

Gas density histograms of galaxies: the observational density probability function of the interstellar gas density

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Abstract. In the steady state, the probability density function (PDF) of the gaseous interstellar matter (ISM) can be observed as a gas density histogram (GDH) of all cells in the system. We made GDHs of the Milky Way Galaxy (MWG) using Galactic plane surveys in CO lines. We found that the GDH in the MWG is log-normal which suggests that the density structure of the molecular gas is a result of many stochastic processes. Using the Nobeyama CO atlas, we made GDHs of nearby galaxies but in column density. Although some galaxies show log-normal, the others show completely different shapes, suggesting that the density structure of galaxies may be different from galaxy to galaxy.

Keywords. ISM: molecules, ISM: structure, galaxies: ISM

The PDF of the gas density is one of keys to address the origin of density structure of the ISM. In the steady system, PDF can be observed as a GDH of all cells in the system. Using the large survey data we made GDHs of the Milky Way Galaxy (MWG) and nearby galaxies. Using the AMANOGAWA-2SB survey in ¹²CO (2-1) & ¹³CO (2-1) (Yoda *et al.* 2010; Handa *et al.* 2013) and the CO (1-0) survey (Dame *et al.* 2001), we made that the GDH of molecular gas in the MWG. All of them are log-normal and the peak of the GDH is about $10^{-1.9} M_{\odot} \text{pc}^{-3}$. The shape of the derived GHD is less affected by models and parameters used. It suggests that the density structure of the molecular gas in the galactic disk of the MWG is a result of many stochastic processes each of which modifies the gas density randomly (Vazquez-Semadeni 1994). Using the Nobeyama CO atlas of nearby galaxies (Kuno *et al.* 2007), we made their GDHs of the column density instead of the volume density. Some galaxies show log-normal like the MWG. However, the others show completely different shapes. These results suggest the major process to make the density structure of ISM is different from galaxy to galaxy. We can address it using the GDH, although we do not know what causes the difference at present.

References

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