The Universe at Low Radio Frequencies
IAU Symposium, Vol. 199, 2002
A. Pramesh Rao, G. Swarup and Gopal-Krishna, eds.

A Galactic Plane Survey in the CO (2-1) Line with the 60 cm Telescopes to address Physical Condition of the Interstellar Matter

T. Handa[1], T. Hasegawa[1], J.I. Morino[1], T. Sawada[1], S. Sakamoto[2], K.S. Usuda[3], A. Luna[4], L. Bronfman[5] and M. Hayashi[2]

[1] *University of Tokyo, Mitaka, Tokyo 181-8588, Japan*
[2] *Nobeyama Radio Observatory, Japan*
[3] *National Astronomical Observatory, Japan*
[4] *National Institute of Astrophysics, Optics and Electronics, Mexico*
[5] *University of Chile, Chile*

Abstract. To address its temperature and density we made observations of the galactic plane in CO (2-1) line with VST1 and VST2. Using a kinetic model we estimate the volume emissivities and the line intensity ratio as a function of galactocentric radius. Using data in the first and 4th quadrants separately we got shallow gradient in the both quadrants; at the smaller radius is the higher in ratio. The gradient is contributed by less bright pixels in the l-v diagram, suggesting molecular gas in interarm is different along the galactocentric radius but in arm is not.

1. Introduction

In galactic radio astronomy at low frequency diffuse ionized gas and HI are two important objects. Although molecular gas is proved at millimeter wavelength, it physically interacts with interstellar matter in other phases proved at low frequency. Therefore, to understand an actual image of interstellar matter observations to address physical condition of molecular gas is also required.

The primary indicator of physical condition of molecular gas is the line intensity ratio of CO (2-1) to CO (1-0). It is because CO is the most sensitive prove to detect molecular gas and comparison between lines of the same molecular species directly reflects physical parameters of the gas without any chemical abundance problems.

2. Observations

To make a comparison to the Columbia-Calan CO (1-0) survey (Cohen et al. 1986, Bronfman et al. 1988) we made CO (2-1) survey using the specially designed twin 60 cm telescopes, VST1 and VST2, which are located at Nobeyama, Japan, and at La Silla, Chile, respectively. The beamsize and sampling grid are the same as the Colombia-Calan survey in CO 1-0, which minimize ambiguity from intensity distribution structure.

https://doi.org/10.1017/S0074180900169256 Published online by Cambridge University Press

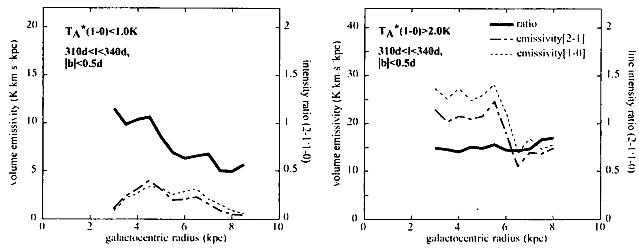

Figure 1. The line intensity ratios along the galactocentric distance. Dim pixels with $Ta^* \leq 1$ K in the longitude-velocity diagram shows gradient (left) but bright pixels with $Ta^* \geq 2$ K do not (right).

The 1st and 4th quadrant surveys cover $20° \leq l \leq 60°, -1° \leq b \leq +1°$, and $300° \leq l \leq 340°, -0.5° \leq b \leq +0.5°$, respectively. The beamsize is 9' and sampling grid is 0.25°in both surveys. In the 4th quadrant typical rms noise level is 0.35 K with 5 km s^{-1} resolution.

Using a simple kinetic model of the Galaxy, totally flat and circular rotation, we estimate line luminosities per volume (the volume emissivity) in both lines as a function of galactocentric radius. The ratio of the volume emissivities in both lines shows an averaged property of molecular gas in the sampling volume.

In the 1st quadrant Sakamoto et al. (1997) found a systematic gradient in the ratio which shows the higher ratio at the smaller radius. Handa et al. (1999) found the same trend in the 4th quadrant, although the ratio in the 4th quadrant is systematically higher than in the 1st quadrant.

Using the data in the 1st quadrant Sakamoto et al. (1997) shows a systematic change of the population of pixels with the high and low ratio. In the 4th quadrant the ratio averaged over the same brightness pixels in the l-v diagram shows systematic correlation and the less bright pixels show the larger dispersion in ratio after considering intensity fractuation due to random noise (Handa et al. 1999).

Galactocentric distributions of the ratio using pixels with different brightness suggest the origin of the gradient. Figure 1 shows the galactocentric distributions of the ratio only using dim and bright pixels separately. It shows the dim pixels show gradient but the bright pixels do not.

In the l-v diagram major spiral arms are traced by bright pixels. The different trends of the ratio for dim and bright pixels suggest molecular gas in interarm is different along the galactocentric radius but in arm is not.

References

Bronfman L., et al. (1988), ApJ, 324, 248

Cohen R.S., et al. (1986), ApJS, 71, 695

Handa T., et al. (1999), in "New Perspectives on the Interstellar Medium", ASP conference series, 168, 399

Sakamoto S. et al. (1997), ApJ, 486, 276

https://doi.org/10.1017/S0074180900169256 Published online by Cambridge University Press