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The Massive Cloud Core Sgr B2(M): Starburst Triggered by a Cloud Collision

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ABSTRACT We have observed Sgr B2 with NMA.Blue- and redshifted features revel the structure of massive core. Massive core was formed by a cloud collision and massive star formation took place by means of collapse of massive core.

Introduction

Sgr B2 molecular cloud complex was formed by a cloud-cloud collision event (Hasegawa *et al.* 1992). In their model, a cloud (most clearly observed at VLSR ~ 75 kms^{-1}) ~15 pc in size and 10^6 $M_{\odot}$ in mass is colliding with the more extended molecular gas (most clearly observed at VLSR ~ 45 kms^{-1}) in the molecular cloud complex in the Galactic Center region. The 75 kms^{-1} cloud is moving toward northeast and is interacting with the 45 kms^{-1} cloud on its side, making a large velocity shear at the interface, which the aligned HII regions, etc are found.Formation of massive stars are most probably triggered in highly turbulent and shocked interface, although the detailed process of the trigger remains unclear.

Observations

We have made high resolution interferometric observations of the CS (J=1-0) emission and absorption from the Sgr B2 complex. Observations were made from 1988 December to 1989 February using the Nobeyama Millimeter Array (NMA) in B, C, and D configurations. The three clusters of HII regions/masers, *i.e.*, Sgr B2(N), Sgr B2(M), and Sgr B2(S), were observed in a 2'.5 field of view. Heavily saturated absorption is observed toward Sgr B2(N), while Sgr B2(M) was detected in emission at extreme blue- and redshifted velocities along with deep absorption at central velocities. The resultant synthesized beam is 8"x 15" (PA=-4°). Five frequency channels were coadded and the resultant velocity resolution is 2.39 kms^{-1}.

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The Structure of Core and Massive Star Formation in Sgr B2(M)

Toward Sgr B2(M) and at its vicinities, however, CS (J=1-0) emission is seen at blue- and redshifted velocities. Figure 1 shows the velocity channel diagrams at VLSR=51.4 kms^{-1} and 87.3 kms^{-1} overlaid on the 15 GHz continuum image. All these two velocities, the CS (J=1-0) line does not show an obvious effect of absorption. The 51.4 kms^{-1} elongate from northeast to southwest and the 87.3 kms^{-1} has elongation from north to south with extent of 30"x 15". The 50 kms^{-1} gas include Sgr B2(S), while the 80 kms^{-1} gas elongate to Sgr B2(N). Compact HII regions locate at the overlapped area between two velocities. Component F denoted by Benson *et al.* (1984) locates between two peaks.

The collision of clouds with two velocities will be finished within 3×10^4 yr when we assume two clouds collide each other with a diameter of 1 pc and relative velocity of 30 kms^{-1}. The central mass required to account for the gravitationally bound motion can be estimated as $1.6 \times 10^4 M_\odot$, where the radius is 0.31 pc and rotational velocity is 15 kms^{-1}. This value is comparable to that of $1.5 \times 10^4 M_\odot$ within radius of 0.3 pc derived from line and continuum results (Lis *et al.* 1990). It may be explained that the separation are gravitationally bound. Our high resolution CS image reveals that the massive core of dense molecular gas associated with Sgr B2(M) is indeed located at the interface of the two colliding clouds.

It is difficult to imagine, however, that this collision has directly triggered the burst of star formation in Sgr B2. Rather, two stages, *i.e.*, formation of the massive dense cores during the collision event and subsequent massive star formation, may be required (Lis *et al.* 1991). A cloud with supercritical mass will suffer relatively rapid contraction and compress the embedded magnetic fields well. Cloud contraction under circumstances of massive core efficiently form protostars with high mass nearly isothermally even if core is heating within $t_K \sim 10^4$yr when mass of star is 30 $M_\odot$. Mass accretion rate in massive core is derived $M \sim 0.1\ M_\odot\ yr^{-1}$. In this condition upper mass of star are assumed to be 100 $M_\odot$.

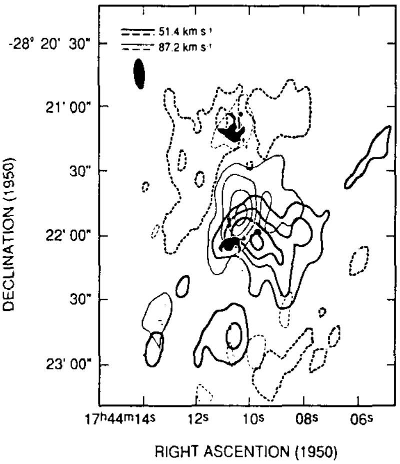

Figure 1: Two emission features of 51.4 kms^{-1} (thin dot and line) and 87.3 kms^{-1} (thick dot and line) separate 15" at Sgr B2(M), which correspond to 0.65 pc. Shaded areas reveal 15 GHz continuum images (Carlstrom *et al.* 1989) corresponded to the ultracompact HII regions.

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