high speed friction of granular layers

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There are many phenomena that can be regarded as granular flow in solid earth science; e.g., grinding of fault gouge, landslide, debris flow, pyroclastic flow, collapse of lave domes, etc. In understanding these phenomena, it is essential to clarify the rheology of granular materials. Unfortunately, despite its importance, we know very little about granular rheology from the fundamental point of view.

The concept of the jamming transition, which is recently proposed in the field of statistical physics, may provide an essential clue to the unifying principle of granular rheology. The jamming transition is a phenomenon that static granular materials obtain the elastic modulii above a certain density. At the same time, sheared granular materials obtain the yield stress above that density. In this sense, the jamming transition can be regarded as solid-liquid transition in granular media. In contrast to ordinary solid-liquid transitions, the jamming transition is thought to be a second-order phase transition, because the second order derivative of the energy (the bulk modulus) changes discontinuously and several physical qunatities show critical fluctuations at the transition point.

In this talk, we show that the granular rheology can be understood in terms of the scale invariace at the jamming transition point, which is a critical point.

By extensive numerical simulations, we find that the velocity dependence of the friction coefficient is described by a power law [1]. This power-law behavior is understood from the viewpoint of critical phenomena by constructing a Landau theory for rheology [2].

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[2]T. Hatano, M. Otsuki, S. Sasa, J. Phys. Soc. Jpn. 76, 023001 (2007)