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A high-resolution CO mapping of the nucleus of the barred-spiral galaxy, M83

Toshihiro HANDA
University of Tokyo, Institute of Astronomy

Sumio ISHIZUKI & Ryohei KAWABE
Nobeyama Radio Observatory

M83 is the best sample to investigate gas response to bar potential because it is one of the nearest galaxy with a pronounced bar structure (distance=3.7 Mpc). Handa et al. (1990) observed it with the Nobeyama 45-m telescope in CO(J=1-0) and found concentration of the CO emission to the dust lanes along the bar and non-circular rotation. However we need better spatial resolution in order to investigate kinematics and distribution of molecular gas in the nuclear region. So we observe the central region of M83 using the Nobeyama Millimeter Array. The synthesized beamsize was 12" × 6" and frequency coverage was 325 km s^{-1}.

Figure 1 shows an integrated intensity map after CLEAN. Most of the CO emission is confined in the narrow ridge from north to south. We call it as the "nuclear molecular ridge". The nuclear molecular ridge connects two major dust lanes on the bar. Its position angle is significantly different from that of the large-scale "molecular bar"; it is 45° (Handa et al. 1990).

In order to investigate kinematics of the ridge we made channel maps with 20 km s^{-1} step. The nuclear molecular ridge is composed from the features which roughly follow the galactic rotation. At the systemic velocity the nuclear molecular ridge has a gap (Figure 2). A radio continuum map (Cowan & Branch 1985) shows that a nuclear star formation complex is located just at the gap. The configuration suggests the inflow gas activates the nuclear star burst activity, as shown in our Galaxy. There are also some features out of the ridge. They do not follow the simple rotation kinematics. We call it as "out-of-rotation" features.

Binney et al. (1991) gave a physical explanation to gas response to bar potential which has been calculated (e.g. Sørensen et al. 1976, Roberts et al. 1976). According their results most gas is accumulated in the shocked region on the "cusped orbit". A weaker gas concentration is also seen at the other side on the same orbit. It is called as "run-over" gas. Considering the configuration of M83 overall kinematics in the central region can be understood well using the bar potential model; the "nuclear molecular ridge" corresponds to the shocked region and the "out-of-rotation" features correspond to the "run-over" gas.

Some barred spiral galaxies show the "twin-peak structure" in CO line (Kenney et al. 1992). The "twin-peaks" are located just at the tangential points of the nuclear star forming ring and dust lanes of the bar, which correspond to the inner Lindblad resonance. The morphology of the nuclear molecular ridge and the nuclear star formation complex is similar to that of the "twin-peak" galaxies. However M83 also has a large scale "molecular bar". Another barred-spiral galaxy, NGC 2782, shows similar morphology to M83 (Ishizuki 1993a, 1993b). The molecular gas distribution in both galaxies is different from the "twin peaks". They look like the "double twin-peak" structure.

Summarizing our results and Kenney's "twin peaks" we propose a morphological sequence of barred spirals with 3 categories; the "twin peaks", the "double twin-peak" and the central single peak structure (Figure 3). At present we have no answer what this sequence means; it should mean the sequence of evolution or dynamical parameters. More observations are required in order to improve the statistics, and qualitative comparison between observations and numerical calculations is required.

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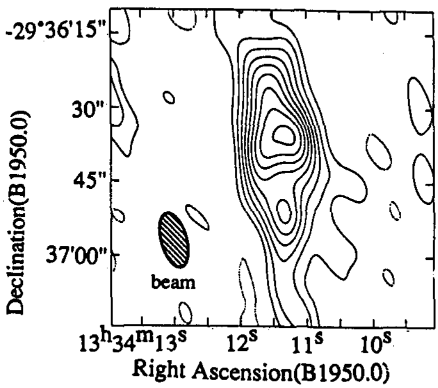

Figure 1: Integrated intensity map of the nucleus of M83. The position angle of the large-scale molecular bar (45 degrees) are different from that of the inner bar.

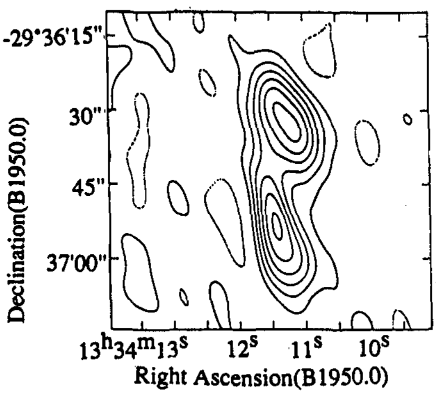

Figure 2: A channel map at v_{LSR}=523 km s^{-1}. The central gap corresponds to the nuclear HII complex.

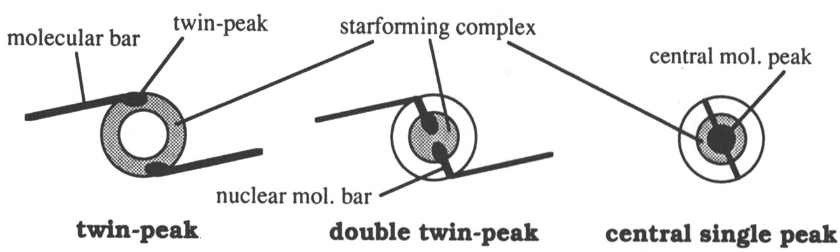

Figure 3: A morphological sequence of barred spiral galaxies in molecular gas distribution; the "twin-peak", the double twin-peaks and the central single peak structure

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