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Onset of jamming for gas-fluidized grains[1]

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Upon approach to jamming, whether for molecular liquids or colloidal particles or grains of sand, the microscopic dynamics can develop dramatic long-ranged correlations while the microscopic structure remains relatively unchanged. Experimentally, it has been difficult to study such phenomena in full detail due to the range of temporal and spatial scales involved. Here we introduce a new model system that is both easier to image and to manipulate at the microscale: a bidisperse system of steel beads rolling stochastically due to a nearly-levitating upflow of air. At fixed air flow, we demonstrate that this system exhibits all the hallmarks of a jamming transition as spheres are added and the area fraction increases toward close-packing. In terms of structure, the pair correlation function and the Voronoi cell shape distribution functions exhibit peak splitting. In terms of dynamics, the mean-squared displacement develops a plateau separating the short-time ballistic from the long-time diffusive motions; in this plateau the displacement distribution is non-Gaussian, due to spatial heterogeneities. While this phenomenology is familiar, one feature observed previously only in simulation is the presence of string-like swirls of rearranging grains. We highlight these by movies of an appropriately time-averaged velocity field. We hope to connect such dynamics both to a microscopic measure of effective temperature and to the macroscopic viscosity of the system.

[1]This work was done in collaboration with D.J. Durian.