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Transport by Vortices in Protoplanetary Disks PHILIP MARCUS, University of California at Berkeley, JOE BARRANCO, San Francisco State University — We present calculations and analyses of 3D vortices embedded in the vertically-stratified, rotating, shearing environment of a nearly Keplerian accretion disk around a protostar. The vortices can efficiently transport angular momentum radially away from the protostar, enabling mass to accrete on the protostar at rates of approximately one solar mass per million years, or higher. They also are efficient at accumulating dust grains, which is important in planetesimal formation. The vortices are most stable when they are located off the mid-plane of the protoplanetary disk. The 3D vortices are very robust - in part due to the fact that like-signed vortices embedded in a like-signed shear readily merge. The vortices do not require an ad hoc set of arbitrary or unlikely initial conditions. They can form from white noise, but the easiest, and probably most plausible, way in which they form is from internal gravity waves. Simulations show that almost any type of perturbation fills the disk with inertial-gravity waves. The waves "break" when they get too far from the disk mid-plane, and then form intense vortices, which readily merge together if they are anticyclonic.

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