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A Freezing/Melting Transition in a Vibrated and Sheared Granular Material[1] ROBERT BEHRINGER, Duke University, KAREN DANIELS, NC State University/Duke University — We describe experiments on an annular layer of granular material that is sheared from above and vibrated from below. Key control parameters are the shear rate, Ω and the dimensionless acceleration, $\Gamma = A\omega^2/g$, where A and ω are respectively the amplitude and frequency of shaking. We measure the pressure, P, at the base of the layer, and volume, V, hence the mean packing fraction of the layer. The outer sidewall is transparent, and we image/characterize the particles in the outer layer. We find a hysteretic transition from a state with 3D order to a disordered state as the shear rate, Ω, is increased. The boundary between these two phases corresponds to equal energy inputs from shearing and shaking. We also characterize distributions for P and V. These are strongly fluctuating quantities, with broad distributions. The Kurtosis of the distributions for P and V are strongly cusped at the transition. This striking behavior suggests that a temperature-like variable may control the transition between the two states. We propose that the non-equilibrium fluctuation-dissipation theorem may provide such a temperature and explore this possibility by measuring the response function, R (for volume) to step changes in Ω. We also determine the volume correlation function, C and use this to determine an effective kT from the slope of the R vs. C curve.

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