MOLECULAR SHELL FORMATION BY SUPERNOVA REMNANTS IN THE GALACTIC CENTER

— What we learn from the case of W44

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1. Introduction

Recent high resolution CO images of the Galactic center (GC) molecular clouds reveal many arc and/or shell structures (Oka et al. 1997). A considerable fraction of them may most probably be formed by an interaction between supernova remnants (SNRs) and molecular clouds. Studies of such cases in less confused areas are needed to clarify this picture. The SNR W44 is a good place for examining the SNR induced shell formation scenario.

2. Giant Moleculer cloud interacting with the SNR W44

We observed CO cloud toward W44 by the Tokyo-NRO 60-cm survey telescope, the 45-m telescope at Nobeyama(Seta et al. 1997). We established W44 as first unambiguously identified example interaction between the SNR and Giant molecular cloud based on following evidences of interaction:

Y. Sofue (ed.), The Central Regions of the Galaxy and Galaxies, 195-196.

1) coincidence in position and in velocity, 2) morphology and kinematics suggestive of interaction, 3) presence of CO line wing emission with very high CO J=2–1/J=1–0 ratios, 4) presence of HCO^+ and HCN line wing emissions , and 5) detection of H_2 emission at 2.2μm.

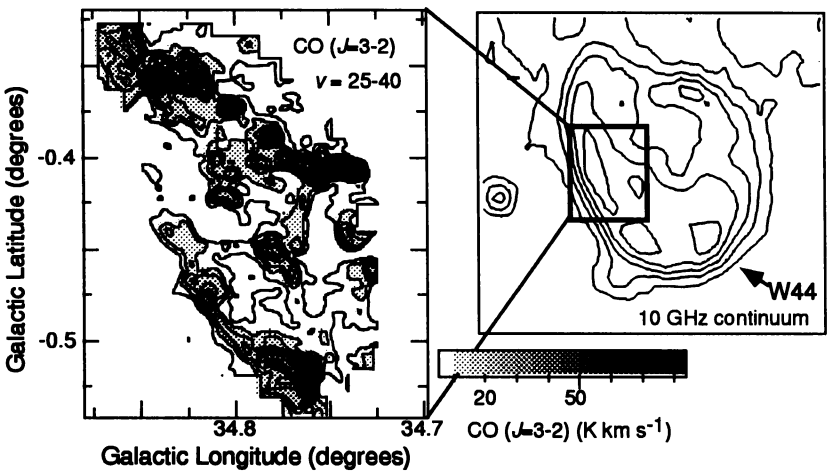

Figure 1. Integrated intensityu map of CO (J=3–2) toward the SNR W44 and radio continuum map (Handa et al. 1987) of the SNR W44.

The LVG analysis shows that the very high ratio gas is optically thin ($\tau < 1$), high temperature (80 K) and high density ($> 10^3$ cm^{-3}). The very high ratio wing suggest that higher J CO line is a good shocked gas tracer, and our JCMT obsrvation proved this idea. Figure 1 shows the distribution of the shocked gas traced by CO (J=3–2) line. Filaments of shocked CO gas run perpendicular to the direction of the SNR expansion. We consider that blast wave of the SNR changed the roundilsh GMC into the filaments of the shocked gas. The mass of the shocked gas was estimated as 9×10^2 $M_\odot$and this is about 0.2% of the mass of the unshocked GMC (6×10^5 $M_\odot$). The kinetic energy of accelerated gas was estimated as 4×10^{48} erg. This means about 0.1% of the energy of one SNR explosion (10^{51} erg) was used as the acceleration of the molecular cloud.

Sequential interactions between SNRs and the molecular cloud which are expected in the GC may further form these molecular filaments into networks, which are observed as shell/arc structures often made of high density molecular gas.

References

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