Hysteresis induced Activity in Giant Vesicle Assemblies

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Hysteresis is ubiquitous in many fields of Physics and beyond. In Soft Matter, hysteretic phenomena are often encountered : contact angle hysteresis in wetting, hysteresis curves in the rheology of soft materials. Shape hysteresis is also a requirement to break the symmetry in a cycle to dissipate or create work, which can lead to the swimming of a deformable object at low Reynolds numbers. In this PhD project, we aim at theoretically and experimentally investigate soft objects showing hysteresis under a deformation cycle at low Reynolds numbers to: (i) extract work in the form of active motion at the scale of the object and (ii) create active materials by assembly of soft objects able to show emerging properties due to collective hysteresis effects.

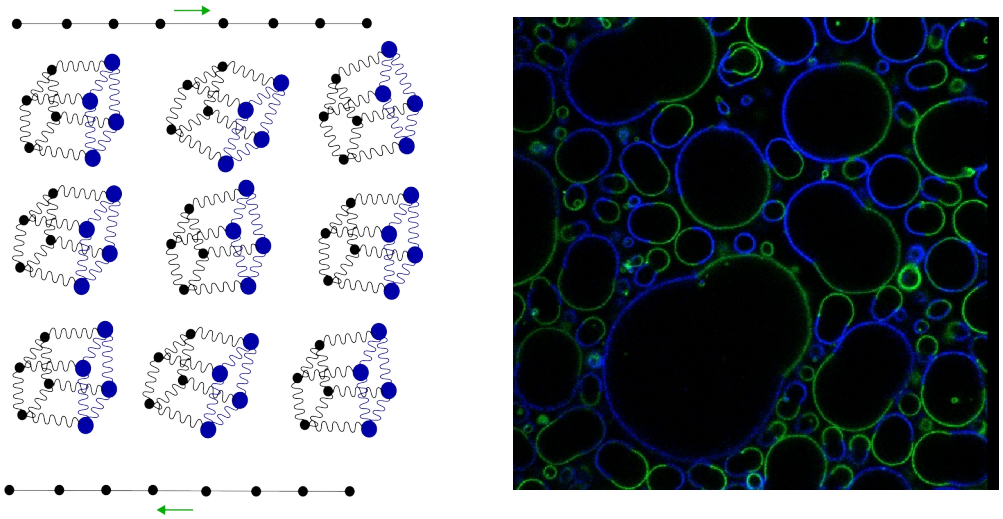

Figure 1. (left) Sketch of the bead-spring model under shear deformation for theoretical investigations. (right) Giant vesicles systems of 10-100 µm size to be investigated under cyclic deformations.

The Stokes hydrodynamics of complex shaped objects will be modeled by putting together beads and coupling them with a hydrodynamic interaction tensor.[1,] The deterministic, or Brownian, equations of motion of the beads can then be integrated, to show interesting features such as swimming strokes or complex shear-induced motion, see Fig. 1.[2] Experimental investigations on giant lipid vesicles will be designed according to theoretical results to demonstrate the activity induced by hysteresis.
The PhD candidate will implement her/his scientific program within the theoretical and experimental environment of the MCube group at the Charles Sadron Institute. She/he should have a strong interest for starting an experimental career in Soft Condensed Matter and Biophysics.

1 J. Rotne and S. Prager, *J. Chem. Phys.*, 1969, **50**, 4831–4837.

2 C. I. Mendoza, C. M. Marques and F. Thalmann, *Phys. Rev. E*, 2010, **82**, 1–4.