Abstract Submitted
for the DFD07 Meeting of
The American Physical Society

**Planetesimal Formation: Trapping Dust in 3D Vortices** XYLAR ASAY-DAVIS, UC Berkeley, JOSEPH BARRANCO, SFSU, PHILIP MARCUS, UC Berkeley — Scenarios of planetesimal formation have been plagued by a difficult puzzle: micron-sized dust grains that accompany the gas around a new star at extraordinarily low density ($\sim 10^{-10}$ g/cm$^3$) must somehow clump together to form kilometer-sized objects and eventually planets. At such low densities, direct interaction between grains is negligible and the kinetic energy of grains is always too large to allow gravitational collapse to occur. Although gravity pulls dust grains toward the mid-plane of the protoplanetary disk, our numerical simulations show that shear instabilities disrupt the dust layer before a Goldreich-Ward gravitational instability could occur. However, 3D, long-lived vortices provide just the kind of environment required to concentrate dust enough for agglomeration or gravitation to create planetesimals. Our numerical simulations have shown that 3D vortices exist as stable, long-lived solutions to the equations of motion of the gas in the disk around a star. These simulations indicate that 3D vortices form from breaking internal gravity waves that are generated by turbulent motion of the gas or by the interaction of existing 3D vortices. The simulations also show that 3D vortices are stable attractors of dust grains, even when the vortices occur off the mid-plane of the disk, where the "downward" pull of gravity must be counterbalanced by "upward" gas drag.

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Date submitted: 03 Aug 2007

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