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1.7" RESOLUTION CO(1-0) OBSERVATIONS OF ARP220: NUCLEAR GAS RING OF MERGER REMNANT

S. K. OKUMURA, R. KAWABE, M. ISHIGURO
Nobeyama Radio Observatory, National Astronomical Observatory, Minamimaki, Minamisaku, Nagano 384-13, Japan

S. ISHIZUKI
Department of Astronomy, Faculty of Science, University of Tokyo, 3-8-1, Yayoi, Bunkyo-ku, Tokyo 113 Japan

ABSTRACT We made aperture synthesis CO(1-0) observations of the central region of Arp220 with the Nobeyama Millimeter Array. Central CO emission was resolved with a size of 975 kpc. It shows a ring-like structure ($r \sim 500$ pc) with a large velocity gradient, 393 $km \cdot s^{-1} \cdot kpc^{-1}$, from southwest to northeast direction. The ring-like emission is located around double radio compact sources. No emission peak was found in the center of the double sources within the velocity range 5100 km s^{-1} to 5800 km s^{-1}. These results suggest that an inclined massive gas ring has been or is being formed in the central 1 kpc of Arp220. Most of the molecular gas in Arp220 is concentrated on this nuclear ring. The radio compact sources are probably located at the inner egde of the ring.

RESULTS

Figure I shows the CO emission from the central 1' of Arp220 averaged over the velocity range $5179 \leq CZ \leq 5634$ km s^{-1}. Two crosses denote the locations of double radio compact sources (Norris 1988), which agree well with those of two near-infrared sources(Graham *et al.* 1990). CO emission observed with the NMA is concentrated in the central $\sim$ 7" area including the double compact sources. Detected CO flux in Fig. I is 398.1 Jy km s^{-1}. It is about 80% of the total CO flux derived from single-dish observations (Casoli *et al.* 1988; Solomon *et al.* 1990). The deconvolved diameter of the central CO condensation is 2.6". It corresponds to 975 pc at a distance of 77 Mpc of Arp220.

Seven CO channel maps are presented with a velocity width of 101.1 km s^{-1} in Fig. II. The most intense emission has radial velocities (CZ) from 5300 to 5400 km s^{-1}. As the velocity increases, the CO peak moves from the southwest to the northeast. Although the emission peaks are situated close to the double compact sources, no intense emission was found in their center.

We found two emission peaks and a clear velocity gradient in a position - velocity diagram (Fig. III) from the southwest to the northeast (P.A.= 45°; see Fig. I). Fifteen CO channel maps with a velocity width of 50.55 km s^{-1} are used in the diagram. The double compact sources are located close to the

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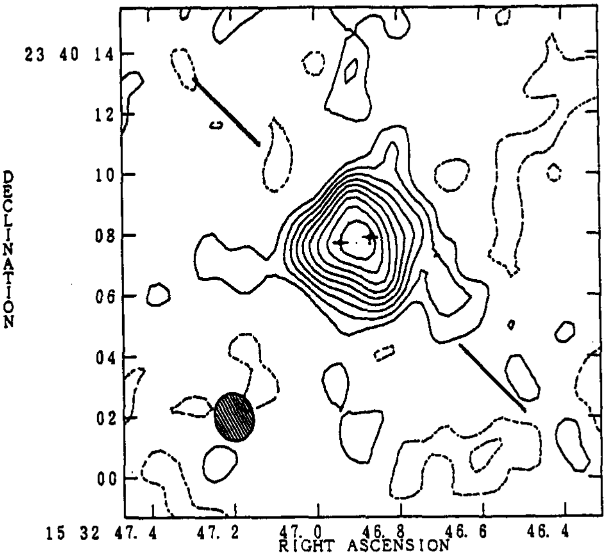

FIGURE I CO CLEAN map averaged over the velocity range $5179 \leq CZ \leq 5634$ km s^{-1}. The contour levels are -24.0, 24.0, 48.0, ... 216 mJy beam^{-1}. The peak flux is 234.4 mJy beam^{-1}. The FWHM size of the synthesized beam is shown on the left of the panel. The positions of two radio compact sources (Norris 1988) are marked by crosses. A solid line indicates the direction of the position - velocity cut used in Fig. III.

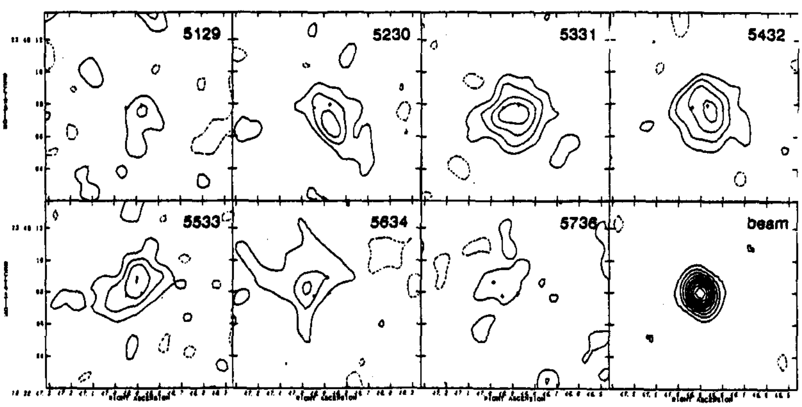

FIGURE II Seven CO channel maps with a velocity width of 101.1 km s^{-1} and the pattern of the natural-weighted beam. The central velocity of each panel is indicated in the top-right corner. The contour interval of the channel maps is 68 mJy beam^{-1} and that of the beam pattern is 10% of the peak. The two crosses are the same as in Fig. I.

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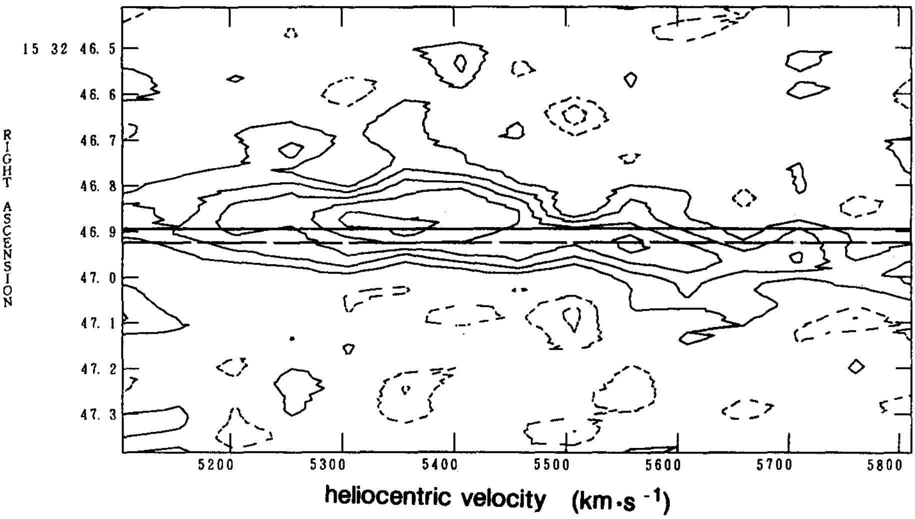

FIGURE III Position - velocity diagram along the cut shown in Fig. I (P.A.=45°). The contour interval is 64 mJy beam^{-1}. The solid (dashed) line in the panel shows projected R.A. position of the western (eastern) radio compact source (Norris 1988).

two emission peaks. The velocity gradient is estimated to be 393 km s^{-1} kpc^{-1} across the two peaks ($\sim$ 450 pc). This is roughly consistent with the previous interferometric CO results (Scoville *et al.* 1991).

We have found a ring-like structure around the double compact sources in the central region of Arp220. The inclination of the ring structure seems to be a few tens of degrees (neither edge-on or face-on).

DISCUSSION

These results suggest that an inclined molecular gas ring (r $\sim$ 500 pc) has been or is being formed in the central region of the merger galaxy Arp220. The double compact sources are probably located at the inner edge of the nuclear ring. The circular rotation velocity is estimated to be about 89 $\times sin(i)^{-1}$ km s^{-1}, where i represents the ring inclination. The rotation time scale of the ring is $1.6 \times 10^7 \times sin(i)$ years.

Arp220 has probably been formed by the merging of two gas-rich spirals (e.g., Scoville *et al.* 1986). The stellar systems of the two spirals would form non-axisymmetric potential like a bar during merging (Noguchi 1990; Barnes 1990). Such bar potential might bring a large amount of molecular gas toward the cental region (e.g Schlosman *et al.* 1989). Frequent cloud-cloud collisions might occur if 10^{10} Mo of molecular gas is concentrated in the central 1 kpc. These collisions would speed up the relaxation of the gas system and may accout for the huge amount of molecular gas that has settled into the ring in such a short time scale (10^7 yrs), although the two galactic nuclei have not merged yet (Graham *et al.* 1990).