Abstract Submitted
for the MAR16 Meeting of
The American Physical Society

**A Phase Diagram Unifies Energy Dissipation, Kinetics, and Rheology in Inertial Granular Flows** ERIC DEGIULI, Ecole Polytech Fed de Lausanne, JIM MCELWAINE, Durham University, MATTHIEU WYART, Ecole Polytech Fed de Lausanne — Flows of hard granular materials depend strongly on the interparticle friction coefficient $\mu_p$ and on the inertial number I, which characterizes proximity to the jamming transition where flow stops. Guided by numerical simulations, we derive the phase diagram of dense inertial flow of spherical particles, finding three regimes for $10^{-4} < I < 0.1$: frictionless, frictional sliding, and rolling. These are distinguished by the dominant means of energy dissipation, changing from collisional to sliding friction, and back to collisional, as $\mu_p$ increases from zero at constant I. The three regimes differ in their kinetics and rheology; in particular, the velocity fluctuations and the stress anisotropy both display non-monotonic behavior with $\mu_p$, corresponding to transitions between the three regimes of flow. We characterize the scaling properties of these regimes, show that energy balance yields scaling relations for each of them, and explain why friction qualitatively affects flow.

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Date submitted: 02 Nov 2015 Electronic form version 1.4