Unified Theory of Inertial Granular Flows and Non-Brownian Suspensions

E. DeGiuli[1†*], G. Düring[2†], E. Lerner[1,3†], and M. Wyart[1]
[1] *New York University, Center for Soft Matter Research, 4 Washington Place, New York, NY, 10003,*
[2] *Facultad de Física, Pontificia Universidad Católica de Chile, Casilla 306, Santiago 22, Chile*
[3] *Institute for Theoretical Physics, Institute of Physics, University of Amsterdam, Science Park 904, 1098 XH Amsterdam, The Netherlands*

Rheological properties of dense flows of hard particles are singular as one approaches the jamming threshold where flow ceases, both for aerial granular flows dominated by inertia, and for over-damped suspensions. Concomitantly, the length characterizing velocity correlations appears to diverge at jamming. Here we introduce a theoretical framework that proposes a tentative, but potentially complete description of stationary flows. Our analysis, which focuses on frictionless particles, applies *both* to suspensions and inertial flows of hard particles. It also predicts the shear-thinning exponent that describes soft particles under certain driving conditions. We compare our predictions with the empirical literature, as well as with novel numerical data. Overall we find a very good agreement between theory and experiment, except for frictional inertial flows whose scaling properties clearly differ from frictionless systems. Our analysis makes several new predictions on microscopic dynamical quantities that should be accessible experimentally.

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* † These authors contributed equally to this work.