Distribution of Molecules in Spiral Arm of M51

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Recently, chemistry of external galaxies has attracted more attention of astronomers than before, because various molecular species become readily detected in nearby galaxies owing to rapid increase of sensitivity in radioastronomical observations. In general, chemical compositions observed toward external galaxies are `average' chemical compositions of a number of giant molecular clouds (GMCs). The GMC-scale chemical compositions are mostly in chemical equilibrium, and mainly depend on structures and environmental conditions of GMCs. Therefore, they cannot directly be discussed on the basis of astrochemical concepts established in nearby molecular clouds in our Galaxy. If the physical meaning of the GMC-scale chemical compositions is adequately established by observational and theoretical studies, we can make use of it as a new tracer to diagnose external galaxies.

With this motivation, we have carried out the spectral line survey toward the spiral arm of M51 with the IRAM 30 m telescope and detected 13 molecular species (Watanabe et al. 2014). The excitation temperatures of the molecules are estimated to be less than 10 K toward P1. Therefore, most of detected molecules would reside in a cold (~10 K) and widespread molecular gas, although a part of molecular emissions may also come from the hot molecular gas. Based on this spectral line survey, we conducted mapping observation of CH_3OH, CS, CN, HNCO, $C^{18}O$ and ^{13}CO with the CARMA interferometer. These molecules are successfully imaged with sufficient signal-to-noise ratios. Although the CO isotopologues traces spiral arm structure, we can see significant difference of the other distributions from molecule to molecule. These differences would be originated from the environment around GMCs or the dynamics in the spiral arm such as cloud-cloud collisions.

References

[1] Watanabe, Y. et al. ApJ, 788, 4