

Internship: Soft microrobots propelled by microorganisms

Gabriel Amselem, LadHyX, Ecole Polytechnique
gabriel.amselem@polytechnique.edu

Mojtaba Jarrahi, FAST, Université Paris-Saclay
mojtaba.jarrahi@universite-paris-saclay.fr

The design of active drug delivery systems is an ongoing challenge whose aim is to provide local doses of drugs to target organs. A promising way to achieve such a feat is to use biohybrid robots: biological motile microorganisms modified to transport a drug. It has been shown that microorganisms such as bacteria, microalgae and amoeba can be used to transport inert microscopic plastic beads bound to their cell surface. The aim of this internship is to go one step further in the transport of loads, and design a novel type of micro robot: steerable microdroplets, propelled by encapsulated microorganisms. There are multiple advantages of using droplets compared to surface-bound loads: in particular, droplets encapsulate a volumic load, and provide a barrier between the encapsulated content and the outside environment, which stabilizes the microorganism and its cargo.

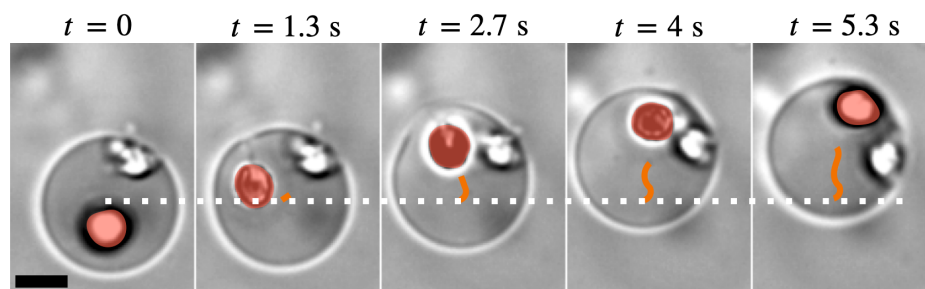


FIG. 1: Droplet propulsion. A swimming microalga (highlighted in red) is encapsulated in a droplet. When the alga swims, the droplet is propelled. Orange trace: trajectory of the center of mass of the droplet. White dotted line: initial position of the center of mass of the droplet. Scale bar: 10 μm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

We have shown that it is possible to propel microdroplets using encapsulated swimming microorganisms, see Fig. 1. We want to better understand the physics of how these droplets swim. 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 filled with obstacles, can it squeeze and move through narrow openings?

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