PhD Seminar #2

Nicolas Bertin: Propulsion of bubble-based acoustic microswimmers

With no protection, a micron-sized free air bubble at room temperature in water has a life span shorter than a few tens of seconds. Using two-photon lithography, which is similar to 3D printing at the micron scale, we can build ``armors" for these bubbles: micro-capsules with an opening to contain the bubble and extend its life to several hours in biological buffer solutions. When excited by an ultrasound transducer, a 20 μm bubble performs large amplitude oscillations in the capsule opening and generates a powerful acoustic streaming flow (velocity up to 5000 body lengths/sec). A collaboration with the Dept. of Applied Mathematics and Theoretical Physics, University of Cambridge, is helping us predict the true resonance of these capsules and the full surrounding streaming flow. The present Bubbleboost project aims at creating red blood cell sized capsules (~ 10-20 μm) that can move on their own with a non-contact acoustic excitation for drug delivery applications.

Elisabeth Agoritsas: Revisiting mean-field elasto-plastic models at the mesoscopic scale

Amorphous materials (e.g. foams, emulsions, or metallic glasses) are composed of constituents of different shapes and sizes, such as bubbles in a soap foam, so that they exhibit a structural disorder that plays a determinant role in their mechanical properties. Several mean-field elasto-plastic models have been developed at the mesoscopic scale, in order to account for the plasticity in sheared amorphous materials, such as the Hébraud-Lequeux (HL) [1] or the Soft-Glassy-Rheology [2] models. Such models have proven to be rather successful in reproducing certain features observed in amorphous systems, but not all at once. Moreover, a consistent picture connecting them is still missing.

Here we discuss the physical ingredients that are put in such mean-field models, distinguishing between thermal and mechanical noises in the mean-field dynamics of amorphous materials. We focus in particular on the role of structural disorder, implemented by means of a distribution of energy barriers for the system to overcome locally when an external constant shear rate is applied to the material, and discuss specifically its implications for a generalization of the HL model [3].

[1] P. Hébraud & F. Lequeux, Phys.Rev.Lett. 81, 2934 (1998). [2] P. Sollich et al., Phys. Rev. Lett. 78, 2020). [3] E. Agoritsas et al., Eur.Phys.J.E 38, 71 (2015).