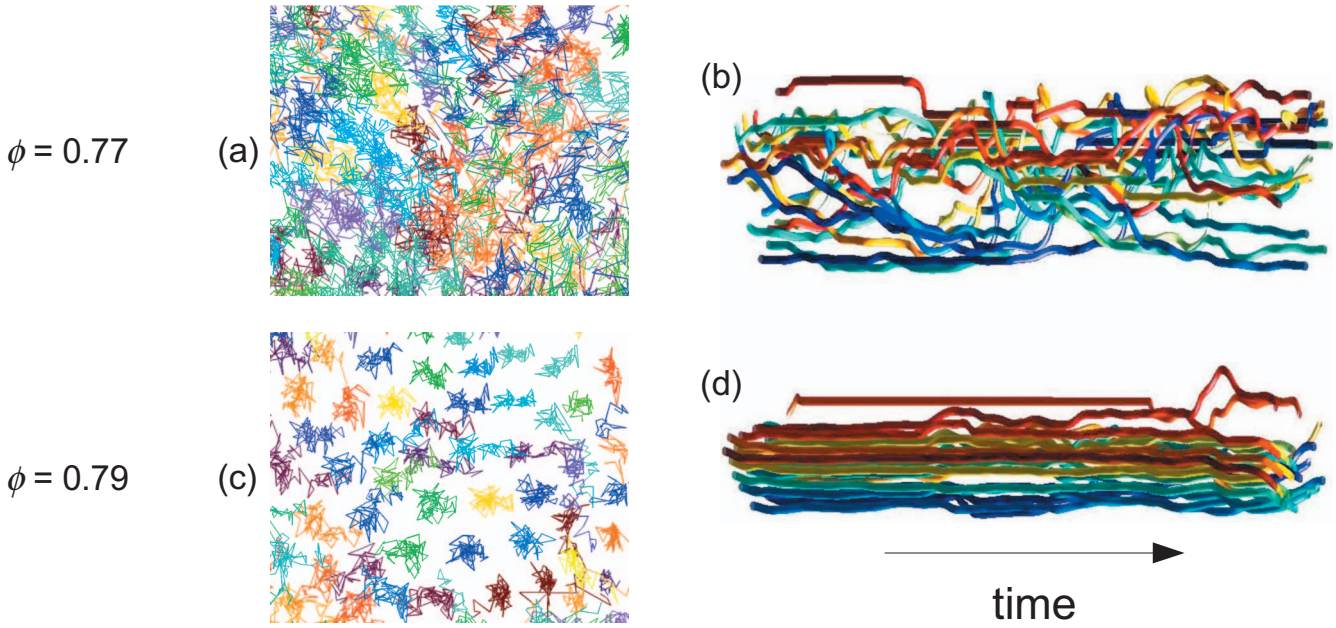

FIG. 1. (Color) [(a) and (b)] Grain trajectories at φ=0.77 and [(c) and (d)] φ=0.79. The space-time plots [(b) and (d)] follow 20 representative grains (enhanced online). [URL: http://dx.doi.org/10.1063/1.3207830.1]

Generating ensembles of two-dimensional granular configurations

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Dense granular materials, like glasses, exhibit slowing dynamics as they approach the jamming transition from a liquidlike state.[1,4] In this video submission to the Gallery of Nonlinear Images, we visualize the effect of the packing fraction φ on the dynamics of a dense two-dimensional granular material floating in a single layer on a horizontal air table. From digital images, we track the positions of grains as they evolve through nearby configurations due to external agitation supplied by bumpers along the walls.[2]

Figure 1 depicts two systems which have only slightly different packing fractions (φ=0.77 and φ=0.79) yet display a marked difference in their dynamics. We visualize this difference using both conventional diffusive measurements as well as the full spatiotemporal trajectories. Panels (a) and (c) show line segments that plot the displacement of each grain (represented by a different color line) during a 2 s interval, for a total duration of 300 s. As can be observed in the images, the chosen values of φ span the transition from diffusive to caged motion: The trajectories in (a) leave few white spaces, while most of the trajectories in (b) remain in their original locations.

In addition, we examine the entanglement of the trajectories by plotting the grain motion along a third axis representing time, shown in panels (b) and (d). The braiding of these trajectories offers a more complete description of the system than the diffusion coefficient, as it includes topological information on the motion of grains with respect to their neighbors. For example, two grains can swap position in either a clockwise or counterclockwise fashion. Future work will quantify this description.[3]

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