Laboratory: Centre Interdisciplinaire de Nanosciences de Marseille (CINaM), UMR 7325
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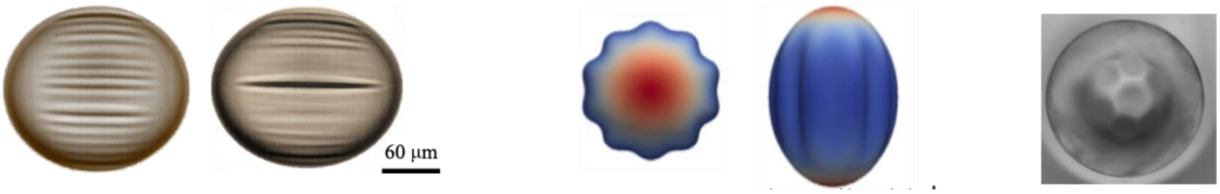
Location: Campus de Luminy, the south of Marseille
Postdoc: 1 year (ANR funding) with possible extension on collective phenomena

Microcapsules under flow, from wrinkling to spatiotemporal dynamics

Capsules or microcapsules are everyday elastic particles consisting of a liquid core bounded by an elastic membrane: pharmaceuticals, cosmetics, nutrition and new materials in construction. They can either protect, transport and deliver active ingredients, or structure space and give the assembly new properties.



Capsules are deformable particles especially under hydrodynamic constraints: see figure for preliminary experimental and numerical studies. They can exhibit two types of instabilities under flow leading to a modulation of the shape at short wavelength (preliminary results, figure) or at wavelength close to the capsule size (known numerically but not experimentally). The former are reminiscent of wrinkling instabilities (figure) while the latter are spontaneous oscillations of the overall shape recalling RBC dynamics. Experimentally, the studies require capsules of a few tens to hundreds of micrometres that are reproducible in size with known mechanical properties: constitutive law, Young modulus, Poisson ratio and thickness. The laboratory has developed the know-how to overcome this problem and has a fruitful collaboration with the group of Professor Anne Juel in Manchester University to produce microcapsules with a PDMS shell. Theoretically, on the one hand, instabilities depend on the reference shape, a characteristic that does not exist in the case of drops or vesicles. On the other hand, the wrinkling instabilities develop on a stationary state in which the shape is ellipsoidal. Numerically, the team has developed an in-house code capable of tracking the emergence of wrinkles (figure). However, it remains a challenge to reach experimental wavelengths.
In the framework of the experimental course at the frontier between soft matter and non-linear physics, we propose a postdoc to study by different methodologies the emergence of wrinkles and folds in several configurations. This is an "old" unsolved problem observed in 1970 by haematologists trying to understand the inversion of curvature at the back of the cells in microcirculation. If the wrinkles are visible on the figures (balloon in a pipe), they are not mentioned in the few papers. An in-house original high-speed imaging system will give access to the complete shape of the capsule.
The profile sought is that of a curious experimenter. He or she may participate in the theoretical development and numerical simulations that allow the limitation of the parameter space.
Collaboration: Professor Anne Juel, University of Manchester