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CO (J=2–1) OBSERVATIONS OF THE MOLECULAR CLOUD COMPLEX IN THE GALACTIC CENTER

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ABSTRACT We report a large scale mapping observation of the Galactic center region in the CO (J=2–1) line using the Tokyo-NRO 60cm survey telescope. Distribution of the CO (J=2–1) emission in the l-V plane suggests that molecular clouds forms a huge complex (*Nuclear Molecular cloud Complex, NMC*). Tracers of star formation activities in the last 10^6–10^8 years show that star formation has occured in a ring $\sim$ 100 pc in radius. Relative to this *Star Forming Ring*, the molecular gas is distributed mainly on the positive longitude side. This may indicate that much of the gas in NMC is in transient orbit to fall into the star forming ring or to the nucleus in the near future.

Molecular gas in the galactic center region is concentrated in the inner a few hundred parsecs of the Galaxy (*e.g.*, Liszt & Burton 1978), and exhibits complicated kinematics. It is known to be warm (30–60K) and dense (Morris *et al.* 1983; Bally *et al.* 1987, 1988). To illustrate the distribution and kinematics of the warmer and denser molecular gas in the galactic center region, we have started a program to make a large-scale map in the CO (J=2–1) line emission. In this paper, we report its initial results, focusing on the gas in the galactic plane.

Observations are carried out using the Tokyo-NRO 60cm survey telescope at Nobeyama with a $9' \pm 1'$ beam (FWHM). About 100 CO (J=2–1) spectra were taken along the galactic plane between $l = -3°$and $3°$, and along strips perpendicular to the plane between $b = -0.^\circ5$ and $0.^\circ5$.

The distribution of the CO (J=2–1) line emission (Fig.1) shows a strong asymmetry; strong emission occurs mainly in the positive longitude with positive velocities. The data are compared directly with the CO (J=1–0) data from the Columbia survey (Bitran *et al.* 1987). The average J=2–1/J=1–0 line intensity ratio is 1.1, which is significantly higher than the ratio for clouds in the galactic disk (0.6 – 0.8; Hasegawa et al. 1992, Sakamoto *et al.* 1992). This means that the gas in the galactic center is denser and $X_{CO}/(dV/dR)$ is smaller.

Fig.1 recalls us a possibility to conceive the molecular clouds in this region as a huge single complex, which is $\sim 2.^\circ5$(375 pc) in l and $\sim 0.^\circ3$(45 pc) in b. We call it *the Nuclear Molecular cloud Complex (NMC)*. If we adopt the conversion factor in the galactic disk ($N_{H_2}/I_{CO} = 2.0 \times 10^{20}$ (cm)$^{-2}$(Kkms^{-1})$^{-1}$), the total mass of NMC is about 10^8 $M_\odot$.

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Probes of star formation activities in the last 10^6–10^8 years, i.e., HII regions (filled circles in Fig.1, data from Pauls and Mezger 1975) and OH/IR stars (Lindqvist *et al.* 1991), show much more symmetric patterns in the *l*-*V* plane. This suggests that star formation has occured in a ring (or a rigid-rotating disk). The structure, *Star Forming Ring*, is $\sim$ 100 pc in radius and its rotation is approximately circular.

The strong asymmetry in the distribution of molecular gas relative to the Star Forming Ring may indicate that much of the gas in NMC is in transient orbits. Some gas may settle in the ring to fuel a starburst, or may fall even closer to the nucleus (like the 20kms^{-1}and 40kms^{-1} clouds, for example).

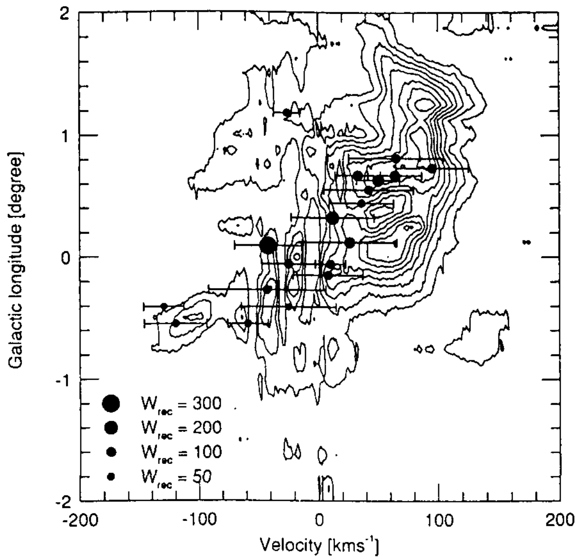

Figure 1—The CO (J =2–1) *l*-*V* diagram at b=0°. Filled circles show the positions, velocities, and integrated intensities (W_{rec} in KkHz) of the H109 α recombination line observed by Pauls and Mezger (1975). The bars represents the widths (FWHM) of the H109 α line.

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