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Stick-slip instabilities in sheared granular flow: The role of friction and acoustic vibrations CHARLES K. C. LIEOU, Los Alamos National Laboratory and University of California, Santa Barbara, AHMED E. ELBANNA, University of Illinois at Urbana-Champaign, JAMES S. LANGER, JEAN M. CARLSON, University of California, Santa Barbara — We propose a theory of shear flow in dense granular materials. A key ingredient of the theory is an effective temperature that determines how the material responds to external driving forces such as shear stresses and vibrations. We show that, within our model, friction between grains produces stick-slip behavior at intermediate shear rates, even if the material is rate strengthening at larger rates. In addition, externally generated acoustic vibrations alter the stick-slip amplitude, or suppress stick-slip altogether, depending on the pressure and shear rate. We construct a phase diagram that indicates the parameter regimes for which stick-slip occurs in the presence and absence of acoustic vibrations of a fixed amplitude and frequency. These results connect the microscopic physics to macroscopic dynamics and thus produce useful information about a variety of granular phenomena, including rupture and slip along earthquake faults, the remote triggering of instabilities, and the control of friction in material processing.

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