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Zombie Vortices: The *Dead* Zones of Protoplanetary Disks are Not Dead CHUNG-HSIANG JIANG, PHILIP MARCUS, SUYANG PEI, UC Berkeley, JOE BARRANCO, SFSU, PEDRAM HASSANZADEH, Harvard, DANIEL LECOANET, UC Berkeley — Numerical simulations, using both the anelastic and fully compressible equations of motion, show that the "dead zones" of protoplanetary disks (PPDs) around forming stars are unstable and filled with vortex-dominated turbulence with Mach and Rossby numbers of order 0.2 – 0.3. The *dead zones* are regions in which the temperature is too cool for the gas to ionize and be destabilized by instabilities associated with the magnetic field. The "dead zones" were thought, by most authors, to be stable to all purely-hydrodynamic instabilities because the flow has an angular momentum that increases with increasing radius in a PPD and is therefore stable by Rayleigh's theorem. However, that theorem in not applicable to stratified flows, such as those in a PPD. We summarize our simulations with emphasis on the finite-amplitude trigger of the instability and show that when the trigger is Kolmogorov noise, the Mach number of the noise that is needed to create instability is proportional to $Re^{-1/2}$, where Re is the Reynolds number of the initial noise.

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