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DETECTION OF INTERARM MOLECULAR CLOUDS IN M51 : MSC OR GMC ?

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In our Galaxy, molecular gas forms clouds with masses of $\sim 10^5 M_\odot$ and with sizes of several 10 pc, which are called Giant Molecular Clouds (Sanders 1985; hereafter GMCs). Such GMCs are also observed in nearby spiral galaxies M31 and M33 (Lada *et al.* 1988; Wilson & Scoville 1990). On the other hand, one of the well-studied spiral galaxy M51 has more massive and larger molecular clouds. Since their typical mass and size are $10^{7-8} M_\odot$ and several 100 pc, respectively, they are called Molecular Superclouds (Rand & Kulkarni 1990; Tosaki *et al.* 1992; hereafter, MSCs). A question arises as what causes the difference in structural properties of molecular gas among the spiral galaxies. In order to answer this question, we should make higher resolution studies both spatially and spectroscopically. In this paper, we present the results of high spectral-resolution study of the MSCs in M51 based on the ^{12}CO ($J = 1 - 0$) mapping made with the Nobeyama Millimeter Array (Tosaki *et al.* 1992). The spatial resolution is $5.''3 \times 4.''9$ corresponding to 240×230 pc at distance of 9.6 Mpc. The spectral resolution is 3.25 km s^{-1}. The analysis is made for the $1'$ region whose center is offset $42''$ south and $7''$ east from the nucleus, because a very intense molecular arm is present in this region. Our Main results and conclusions are as follows.

(1) We have detected 29 molecular clouds as distinct components both spatially and kinematically. Their peak intensities are larger than 3σ rms noise and their sizes are larger than the synthesized beam. While 12 clouds among them are distributed on the molecular spiral arm, the rest 17 clouds are found in interarm regions. In some cases, there are a few clouds separated kinematically at the same position.

(2) We are able to find HII regions near most of the interarm molecular clouds (15/17) within $10''$ (corresponding to 460 pc), although their physical relation is uncertain.

(3) The on-arm clouds have a mean mass of $2 \times 10^7 M_\odot$ and a mean velocity width of 16 km s^{-1}, significantly larger than those of GMCs in our Galaxy. On the other hand, the interarm clouds have a mean mass of $8 \times 10^6 M_\odot$, corre-

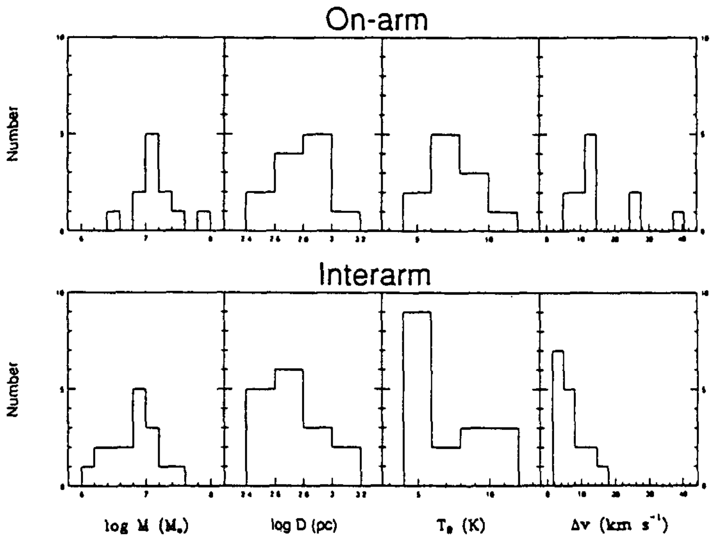

FIGURE I Comparison of the physical quantities between on-arm and interarm molecular clouds. The upper panels are for the on-arm clouds and the lower one for the interarm clouds. The compared physical quantities are frequent distributions of masses, sizes, brightness temperatures, and velocity dispersions from left to right.

sponding to those of the largest GMCs in our Galaxy, and the typical velocity width is smaller than 3.25 km s^{-1}, similar to those of GMCs.

(4) For all the clouds, there is a good correlation between the mass estimated from CO flux and the virial mass calculated with their size and velocity width [M_{vir} =525D (pc) Δv (km s^{-1})]. Most of the clouds have $M_{CO}/M_{vir} \geq 1$, suggesting that the molecular clouds are gravitationally bound. This tendency is more significant for the interarm clouds.

(5) In summary, the present high-spectral resolution analysis shows that the molecular clouds in the molecular arm still have properties of MSCs while the interarm clouds have the physical properties of the largest GMCs in our Galaxy.

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