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Jamming in Vibrated Granular Systems[1]

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Granular materials exist all around us, from avalanches in nature to the mixing of pharmaceuticals, yet the behavior of these"fluids" is poorly understood. Their flow can be characterized by the continuous forming and breaking of a strong force network resisting flow. This jamming/unjamming behavior is typical of a variety of systems, including granular flows, and is influenced by factors such as grain packing fraction, applied shear stress, and the random kinetic energy of the particles. I'll present experiments on quasi-static shear and free-surface granular flows under the influence of external vibrations. By using photoelastic grains, we are able to measure both particle trajectories and the local force network in these 2D flows. We find through particle tracking that dense granular flow is composed of comparable contributions from the mean flow, affine, and non-affine deformations. During shear, sufficient external vibration weakens the strong force network and reduces the amount of flow driven by sidewalls. In a rotating drum geometry, large vibrations induce failure as might be expected, while small vibration leads to strengthening of the pile. The avalanching behavior is also strongly history dependent, as evident when the rotating drum is driven in an oscillatory motion, and we find that sufficient vibration erases the memory of the pile. These results point to the central role of the mobilization of friction in quasi-static granular flow.

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