

Giant Molecular Clouds and Star Formation in the Tidal Molecular Arm of NGC 4039

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The properties of tidally induced arms provide a means to study molecular cloud formation and the subsequent star formation under environmental conditions which in principle are different from quasi stationary spiral arms. We report the properties of a newly discovered molecular gas arm of likely tidal origin at the south of NGC 4039 and the overlap region in the Antennae galaxies, with a resolution of $1''.68 \times 0''.85$, using the Atacama Large Millimeter/submillimeter Array science verification CO(2–1) data (Fig. 1) [1].

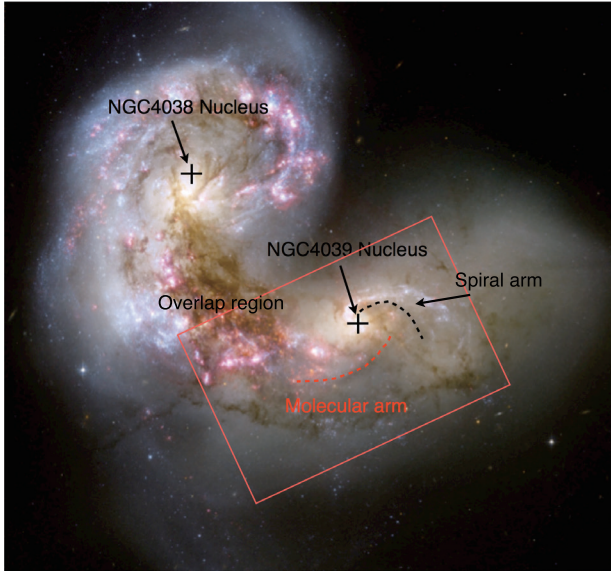


Figure 1: HST Optical composite image of Antennae galaxy indicating the positions of the NGC 4038/9 nuclei, the overlap region, NGC 4039's spiral arm, and the molecular arm of tidal origin that we study in [1]. The rectangle indicates the mosaic covered by ALMA observations.

The arm extends 3.4 kpc ($34''$) and is characterized by widths of $\lesssim 200$ pc ($2''$) and velocity widths of typically $\Delta V \simeq 10\text{--}20$ km s^{−1} (Fig. 2). About 10 clumps are strung out along this structure, most of them unresolved, with average surface densities of $\Sigma_{\text{gas}} \simeq 10\text{--}100 M_{\odot} \text{pc}^{-2}$, and masses of $(1\text{--}8) \times 10^6 M_{\odot}$. These structures resemble

the morphology of beads on a string, with an almost equidistant separation between the beads of about 350 pc, which may represent a characteristic separation scale for giant molecular associations.

We find that the star formation efficiency at a resolution of $6''$ (600 pc) is in general a factor of 10 higher than in disk galaxies and other tidal arms and bridges. This arm is linked, based on the distribution and kinematics, to the base of the western spiral arm of NGC 4039, but its morphology is different to that predicted by high-resolution simulations of the Antennae galaxies.

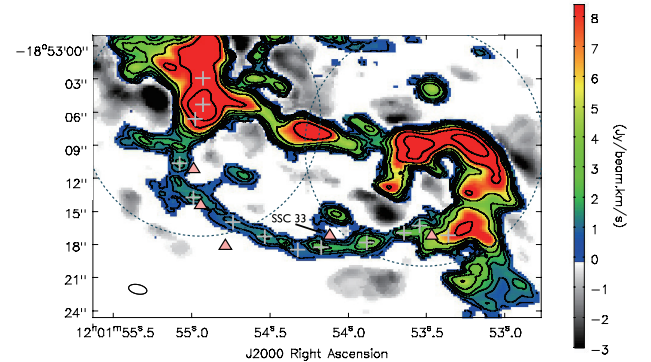


Figure 2: Integrated intensity map, emphasizing the tidal molecular arm to the South. The triangle signs show the location of super stellar clusters along the molecular arm.

Reference

[1] Espada, D., et al.: 2012, *ApJ*, **760**, L25.