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The response of atomic and molecular gas to a disk-disk collision

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Abstract

The physical and morphological properties of the atomic and molecular gas in early stage interacting systems are investigated in detail using two complementary approaches; (1) by studying the response of gas particles and its observational consequences using the results from a numerical simulation of an equal mass disk-disk collision, and (2) by mapping the distribution and kinematics of atomic (H I) and molecular (CO (1-0)) gas in 10 systems that show clear optical evidence of recent interaction. Stars in the simulation respond to the tidal interaction by forming both transient arms and long lived $m = 2$ bars, but the gas responds differently and flows directly toward the central regions within 10^8 years after the initial collision, where it forms a dense gas concentration that resembles a nuclear ring. It is further demonstrated that non-circular gas kinematics can produce distinct emission features in the "forbidden velocity quadrants" of the position-velocity diagram (PVD). These theoretical predictions are tested on an observational sample of 10 comparable-mass early stage interacting systems traced in H I and CO (1-0) emission. The H I and H_2 masses range from $(1.0-34.0) \times 10^9 M_\odot$ and $(0.7-44.7) \times 10^9 M_\odot$ in H I and H_2 (from CO (1-0)) respectively. The position velocity diagrams (PVDs) and the rotation curves are presented, some of which show observational signature of inflow and/or anomalous kinematical structure possibly related to a nuclear ring. It is found that the average molecular fraction is higher in interacting systems, and that the average Compactness (K) is much smaller, implying an extended and abundant nature of molecular gas in the perturbed disks. ^ New high resolution CO (3-2) interferometric map of the IR-bright interacting galaxy system VV 114 observed with the Submillimeter Array (SMA) reveal a substantial amount ($4 \times 10^9 M_\odot$) of warm and dense gas in the IR-bright but optically obscured galaxy, VV 114E, and the overlap region connecting the two nuclei. Extensive CO (2-1) emission is also detected, revealing detailed distribution and kinematics that are consistent with the earlier CO (1-0) results. ^

Subject Area

Astronomy

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