Master 2 Internship

Title: Light-controllable synthetic cells

Type: Experimental

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PhD funding (if any):

Project: Light-controllable synthetic cells

Cells are nature's most sophisticated micro-factories, constantly sensing, adapting, and coordinating complex behaviours. This remarkable complexity inspires the creation of synthetic cells (e.g., made of lipids, polymers) that can perform life-like functions such as movement, fusion and division. The aim of this project is to engineer a synthetic cell through bottom-up assembly whose dynamics can be precisely **programmed** by an internal "engine" composed of light-activated nanomotors. Preliminary results have indicated **a cell shape transition** under laser irradiation that could open the way to photo-controllable synthetic cells.

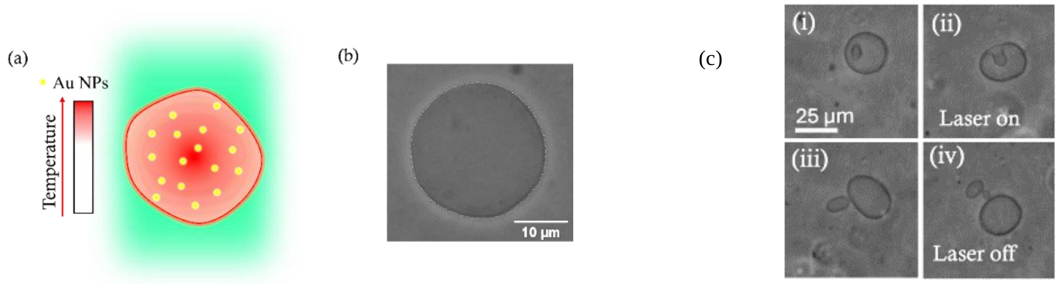

***Figure 1:* *(a)* Concept of a synthetic cell loaded with nanomotors (Gold Nanoparticles). When exposed to light, the particles heat up and create internal stresses that can change the vesicle's shape. *(b)* Microscope image of a giant cell membrane with its fluctuating contour mapped. *(c)* Shap change under laser irradiation.**

The project has two phases: **(1)** A key element of these synthetic cells is their membrane (Fig 1a-b), a dynamic boundary which constantly fluctuates due to Brownian motion. By mapping these fluctuations over time, we want to **extract** the membrane's fundamental **mechanical properties**: bending rigidity and tension. **(2)** To go beyond observation and **actively control** the dynamics of the membranes, the goal is to integrate a statistical ensemble of **light-actuated nanoparticles** (Fig 1a) within the synthetic cell. When activated, these particles generate localized forces, effectively programming the membrane's dynamics. This approach paves the way towards photo-controllable synthetic materials, where the properties and shape can be tuned with precision.

Candidate profile:

The Optoflow group at LOMA (Bordeaux) is looking for a highly motivated Master student to join our team on this project under the supervision of Dr Antoine Aubret (Permanent

CNRS), Dr Ulysse Delabre (Permanent UB) and Dr Vandana Sharma (Postdoc). Experiments will be highly interdisciplinary including optics, physical-chemistry. This project is part of the RRI Frontiers of Life of University of Bordeaux.

How to apply:
We welcome all applications, irrespective of gender, ethnicity, or any physical conditions. Our group, and in general the LOMA, strongly advocates providing an inclusive and respectful environment favouring the well-being of its members.

References
[1] Delabre, U., Feld, K., Crespo, E., Whyte, G., Sykes, C., Seifert, U. and Guck, J., 2015. Deformation of phospholipid vesicles in an optical stretcher. **Soft matter**, 11(30), pp.6075-6088
[2] Aubret, A., Martinet, Q. and Palacci, J., 2021. Metamachines of pluripotent colloids. **Nature communications**, 12(1), p.6398
[3] Aubret, A., Youssef, M., Sacanna, S. and Palacci, J., 2018. Targeted assembly and synchronization of self-spinning microgears. **Nature Physics**, 14(11), pp.1114-1118.
[4] Goy, N.A., Bruni, N., Girot, A., Delville, J.P. and Delabre, U., 2022. Thermal Marangoni trapping driven by laser absorption in evaporating droplets for particle deposition. **Soft Matter**, 18(41), pp.7949-7958