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Atomic and Molecular Gas in the Merger Arp 299

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Abstract. We present MERLIN observations of the atomic and molecular gas of IC 694 a member of the merger system Arp 299. The radio continuum of IC 694 is consistent with a disk of synchrotron emission powered by supernovae remnants. The atomic and molecular gas are located in a similarly orientated 250 pc large disk.

The merging system Arp 299 (Mrk 171) consists of two interacting galaxies, IC 694 and NGC 3690. Its far-infrared luminosity of $5.2\times10^{11}L_{\odot}$ places it in the gap between the nearby starburst galaxies (eg M82) and the more distant Ultra Luminous far- InfraRed Galaxies (ULIRGs, eg Arp 220). The system is rich in molecular gas, with bright CO condensations in the two galactic nuclei, particularly in IC 694, where the molecular gas mass in the inner 280 pc radius is $\sim 5\times10^{9}$ $M_{\odot}$ and where the mm molecular line rations reveal a highly disrupted molecular ISM with a bulk temperature $\geq$ 100 K (Aalto et al 1997). The detection of OH megamasers and HI absorption in Arp 299 (Baan & Haschick 1990, BH90), further emphasises the notion of extreme conditions in the ISM.

In order to investigate the conditions of the atomic and molecular gas in detail we made sub-arcsecond (10-40pc) resolution MERLIN observations of the HI absorption, the OH megamaser emission and of the λ6cm Formaldehyde (H_2CO) line, and compared them with the 200 pc resolution CO images of Aalto et al (1997).

The observations were made in the spring of 1998. The observations of the source were phase-referenced to the nearby calibrator 1125+596. Initial editing and calibration were carried out using standard MERLIN software; further analysis and imaging was performed in AIPS. Here we present preliminary results for the galaxy IC 694.

The radio continuum, the atomic and molecular gas of IC 694

The radio continuum shows a 200$\times$ 250 pc large, diffuse emission, elongated at $\sim 135^{o}$, surrounding a brighter, 150 pc long ridge. The overall spectral index is flat between λ6 and 21 cm. The structure of IC 694 in not that of a typical core-jet seen in bright AGN. Instead, the morphology of IC 694 is consistent with synchrotron emission from electrons accelerated by radio supernovae remnants in a disk, similar to those found in several other ULIRGs (e.g. Mrk 231, Mrk 273 Carilli et al 1998, 2000).

Figure 1 presents the intensity-weighted mean velocity fields and the position-velocity diagrammes of the 200 pc resolution CO observations of Aalto et al. (1997) (left) and our HI (middle) and OH (right) observations.

The fairly regular looking spider diagram of the HI absorption reveals a 240 pc, rotating disk-like structure with inclination $\sim 60^{\circ}$, elongated along the

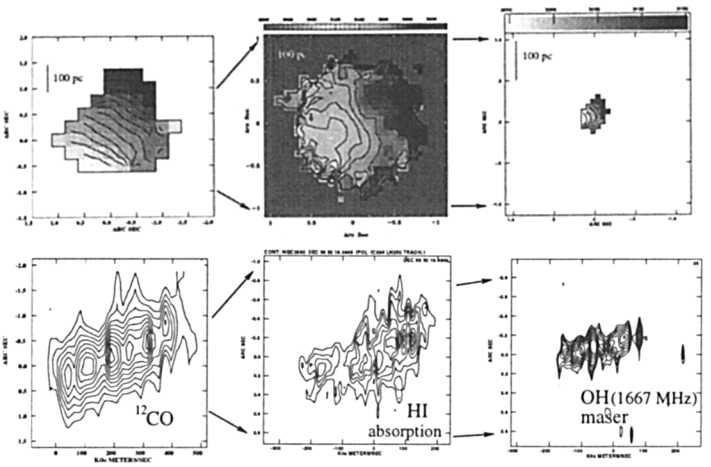

Figure 1. A comparative look of the velocity distribution and the position velocity diagrammes of the CO emission (left), the HI absorption (middle) and the OH megamaser (right) lines of IC 694

major axis of the radio continuum with a velocity gradient of 2094.4 km/s kpc^{-1}. The position-velocity diagramme shows several absorption components (with optical depth 0.1–0.5) along the major axis of the continuum, indicating the clumpy nature of the rotating structure. The total HI column density is $N_{HI} \sim 1.26 \times 10^{20} T_S$, implying a mass for the HI of $M_{HI} = 3.6 \times 10^6 M_\odot$, roughly 1% of the dynamical mass (for T_S=100 K).

OH megamaser emission is only observed in IC 694. The 1665 MHz line is almost resolved out, implying that it arises in a more extended region. The 1667 MHz line emission arises in a 100 pc large rotating structure with a velocity gradient of 2750 km/s kpc^{-1}, orientated at 135°. The position-velocity diagramme shows a clumpy nature for the rotating structure similar to that observed in the HI disk.

The atomic and molecular gas in the nucleus of IC 694, is located in flattened rotating structures that have the same axis and similar velocity ranges. The CO emission and HI absorption seem to occupy the same space (250 pc) suggesting that the HI and molecular gas phases are mixed. It is possible that the HI is a photodissociation product of the molecular gas. The OH seems to be located further in, in the same rotating disk. The turbulence of the gas is generally high — it often exceeds 100 km/s. This is consistent with the notion of extremely high gas pressures in the centers of ULIRG galaxies with steep potentials.

References

Aalto S., Radford S.J.E., Scoville N.Z., Sargent A.I., 1997 ApJ, 475, L107

Baan W. A., Haschick A., 1990 ApJ, 364, 65.

Carilli C.L., Wrobel J.M., Ulvestad J.S. 1998, AJ, 115, 928.

Carilli C.L., Taylor G.B., 2000, ApJ, 532, L95.

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