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Fluid dynamics of liquid-granule mixture

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Wet granular materials shows behavior very different from that of dry granular materials, and the behavior depends strongly on the amount of the liquid. When grains are partially wet, the liquid bridges and clusters exert the cohesive force among grains [1]. For larger amount of liquid, the pores among grains are filled and the system becomes dense slurry, where both grain-liquid interaction and grain-grain interaction play important roles [2-4].

In this talk, we introduce simple models to describe the behavior of wet granular materials [1-3]. We especially focus on a model for a dense mixture of granules and liquid, that shows a severe shear thickening and is called a dilatant fluid. We construct a fluid dynamics model for the dilatant fluid by introducing a phenomenological state variable for a local state of dispersed particles [2,3]. We demonstrate that the model can describe basic features of the dilatant fluid, and predicts an instability in a shear flow for some regime to exhibit the shear thickening oscillation, i.e., the oscillatory shear flow alternating between the thickened and the relaxed states [2,3]. We also report the first experimental observation of the shear thickening oscillation with starch-water mixture in the Tayler-Couette flow geometry [4].

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Presenter: Prof. MITARAI, Namiko (Niels Bohr Institute)