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Cooling and fragmentation of narrow self-gravitating disks

WILLIAM DUMAS, University of Oregon, KATHRYN HADLEY, Oregon State University, JAMES IMAMURA, ERIK KEEVER, REBECKA TUMBLIN, University of Oregon — We perform nonlinear hydrodynamic simulations to investigate the evolution and possible fragmentation of narrow, self-gravitating, radiating disks surrounding a central point mass protostar. As initial conditions we use equilibrium models of axisymmetric polytropic disks and hold the ratio of the inner to outer edge of the disk at $\frac{r_-}{r_+} = 0.6$ and vary the star to disk mass ratio $\frac{M_*}{M_d} = 0.1, 1, 2$, and 5. For each model we use a parameterized cooling function with weak, moderate and strong cooling rates. For weakly cooled models, the growth of gravitational instabilities (GIs) lead to nonaxisymmetric overdensities in the disk. Previous work has shown that, for low $\frac{M_*}{M_d}$, these cause the disk to fragment into isolated clumps, even in the absence of cooling. For high $\frac{M_*}{M_d}$, collapse of the overdense regions is apparently disrupted as arms develop in lieu of isolated clumps. When M_* is equal to M_d, the equilibrium model evolves towards a system with both a massive clump and several arms which contain a significant portion of the systems mass. We discuss the possible role of GIs in disks as a mechanism for the formation of binary and multiple stellar systems, such as the triple protostar system L1448 IRS3B.

William Dumas
University of Oregon

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