THE MOLECULAR BAR AND ARM OF THE BARRED-SPIRAL GALAXY M83

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ABSTRACT. CO(J=1-0) line observations of the southern arm of the barred-spiral galaxy M83 were made with the 45-m telescope of the Nobeyama Radio Observatory with a 17"-beam. The CO emission is concentrated to the spiral arm, but it is much weaker than in the bar. The comparison between the CO flux and the far ultraviolet flux suggests the star forming efficiency is much lower in the bar than in the spiral arm.

1. Introduction

In 1970s many investigators predict the interstellar shock at the bar of a barred-spiral galaxies (*e.g.* Sørensen *et al.* 1976). In order to confirm this prediction we observed the bar of the nearest barred-spiral galaxy M83 in the CO(J=1-0) line using the 45-m telescope of the Nobeyama Radio Observatory (NRO) with 16"-beam (Handa *et al.* 1990). This observation shows that molecular gas is concentrated in the leading edge of the bar (the "*molecular bar*") and that it shows noncircular motion around the nucleus, which is consistent to the gas inflow motion.

On the other hand, the galactic shock model (*e.g.* Roberts 1969) predicts the interstellar shock at the spiral arm. In order to investigate the difference on the star-formation triggered by these two types of the interstellar shock, we conducted to extend the observations of M83 to the southern disk region from the observations made by Handa *et al.* (1990).

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2. Observations

The observations were made during February 1987 and January 1988 using the 45-m telescope at NRO. The observed line was the $^{12}CO(J=1-0)$ molecular line at 115.27 GHz. The half-power beam width (HPBW) was 17", corresponding to 300 pc at the distance of the galaxy, 3.7 Mpc. The resultant velocity resolution was about 10 km s^{-1}. The aperture efficiency (η_a) and the main beam efficiency (η_{mb}) were 0.26 and 0.45, respectively. The system noise temperature was about 1200-1700 K at 20°. The typical noise level of profiles is 0.04-0.07 K. The pointing accuracy is about ±3" rms.

We got profiles at 64 positions on the 15"-grid. The mapping area covers the southeastern part of the disk.

3. Results and Discussion

3.1 MOLECULAR GAS DISTRIBUTION

Figure 1 shows the integrated intensity distribution of the CO line. In the disk region the CO emission shows a spiral structure. We call it as the "*molecular spiral arm*" here. ***The "molecular spiral arm" is much weaker than the "molecular bar".*** It suggests that the interstellar shock in the spiral arm is weaker than in the bar.

Near the bar-arm transition region the CO emission traces the dust lane, but in the outer region it traces the HI ridge rather than the dust lane (see Allen *et al.* 1986). In general we should not say anything about the distribution molecular clouds from the dust lane morphology.

3.2 POSITIONAL SHIFT BETWEEN THE CO AND THE FUV EMISSIONS

In order to investigate the star-formation activity we employ the far ultraviolet (FUV) image because it means the distribution of young stars. The FUV image we used was obtained at λ1540Å by Bohlin *et al.* (1983). The FUV emission also shows the spiral arm but it is shifted from the "molecular spiral arm". After the galactic shock scenario (*e.g.* Roberts 1969) the shift between the CO and FUV emissions suggests that the molecular gas streams from the west to the east and forms stars after crossing the spiral shock. The direction of the gas stream suggests that the gas rotates faster than the potential pattern. This means that the corotation radius is in the outer disk region not at the end of the bar.

3.3 STAR-FORMATION EFFICIENCY IN THE BAR AND THE DISK REGIONS

The comparison between the CO and FUV fluxes shows the star-formation efficiency, which means how many stars are formed from the unit mass of molecular gas. The comparison shows that 3 regions of the galaxy shows different properties. In the nuclear region both the CO and the FUV emissions are very strong. In the bar region the CO emission is strong and concentrates to the molecular bar but the FUV radiation is very weak. in the disk region the CO emission shows weak concentration to the spiral arm but the FUV radiation is rather strong.

Figure 2 shows the flux ratios (FUV flux / CO flux) integrated over 4 regions of the galaxy; those are the nucleus, the bar, the bar-arm transition, and the disk regions. In the bar region the ratio is very small, which means the star-formation efficiency is very low there. We believe that there is some mechanism which suppress the star-formation in the bar. One possibility is the rapid falling motion of molecular gas from the bar into the nucleus before forming stars. But if it is the case, maintenance of the massive molecular bar should be difficult.

References

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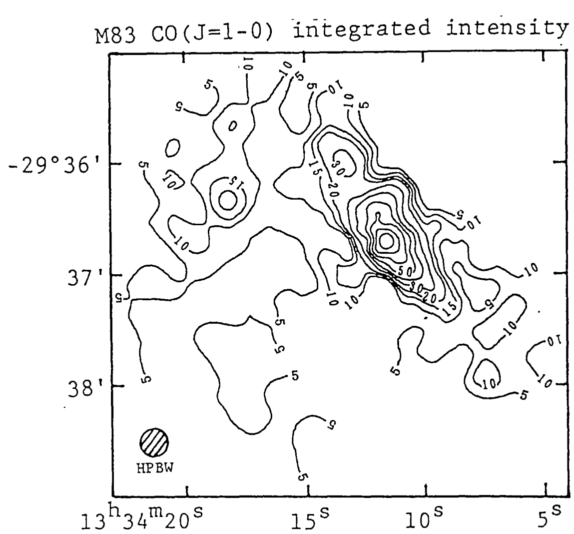

Fig.1:CO emission distribution of M83
The contour unit is K km s^{-1} (T_A*).

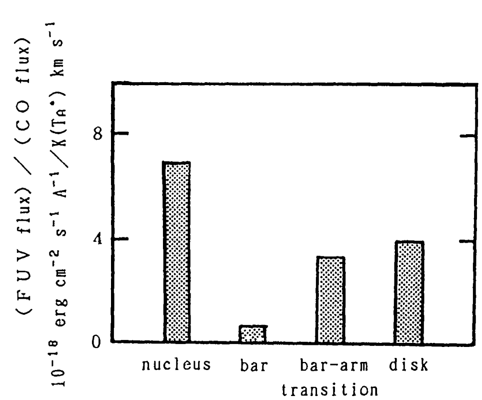

Fig.2:Flux ratios of FUV/CO
in 4 regions in M83