Master internship in microfluidics/acoustics at IEMN (Université de Lille):

Elastic modulus via vibration measurements

Duration: 2 months (M1) or in an extended version 4-6 months (M2)
Anticipated starting date: January 2026 or later
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Keywords: Acoustics, vibrations, ultrasound, laser Doppler vibrometry.

Recent studies have shown that it is possible to propel micrometer-sized swimmers via remote acoustic actuation (Fig. 1, right and also [1]). The underlying physical mechanisms to achieve this propulsion are not yet fully understood, but they involve (i) non-linear fluid dynamics and (ii) the vibrations of the swimmer itself. In the proposed internship, we will be interested second aspect, the vibrations of the solid. The material used for these swimmers is generally a polymer, whose elastic properties can be easily tuned by modifying the exact material composition. As a consequence, the respective elastic moduli cannot be systematically found in literature. We, therefore, propose to study the elastic modulus as a function of different material compositions. The method recently used in our group is based on measuring the deformations of a micro-cantilever (Fig. 2, center) with laser Doppler vibrometry and evaluating their eigenmodes.

The objective of the internship is to evaluate the elastic moduli of different polymer cantilevers. The work will include the fabrication of the cantilevers and experimental devices, as well as Laser Doppler vibrometer measurements. An important part will further be the post-processing of the measurements to extract the shape modes.

The candidate must have at least basic notions in acoustics/vibrations. A strong interest for work with Python (post-processing) and a minimum interest in experimental work is required. *[In case of an M2 internship and depending on the candidate's profile, either (i) theoretical and numerical aspects or (ii) the interaction with the liquid could be included in the work. In this case, the internship could be followed by a PhD thesis on a similar topic (through application on a merit-based scholarship at the University of Lille).]*

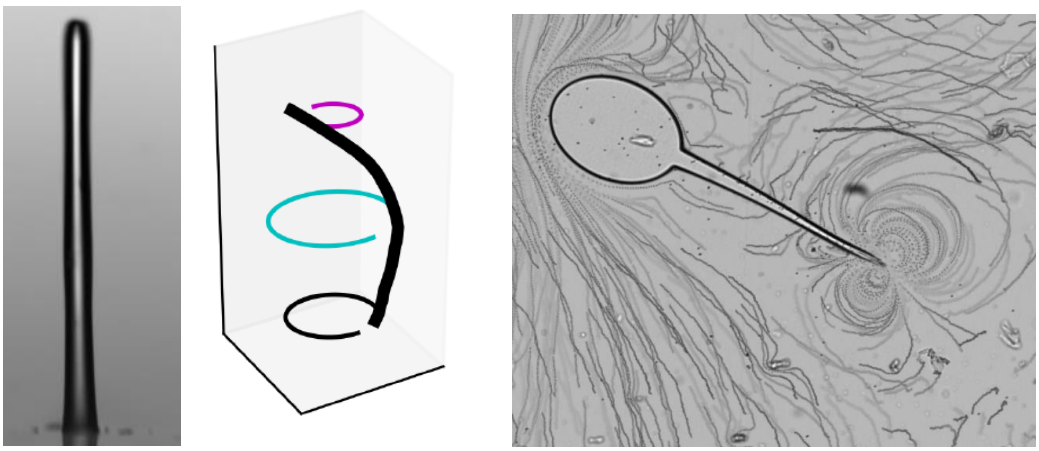

Fig. 1 : Left – snapshot of a 600 µm long cantilever. Center – 3D recontruction of its deformation using laser Doppler vibrometry. Right – the context of this study are acoustic micro-swimmers, the aim is to characterize the elastic modulus of the polymers typically used.

[1] Kaynak, Murat, et al. "Acoustic actuation of bioinspired microswimmers." *Lab on a Chip* 17.3 (2017): 395-400.