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) × 10^9 M⊙ and (0.7–44.7) × 10^9 M⊙ 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 × 10^9 M⊙) 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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