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Gravitational coupling in protostellar star-disk models including computationally resolved stars

KATHRYN HADLEY, Oregon State University

We find that gravitational coupling between modes inherent in a computationally resolved protostar and its surrounding disk can significantly alter evolution of the disk. Typical hydrodynamic calculations of star-disk systems treat the star as a point mass. Our linear, quasi-linear and nonlinear hydrodynamic calculations were performed on fully self-gravitating systems including a star with spatial extent, enabling multipole gravitational coupling between the star and disk. Model sequences were calculated for stars with *increasing flatness* for uniformly rotating (UR) and differentially rotating (DR) stars. Slowly rotating UR stars did not exhibit large effects due to multipole coupling. Our flattest DR stars, however, fell well above the dynamic barlike mode instability threshold for Maclaurin spheroids. Coupling between the star and disk produced qualitative changes, with disks supporting smoothly winding arms uncharacteristic of models with more spherical stars. Monopole coupling drives one-armed modes in both the point star and resolved star models. In the nonlinear simulation, flattening in the star caused redistribution of angular momentum, leading to significant mass-shedding from the star onto the disk, an effect not seen in the point star case.

In collaboration with: James Imamura, Willis Rogers and Attila Varga, Oregon State University