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Is a sedimenting array of disks stable? RAHUL CHAJWA, RAMA GOVINDARAJAN, International Centre for Theoretical Sciences, Tata Institute of Fundamental Research, Bengaluru 560089, India, NARAYANAN MENON, Department of Physics, University of Massachusetts, Amherst, Massachusetts 01003, USA, SRIRAM RAMASWAMY, Centre for Condensed Matter Theory, Department of Physics, Indian Institute of Science, Bengaluru 560 012, India — We study experimentally the stokesian sedimentation (Re $\sim 10^{-4}$) of a one dimensional lattice of discs in a quasi-two-dimensional geometry with the trajectory of the centres of the disks lying in a plane. We induce initial positional perturbations over a configuration in which the disks are uniformly spaced with their separation vectors and normals aligned, and perpendicular to gravity. For various perturbation wavenumbers and interparticle separations, we find two classes of behaviour:(i) a transient wave of orientations coupled with number-density fluctuations and (ii) a clumping instability resembling that of spheres [J.M. Crowley, J.Fluid Mech. 45, 151 (1971)], decorated with orientations. We construct the equations of motion for displacements and orientations using pairwise addition of forces and torques [R. Chajwa et. al. PRL 122, 224501 (2019)]. Linear stability analysis demarcates a phase boundary between neutrally stable and unstable regimes in the plane of wavenumber and lattice spacing, consistent with our experiments. We predict non-modal growth in this plane, with a critical density of the lattice below which all wavenumbers are asymptotically stable, showing that orientable particles need not be subject to the inevitable clumping instability of spheres.

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