LadHyX Seminar – May 6, 14:00

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Two case studies of flow instabilities in sheared particle dispersions: "dilute, attractive and confined" vs "dense, repulsive and frictional"

Dispersions of colloidal (Brownian) particles and granular (non-Brownian) particles into a Newtonian fluid display a wide variety of interesting phenomena under flow from shear-induced layering to spectacular shear thickening. Such a rich phenomenology is driven by the particle volume fraction, the interactions between the particles, and the flow geometry. In this talk, I will focus on two extreme cases of instabilities observed in particulate suspensions under shear.

I will first address the flow of dilute suspensions made of attractive particles and confined between two shearing surfaces separated by a distance of the order of 10-100 particle sizes. In this case, experiments show that, at low enough shear rates, an initial homogeneous dispersion gives way to a pattern of log-rolling flocs aligned along the vorticity direction and separated by the pure suspending fluid [1]. Based on numerical simulations, I will interpret such a "phase separation" as the signature of an underlying flow instability triggered by perturbations in the particle concentration field.

I will then examine the case of discontinuous shear thickening (DST), where a dense suspension of repulsive particles suddenly jams under shear due to frictional contacts. Using ultrasound imaging in a cornstarch suspension, I will show that the chaotic-like dynamics observed in the shear-rate response to an imposed shear stress result from localized bands that travel along the vorticity direction [2]. Recent models and simulations of DST confirm an instability scenario that involves unsteady vorticity bands.

[1] Z. Varga et al., PNAS 116, 12193 (2019)
[2] B. Saint-Michel et al., Phys Rev X 8, 031006 (2018)