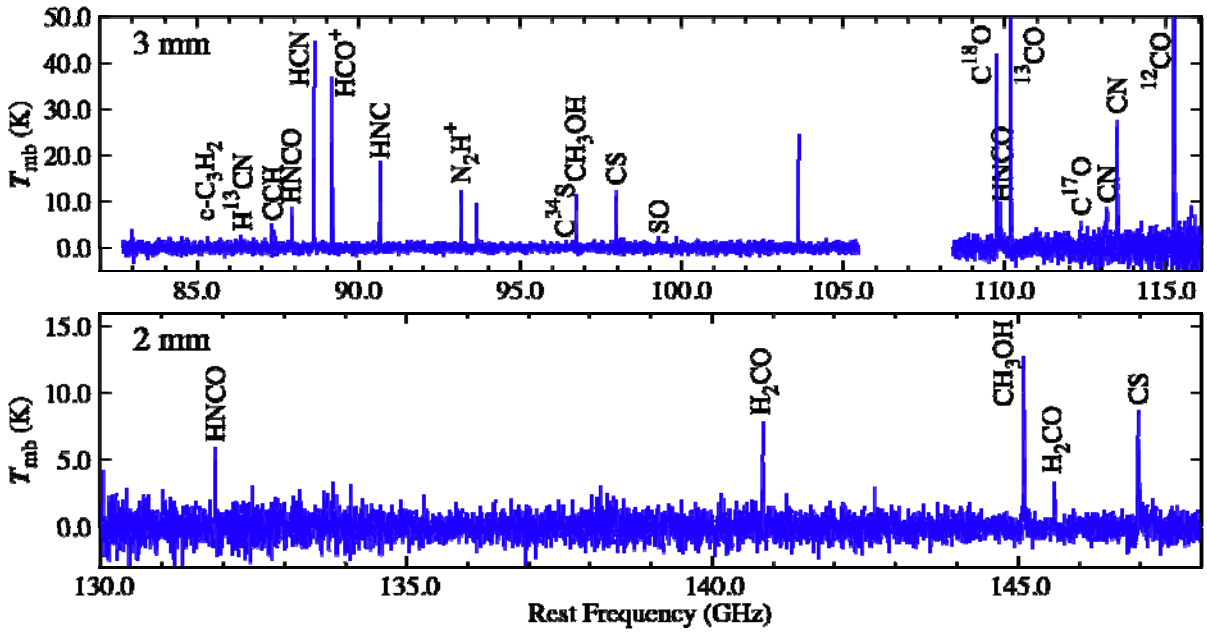

Figure 1: Spectrum of a spiral arm in M51 (upper: 3 mm band, lower: 2 mm band).

References

[1] Koda et al. 2009, ApJL, 700, 132
[2] Tercero et al. 2011, A&A, 528, 26 .