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THE CO(J=2–1)/CO(J=1–0) LUMINOSITY RATIO IN THE ORION GIANT MOLECULAR CLOUDS

Seiichi SAKAMOTO,[1] Tetsuo HASEGAWA,[2] Masahiko HAYASHI,[1] Toshihiro HANDA,[2] and Tomoharu OKA[1]

[1] *Department of Astronomy, University of Tokyo, Bunkyo-ku, Tokyo 113, Japan*
[2] *Institute of Astronomy, University of Tokyo, Mitaka, Tokyo 181, Japan*

ABSTRACT. The first results of large-area mapping observations of nearby giant molecular clouds in the CO(J=2–1) emission are presented. The CO(J=2–1)/CO(J=1–0) luminosity ratio is 0.75 and 0.62 for the Orion A and B clouds, respectively. These values are consistent with those observed typically in disks of galaxies (~0.6), and are significantly lower than large values ($\gtrsim$1) often observed in active star-forming regions in galaxies. Active star-forming regions in galaxies cannot be explained by ensemble of Orion-like GMCs; they may contain a different population of molecular clouds with high J=2–1/J=1–0 luminosity ratio.

Recent advancement of millimeter- and submillimeter-wave interferometry enables us to observe molecular clouds and their complexes in nearby galaxies. Property of the complexes were investigated mainly by multi-transition study of ^{12}CO. Understanding of entire property of typical molecular clouds is, however, insufficient although it acts as a guideline for proper interpretation of the extragalactic results. This is because most of the former observations of molecular clouds are biased to central regions of clouds where star-formation is active.

We observed almost whole extent of the Orion A and B giant molecular clouds for the first time in the CO(J=2–1) emission using the Tokyo-NRO 60 cm telescope. This telescope has almost the same angular resolution of 9′ at 230 GHz as that of the Columbia 1.2 m telescope at 115 GHz, which corresponds to 1.2 pc at the distance of the Orion clouds.

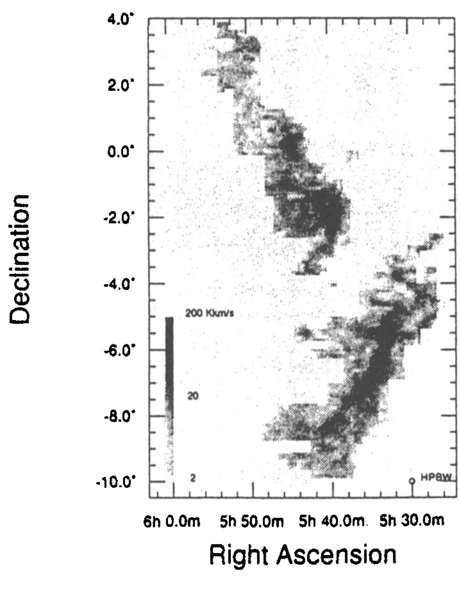

Figure 1._ A gray-scale representation of the CO(J=2–1) integrated intensity map. The effect of atmospheric attenuation and beam efficiency has been corrected.

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The spectra were integrated in the LSR velocity range of 0–20 kms^{-1} and were compared with the CO(J=1–0) data taken with the same angular resolution (Maddalena et al. 1986). We found that the CO(J=2–1)/CO(J=1–0) intensity ratio decreases systematically toward the peripheries of the clouds, which suggest that gas density in clumps located in the peripheral regions is lower than gas density in clumps located in the central ridges.

For the Orion A and B clouds, the CO(J=2–1)/CO(J=1–0) luminosity ratio integrated over the observed regions is 0.77 and 0.66, respectively. Extrapolation to less bright unobserved regions gives 0.75 and 0.62 as plausible luminosity ratios for respective clouds. These are consistent with those observed typically in disks of galaxies (~0.6; Casoli 1991 and references therein), and are significantly lower than large values often observed in active star-forming regions in galaxies (~2; e.g. Eckart et al. 1990, Loiseau et al. 1990, Turner 1993) and in the central region of the Galaxy (~1.1; Oka et al. 1993). Active star-forming regions in galaxies cannot be explained by an ensemble of Orion-like GMCs; they may contain a different population of molecular clouds with high J=2–1/J=1–0 luminosity ratio.

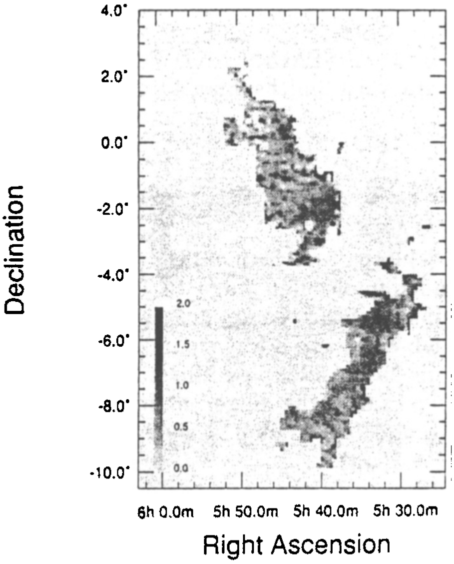

Figure 2._ A gray-scale representation of the CO(J=2–1)/CO(J=1–0) integrated intensity ratio map. The effect of atmospheric attenuation and beam efficiency has been corrected.

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