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Hydrodynamic Simulations of Steady-State Density Inversion in Vertically Shaken Granular Layers[1] FARHEEN SYEDA, JOSH PANFIL, JON BOUGIE, Loyola University Chicago — We investigate density inversion in shaken granular layers using three-dimensional, time-dependent continuum simulations to Navier-Stokes order for a layer of uniform, inelastic, frictionless spheres on a vertically oscillating plate. For given shaking strength, these simulations show cyclic time dependence of the granular layer correlated with the time-dependent oscillation of the plate for low accelerational amplitude. In such cases, the highest density region can be found near the plate during portions of the cycle. When the accelerational amplitude exceeds a critical value, the layer exhibits a steady-state density inversion, in which a high-density region is found far from the plate, supported by a lower-density, gas-like region below. For a variety of dimensionless shaking strengths S, we study the transition from a time-dependent, non-density-inverted state to a steady-state density inversion as a function of the dimensionless accelerational amplitude Γ. In each case, the density profile of the layer exhibits a cyclic oscillation at the driving frequency for low Γ and the response frequency matches the driving frequency through the transition. However, the amplitude of time-dependent response drops as Γ exceeds a critical value.

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Jonathan Bougie
Loyola University Chicago

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