Molecular Gas Fraction in Interacting Galaxies in Early and Mid Stage Using ^{12}CO(J = 1–0) Mapping Observations

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Galaxy interactions play an important role on galaxy evolution. An enhancement of infrared luminosity has been observed from interacting galaxies, meaning that star formation activity is enhanced during the galaxy interaction. However, the detailed mechanism of this phenomena is still unknown. Since molecular gas is a fuel of star formation, it is important to understand how molecular gas is affected through an interaction event for revealing the interaction-induced star formation in interacting galaxies.

We previously have discovered the molecular gas distributions for four interacting galaxies in early and mid stage by mapping observations of ^{12}CO(J = 1–0) emission line with the Nobeyama 45-m radio telescope [1]. Molecular gas distributions are different from atomic gas and stellar distributions: they are not concentrated to their centre of progenitors compared with isolated galaxies. This fact suggests that physical properties of molecular gas is affected even at the beginning of the interaction.

In order to inquire detailed effects onto molecular gas by the interaction, we investigate global molecular gas fraction $f_{\rm mol}^{\rm global}$, which is defined as

$$f_{\rm mol}^{\rm global} = \frac{M_{\rm H2}}{M_{\rm total}}, \quad (1)$$

where $M_{\rm H2}$ and $M_{\rm total}$ are molecular gas and total gas (a sum of molecular gas and atomic gas) mass of the galaxy, respectively. We find that the global molecular gas fraction for interacting galaxies is significantly higher than isolated galaxies, implying the conversion from atomic gas to molecular gas by the interaction.
We further derive local molecular gas fraction $f_{\rm mol}$. $f_{\rm mol}$ is expressed by the following equation:

$$f_{\rm mol} = \frac{\Sigma_{\rm H2}}{\Sigma_{\rm total}}, \quad (2)$$

where $\Sigma_{\rm H2}$ and $\Sigma_{\rm total}$ are the surface density of molecular gas and total gas, respectively. Figure 1 shows $f_{\rm mol}$ distributions for four target interacting galaxies. All interacting systems illustrate complex $f_{\rm mol}$ distributions, while an isolated galaxy has a $f_{\rm mol}$ peak at the galactic centre and $f_{\rm mol}$ decreases with an increase of radius. In order to investigate how these distributions achieved, we perform theoretical model fitting based on [2]. Following the failure of the fitting, we include a new term representing external pressure to the original model. Our new model successfully explains the observed $f_{\rm mol}$–$\Sigma_{\rm total}$ relations. We conclude that higher molecular gas fraction in interacting galaxies is achieved efficient conversion from atomic gas to molecular gas which is by high external pressure. The molecular gas produced through this process may be an ingredient of active star formation in interacting galaxies [3].

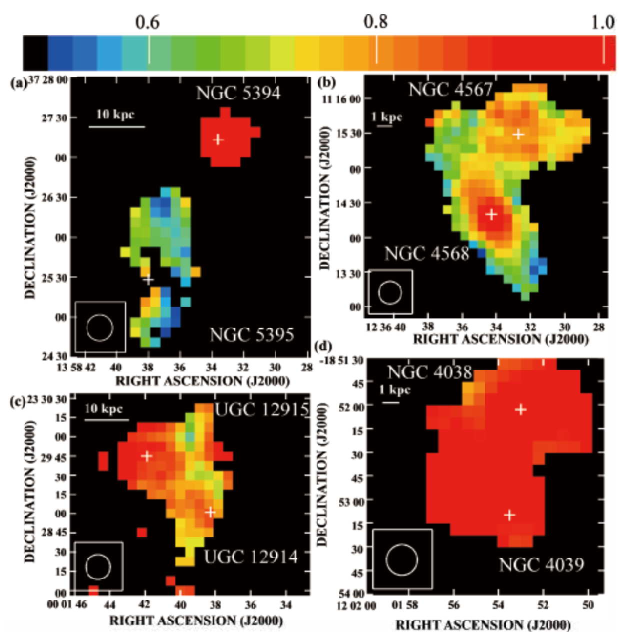

Figure 1: Local molecular gas fraction $f_{\rm mol}$ for four target interacting galaxies.

References

[1] Kaneko, H., et al.: 2013, *PASJ*, **65**, 20.
[2] Elmegreen, B. G.: 1993, *ApJ*, **411**, 170.
[3] Kaneko, H., et al.: 2017, *PASJ*, **69**, 66.