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Are falling plumes of particles unstable in Stokes flow? ANDREW CROSBY, JOHN LISTER, University of Cambridge — A falling plume of heavy particles in viscous flow is observed experimentally to undergo a varicose instability (Pignatel et al., 2009), even though a continuum plume in Stokes flow is known to be stable. We explore this problem through numerical simulations of non-Brownian particle plumes in Stokes flow, varying the average particle number density. An initially cylindrical, axially periodic, particle plume does develop varicose perturbations to its boundary. We demonstrate that this apparent instability is caused by fluctuations in mean particle density, which provide the mechanism for radial perturbations to grow, and determine the growth rate. A competing non-linear wave-breaking mechanism and hydrodynamic diffusion cause the perturbations to saturate and destroy individual bulges. Density fluctuations, wave-breaking and diffusion combine to give a statistically quasi-steady state of bulges on the plume, with much slower diffusive growth of the mean radius. This provides an example of how a background shear flow can greatly reduce hydrodynamic diffusion due to the reversibility of the Stokes equations.

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