Proposal for a Master 2 internship

Anomalous shear localization in a granular soap film

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Particle-laden interfaces are ubiquitous in natural environment (*e.g.* insect colonies [1]) and industries (*e.g.* stabilizing foams or emulsions [2], filtration processes, armored drops used as microreactors or prevent sloshing [3]). Due to their countless applications numerous studies have been devoted to understanding the mechanical behavior of particle laden interfaces [4]. This peculiar material belongs to the global class of attractive granular material. As for free granular material their rheology is non local and when submitted to shear, a shear band develops separating an inertial zone from a quasi-static one [5]. Preliminary experiments conduct at FAST on granular soap films have shown that, in oscillatory shear, contrary to free granular material, the localization of the shear band in the cell depends on the oscillation frequency. This observation suggests an elastic origine of the position of the shear localization. The goal of the internship is to study the different flow regime and the shear localization for different soap film elastic properties and surface viscosities. The experiments will be conduct in a rheometer with a transparent cell that allow high speed camera to record grains position.

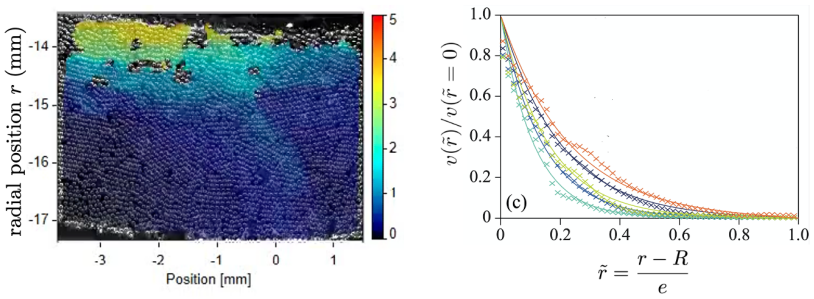

Figure 1: (a) Picture of a granular soap film with the grain velocities in color map. (b) Radial velocity profiles of the particles for different imposed stress.

The internship will take place in the Granular and Suspension group at FAST Laboratory, which has long experience and recognized expertise in granular media. The internship could be followed by a PhD (Application to the Ecole Doctorale SMEMAG).

References

[1] Nathan J. Mlot, Craig A. Tovey, and David L. Hu. Fire ants self-assemble into waterproof rafts to survive floods. *Proceedings of the National Academy of Sciences*, 108(19):7669–7673, 2011.

[2] S. U. Pickering. Cxcvi. *J. Chem. Soc., Trans*, 91(0):2001–2021, 1907.

[3] F. Moisy, J. Bouvard, and W. Herreman. Counter-rotation in an orbitally shaken glass of beer. *EPL (Europhysics Letters)*, 122(3):34002, jun 2018.

[4] Yousra Timounay, Olivier Pitois, and Florence Rouyer. Gas marbles: much stronger than liquid marbles. *Physical Review Letters*, 118(22):228001, 2017.

[5] Jonathan Lalieu, Antoine Seguin, and Georges Gauthier. Rheology of a 2d granular film. *Soft Matter*, 19(35):6838–6843, 2023.