CO MAPPING OF THE INNER FEW HUNDRED PARSECS OF THE GALAXY

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Abstract. We have made high resolution mapping observations of ^{12}CO (J=1–0) and ^{13}CO (J=1–0) from the central few hundred parsecs of the Galaxy using the NRO 45m telescope (HPBW=16″). The high resolution CO maps reveal many molecular arc and/or shell structures which could have resulted from interactions with supernovae. We also found a large (radius $\sim$ 50 pc) ring structure surrounding the region of diffuse X-ray emission, expanding at $V_{\rm EXP} \simeq 200$ km s^{-1}. This and other evidence suggest that a galactic superwind following a burst of star formation in the recent past is sweeping up the ambient gas. The Galactic center may have experienced a burst of star formation $\sim 5 \times 10^7$ years ago, and it may be in post-starburst phase now.

1. Introduction and Observations

Molecular gas is strongly concentrated in the inner few hundred parsecs of the Galaxy (see Morris in this volume), where nearly 10% of the molecular

Figure 1. ^{12}CO channel maps. a) Molecular arcs, b) Filaments

mass in the inner Galaxy is found. Toward these galactic center molecular clouds, the lines that trace the high density region ($n(\mathrm{H}_2) \geq 10^{4-5}\mathrm{cm}^{-3}$) are strongly detected, and this suggests that this region contains a large amount of dense gas which naturally leads to active star formation. However, current "star formation efficiency" (SFE $=$ SFR$/M_g$) is not more than a half of that in the molecular annulus in the Galaxy (Güsten 1989). This moderate star formation activity appears inconsistent with the abundance of dense molecular gas in a picture with steady star formation.

We have made high resolution mapping observations of ^{12}CO (J=1–0) and ^{13}CO (J=1–0) lines with the NRO 45m telescope (beamwidth $16''$) using the newly equipped 2×2 multi-beam SIS receiver. We have collected about 25000 ^{12}CO and over 9000 ^{13}CO spectra so far with $34''$ grid spacing. The ^{12}CO data cover almost the full extent of the Galactic center molecular cloud complex. We used wide-band AOSs with 250 MHz bandwidth (650 km s^{-1} @ 115 GHz), which is sufficiently wide to cover the broad line profile from the Galactic center molecular clouds.

2. Parsec-Scale Structure of Galactic Center Molecular Clouds

In our large-scale and high-resolution CO maps, we found quite a few, molecular arc structures in the Galactic center molecular clouds (Figure 1a). Some of them show clear kinematics of an expanding shell that may have been formed by interactions with supernova remnants and/or stellar wind. The clouds within $|l| \leq 1°$ are bright in CO and show very sharp emission edges compared with the ones in the outer region. The sharp edge could be understood as a result of high external pressure (Spergel & Blitz 1992), due to hot gas ($T_{\mathrm{k}} \geq 10^{7-8}$ K) indicated by X-ray observations (Yamauchi et al. 1990). We also find a number of molecular filaments in the CO emission within $|l| \leq 1°$ at positive velocity side (Figure 1b). They

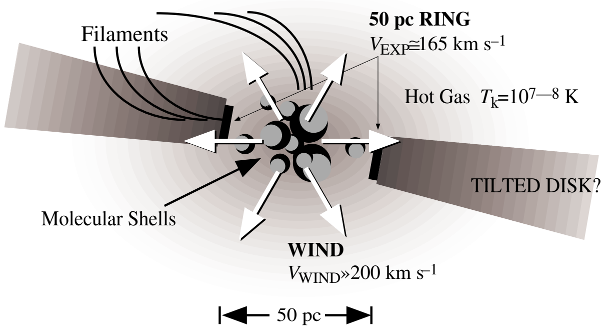

Figure 2. Schematic view of the Galactic center

rise up out of the plane as the velocity becomes higher as if being blown off by strong wind from the inner region.

We also find a large (radius ~ 50 pc) ring structure expanding at $V_{\rm EXP} \sim 200$ km s^{-1}. Its tight anti-correlation with X-ray (Watson et al. 1981), as well as its enhanced ^{13}CO/^{12}CO intensity ratio at the highest velocities, suggests that a hot gas supplied by a number of supernovae and stellar winds is sweeping up the ambient gas. Kinetic energy of this expanding ring is about 10^{54} ergs, corresponding to the kinetic energy released by a thousand supernovae. This value is consistent with the estimation from X-ray observations with the Ginga satellite (Yamauchi et al. 1990).

We suggest these results may give the key to solve the inconsistency raised in the introduction. A burst of star formation with a short duration time will have peak in the mechanical energy released as superwind about 5×10^7 years after a starburst (Heckman et al. 1993). If our Galactic center is now in this post-starburst phase, we can consistently understand the observed features described above and the concentration of intermediate mass (4–9 $M_\odot$) AGB stars in the central 100 pc (Lindqvist et al. 1991). These AGB stars seem to be remnants of previous starburst.

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