Abstract Submitted
for the DFD09 Meeting of
The American Physical Society

Hollow Vortices in Protoplanetary Disks Dynamically Stabilized by Trapped Dust Grains XYLAR ASAY-DAVIS, Los Alamos National Lab, UC Berkeley, KATHERINE DECK, PHILIP MARCUS, UC Berkeley — We present 2D simulations of particle-laden vortices that dynamically maintain their hollow vorticity distribution (i.e., the vorticity is not a maximum at the vortex center). Vortices of this type may be the birthplaces of planets within in protoplanetary disks around newly formed stars. The vortices are embedded in a rotating, shearing Keplerian flow. Horizontally, the combination of the vortex flow and the Keplerian background flow drag dust grains, the building blocks of planets, to the center of the vortex. Vertically, grains may settle into the midplane of the disk, where the local gravity is zero, or they may be held aloft against gravity by an updraft within the vortex, just as hailstones are lofted in a thunderstorm. Our numerical simulations show that, as dust grains accumulate in the center of a vortex, the drag from the grains extracts angular momentum from the fluid flow, hollowing out the vortex. In the absence of dust grains, a hollow vorticity distribution is not stable; the vortex will readjust itself (sometimes violently) so that its vorticity decreases monotonically from the center. When dust is present, the vortex remains hollow in a dynamic equilibrium.

Xylar Asay-Davis
Los Alamos National Lab

Date submitted: 07 Aug 2009

Electronic form version 1.4