Internship: Making droplets swim using microorganisms

Gabriel Amselem, LadHyX, Ecole Polytechnique
gabriel.amselem@polytechnique.edu
Mojtaba Jarrahi, FAST, Université Paris-Saclay
mojtaba.jarrahi@universite-paris-saclay.fr

Active (self-propelled) particles hold significant promise in the development of innovative active and smart materials that can move directionally, deform, and adapt to crowded environments. At the macroscopic scale, recent advances have made use of collections of centimetric robots enclosed within a deformable membrane, transforming the membrane into an active object that is more than the sum of its components [1]: its properties (such as its ability to move around obstacles) emerge from the steric interactions between the individual active particles and the flexible boundary. The aim of this internship is to transpose these macroscopic experiments to the microscopic scale.

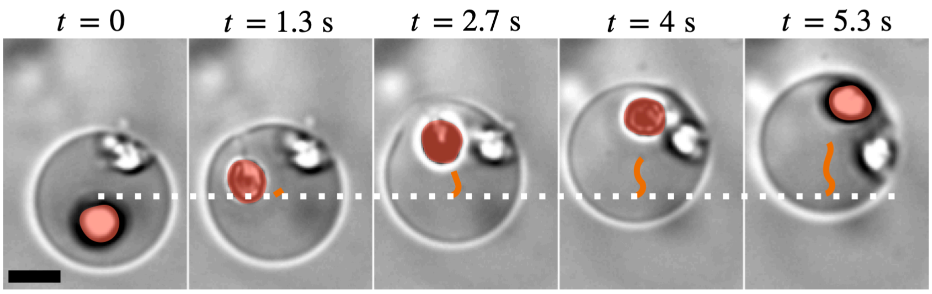

FIG. 1: Droplet propulsion. A swimming microalga (highlighted in red) is encapsulated in a droplet. When the alga swims, the droplet is propelled. Orange trace: trajectory of the center of mass of the droplet. White dotted line: initial position of the center of mass of the droplet. Scale bar: 10 μm.

We have recently designed a new kind of active particle: a droplet propelled by a swimming microalga, which is encapsulated in the droplet. As the enclosed microalga swims, the droplet is propelled, see FIG. 1. We want to better understand the physics of what is happening. As an intern, you will quantify the influence of different experimental parameters on the efficiency of droplet propulsion: does a droplet swim faster when it is bigger, contains more algae, when the interface is more deformable? On a more applied side, the algae are sensitive to light and swim in the light direction, can we control the motion of the drop in real time by dynamically changing the light gradient? What happens when such a droplet is in a complex environment such as a porous medium, can it squeeze and move through narrow pores?

The project is experimental, and involves quantitative image and data analysis. The internship can be followed by a PhD thesis.

[1] Boudet, J.F., Lintuvuori, J., Lacouture, C., Barois, T., Deblais, A., Xie, K., Cassagnere, S., Tregon, B., Brückner, D.B., Baret, J.C. & Kellay, H. (2021). From collections of independent, mindless robots to flexible, mobile, and directional superstructures. *Science Robotics*, 6(56), p.eabd0272.