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FORMATION OF MASSIVE CLOUDS AND DWARF GALAXIES DURING TIDAL ENCOUNTERS

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Gerola et al. (1983) propose that isolated dwarf galaxies can form during galaxy interactions. As evidence of this process, Mirabel et al. (1991) find 10^9 $M_\odot$ clouds and star formation complexes at the outer ends of the tidal arms in the Antennae and Superantennae galaxies. We describe observations of HI clouds with mass $> 10^8$ $M_\odot$ in the interacting galaxy pair IC 2163/NGC 2207. This pair is important because we believe it represents an early stage in the formation of giant clouds during an encounter. We use a gravitational instability model to explain why the observed clouds are so massive and discuss a two-dimensional N-body simulation of an encounter that produces giant clouds. For more details see Elmegreen et al. (1992a).

VLA HI observations (Elmegreen et al. 1992b) reveal 10 giant clouds with HI mass in the range 1–5 $\times$ 10^8 $M_\odot$ in the outer parts and in the main disks of the galaxy pair IC 2163/NGC 2207 (see Fig. 1). One of the giant clouds in NGC 2207 lies between the optical spiral arms and shows no evidence of present star formation; this suggests it may be young. The measured velocity dispersion in each of these 10 clouds is typically about 40 km/s, the same as in much of the main disk of NGC 2207, but a factor of 4 times higher than for clouds in normal disk galaxies. The high velocity dispersion, which results from the agitation of the ISM by the galaxy interactions, appears to be the key to understanding why these giant clouds are at least 10 times more massive than the largest clouds in normal galaxies. In gravitational instability, the Jeans mass scales as the fourth power of the effective velocity dispersion. Giant clouds can form where the value of the Jeans mass is suitable and where the local value of the instability parameter Q for the gas is below threshold, e.g., in the outer regions and on the tidal arms. The time scale for these giant clouds to form by gravitational instability is 50–100 million years, and significant star formation should commence in about twice that time. This time scale is consistent with other evidence that IC 2163/NGC 2207 is a recent encounter.

We present results of an N-body gas + star simulation of an encounter between galaxies with extended gas disks and nearly equal mass. Giant complexes with a mass of about 10^8 $M_\odot$ and an internal velocity dispersion of about 25 km/s form in the tidal tail. The largest clumps in the simulations have a mass consistent with the Jeans mass and with the values observed in IC 2163/NGC 2207. In a simulation with a companion mass equal to 1.4 times the mass of the galaxy, giant complexes in the tidal tail escape to form independent dwarf galaxies.

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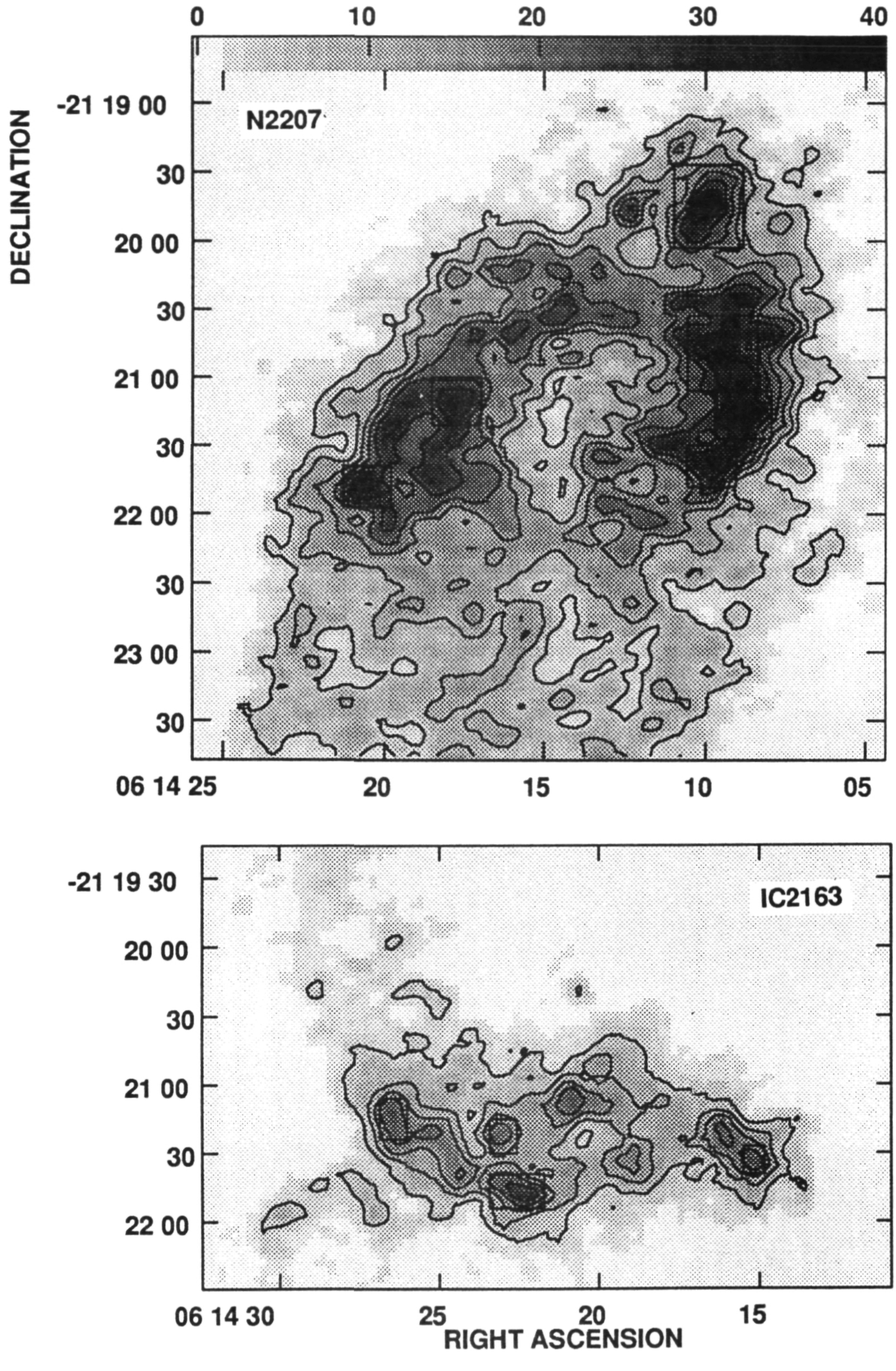

Figure 1. HI column density in IC 2163 and NGC 2207, presented as contours and as greyscale. The HI emission from the two galaxies was separated by using velocities and continuity. The greyscale wedge is labelled in units of $M_{\odot}$ pc^{-2}. Boxes are drawn around the 10 giant clouds.