Abstract

The purpose of this thesis is to understand how the physical properties of giant molecular clouds (GMCs) and their ability of star formation vary with galactic environments. We focus on the influence of surface density of gas (Σ_{H_2}) and dynamics of bar structure.

In the first part of this thesis, relation of molecular gas and SFR is investigated in terms of Kennicutt-Schmidt law (K–S law). ^{12}CO (1–0) and optically thin ^{13}CO (1–0) are independently used to derive Σ_{H_2} of IC 342. ^{12}CO-to-H_2 conversion factor is calibrated with metallicity and CO intensity for entire galaxy. Σ_{H_2} is also derived with the standard derivation of ^{13}CO-base column density. Slopes of K–S law are found to be ~ 1.4 at the low-Σ_{H_2} regions ($\leqslant 100$ $M_\odot$ pc^{-2}), while it becomes $\sim$2.0 in the high-Σ_{H_2} regions ($\geqslant 100$ $M_\odot$ pc^{-2}). The variable slopes attributed to the different star forming mechanisms. In the spiral arm (low-Σ_{H_2} regions), star formation is induced by the gravitational instability. At the central region of the galaxy where Σ_{H_2} is high, K–S law suggests that the star formation is triggered by cloud-cloud collisions or a self-regulated star formation. Our results of IC 342 are confirmed with similar analysis in 15 galaxies. Hence, the non-universal K–S law is common in galaxies. Besides, how molecular gas been collected into a region is a key factor in controlling the degree of star formation activity. This issue is addressed further in terms of galactic dynamics in the next project.

The aim of the second project is to explore the role of galactic bar in regulating GMC properties and star formation. High resolution (100 pc) ^{13}CO (1–0) map in the bar and central region of NGC 6946 is created by single dish and interferometer observations. An asymmetric bar is seen in the map, that is, the northern bar shows a typical gas distribution of a bar, whereas the morphology of the southern bar is unclear. The strong bar (northern bar) is warmer and denser than the weak (southern) bar. Star formation efficiency (SFE) has been enhanced in the strong bar. Moreover, based on the analysis of the position-velocity diagrams, the strong bar is ongoing larger velocity jumps (shocks) across the bar. We compare the resolved GMCs properties of the strong, weak bar, and the galactic disk of NGC 6946. We found that GMCs properties are similar in the weak bar and galactic disk. However, for the GMCs with equivalent masses, GMCs in the strong bar are more compact and denser than other areas. Consequently, they have shorter free-fall time and higher SFE. We compile GMC data from literature, and compare the GMCs properties of NGC 6946 with that of other nearby galaxies. The compact GMCs are found in the high-SFE environments, such as the Antennae galaxies, Galactic center, and the inner disk of spiral galaxies. The formation of those compact GMCs may be an outcome of their high external pressure environments.