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AMANOGAWA-2SB survey: a northern galactic plane survey in ^{12}CO ($J = 2-1$) and ^{13}CO ($J = 2-1$) with the Amanogawa telescope

Toshihiro Handa[1], Takahiro Yoda[2], Kotaro Kohno[3], Taku Nakajima[4], Jun-ichi Morino[4], Yoshinori Yonekura[5], Hideo Ogawa[6], Kimihiro Kimura[6] and Kazuhiro Dobashi[7]

[1]Depart. Astron. & Phys., Kagoshima Univ., Korimoto 1-21-35, Kagoshima 890-0065, Japan; email: handa@sci.kagoshima-u.ac.jp; [2]Yamanashi Gakuin highschool, [3]University of Tokyo, [4]National Astronomical Observatory of Japan, [5]Ibaraki University, [6]Osaka Prefecture University, [7]Tokyo Gakugei University

Abstract. We performed ^{12}CO($J = 2-1$) and ^{13}CO($J = 2-1$) line surveys of the galactic plane using the AMANOGAWA telescope (Nakajima *et al.* 2007) which covers $5^\circ \leqslant l \leqslant 180^\circ$ on a 7'.5 grid. The telescope beamsize and velocity resolution are $8.7' \pm 0.4'$ and 1.3 km s^{-1}. The resultant rms noise level is typically 0.12 K in $T_{\rm A}^*$. We found a linear correlation between ^{12}CO($J = 2-1$) and ^{12}CO($J = 1-0$) and a curved correlation between ^{12}CO($J = 2-1$) and ^{13}CO ($J = 2-1$), although the intensity ratios of these three lines have intrinsic variation. These correlations can be reproduced with simple radiative transfer equations suggesting some restrictions on the physical quantities of molecular gas on a galactic scale.

Keywords. surveys — ISM: molecules — Galaxy: disk

We performed ^{12}CO($J = 2-1$) and ^{13}CO($J = 2-1$) line surveys of the galactic plane. After a shallow survey toward the galactic equator (Yoda *et al.* 2010), we extended the observed area. The telescope beamsize and velocity resolution are the same as the survey in ^{12}CO($J = 1-0$) of Dame *et al.* (2001) (see abstract for details). Using the data toward $b = 0^\circ$ and $l \leqslant 90^\circ$, we found two relations in the CO line intensities which are present in the majority of the data. One is a linear correlation between ^{12}CO($J = 2-1$) and ^{12}CO($J = 1-0$). The averaged ratio is $R_{2-1/1-0} = 0.640 \pm 0.058$, although there is large intrinsic dispersion. This implies that the total CO emission in the Milky Way Galaxy comes from subthermally excited gas. This ratio allows us to use the conversion factor between CO($J = 2-1$) line intensity and H_2 column density as $X_{\rm CO(2-1)} = 2.8 \times 10^{20}$ km s^{-1} K^{-1} and the the CO(1-0)-H_2 conversion factor of $X_{\rm CO(1-0)} = 1.8 \times 10^{20}$ km s^{-1} K^{-1} (Dame *et al.* 2001). The other relation is a curved correlation between ^{12}CO(J=2-1) and ^{13}CO ($J = 2-1$). A simple opacity effect without beam dilution cannot reproduce the relation. For an interpretation of the data, we use a toy model based on simple radiative transfer and two assumed linear relations; $\frac{\eta_{13} T_{13}}{\eta_{12} T_{12}} = \alpha$ and $\eta_{13} T_{13} = \beta \tau_{13}$. We can reproduce the curve between ^{12}CO and ^{13}CO line intensities, when (α, β) ranges from $(0.3, 0.7{\rm K})$ to $(0.5, 2.8{\rm K})$; the best fit is given at $(0.4, 1.3{\rm K})$.

References

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