Master 2 internship proposal

Physique et Mécanique des Milieux Hétérogènes

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Flowing suspensions

Suspensions made of colloidal particles dispersed in a liquid are ubiquitous in a wide range of applications including cosmetics (toothpaste), foodstuff (coffee), construction materials (paints) or even in biological (blood), and geophysical fluids (muds). Those complex materials exhibit a variety of rheological behaviours limiting their ability to flow and deform under solicitation. In particular, at higher volume fraction, dense suspensions exhibit shear-thickening behaviour [1-3], i.e., a rapid and reversible increase of viscosity under shear (Figure 1a). By using a transparent suspension [3] (Figure 1b), we will describe and rationalize the flowing conditions of this ambiguous regime between solid and liquid states. The project will aim to quantify flows of shear-thickening suspensions using PIV techniques in various geometries. The expected results will contribute to solve practical questions such as industrial or geophysical complex flows, or even the puzzling run of a person over a bath filled with a shear-thickening fluid (Figure 1c).

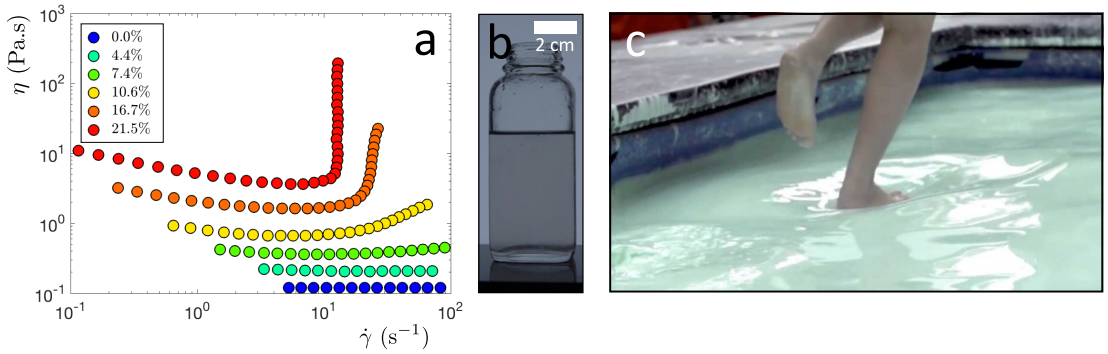

Figure 1: Shear-thickening suspensions. **a)** Flow curves $\eta(\dot{\gamma})$ of a suspension of fumed silica particles. At large volume fraction ϕ, the viscosity η increases (green to orange data) or even diverges (red) with the shear-rate $\dot{\gamma}$. **b)** Transparent shear-thickening suspension made of fumed silica [3]. **c)** While a walking person sinks into a liquid-like pool filled by a dense suspension, a faster solicitation transforms the shear-thickening fluid into a solid allowing a person to run on it.

References:

[1] J. J. Stickel and R. L. Powell, Fluid mechanics and rheology of dense suspensions, *Annual Review of Fluid Mechanics* 37 (2005).
[2] J. F. Morris, Shear thickening of concentrated suspensions: recent developments and relation to other phenomena. *Annual Review of Fluid Mechanics* 52 (2020).
[3] **P. Bourrianne**, V. Niggel, G. Polly, T. Divoux and G. H. McKinley, Tuning the shear thickening of suspensions through surface roughness and physico-chemical interactions. *Physical Review Research* 4(3) (2022).

The applicant should have interests in fluid mechanics and soft matter.
Possibility to apply for PhD position.