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

Microstreaming for acoustically excited micro-swimmers

Duration: 4-6 months (M2) or in a shortened version 2 months (M1)
Anticipated starting date: January 2026 or later
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Keywords: Acoustics, microfluidics, ultrasound, high-speed imaging.

In the past few years, researchers have managed to propel micrometer sized swimmers in a 2D plane by exciting them with ultrasound [1] (Fig. 1, left). The underlying physical mechanisms to achieve this propulsion are generally supposed to be the following: (i) the acoustic actuation sets the tail of the swimmer into vibration, (ii) the interaction of the vibrating tail with the surrounding liquid creates a flow called microstreaming (which, mathematically, is induced through nonlinear effects), (iii) the microstreaming exerts a relative force between the swimmer and surrounding liquid allowing the swimmer to be pushed forward. However, a detailed understanding is yet missing and hindering the conception of fully controllable 3D micro-swimmers. To leverage these shortcomings, our team is currently working on the detailed experimental, theoretical and numerical modeling of micro-streaming flows around swimmer-tails.

The objective of the internship is to conduct experiments on swimmer-tails and to compare them to the theoretical models developed in our group. The work will include the fabrication of the swimmers and experimental devices (partly in the clean room), high-speed imaging of the micro-streaming flows and the post-processing of the recordings to extract flow patterns and velocities. Furthermore, the aim is to analyze the obtained results and correlate them to theoretical predictions, to construct a coherent understanding of the microstreaming involved.

The candidate must have a strong background in fluid dynamics and at least basic notions in acoustics or vice versa. Furthermore, an interest in experimental work is required. Depending on the candidate's profile and duration of the internship, theoretical and numerical aspects can be included in the work. 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).

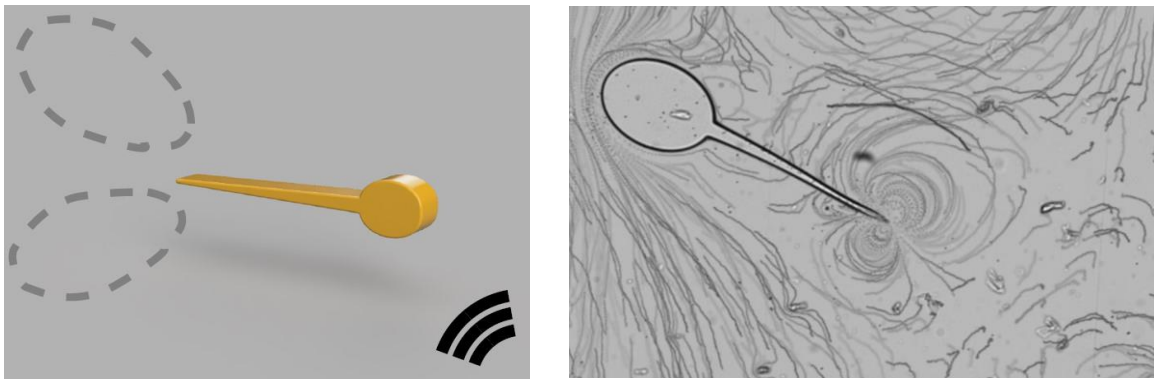

Fig. 1 : Left – Functioning principle of a microswimmer. The acoustic wave, excites the swimmer, which creates streaming flow and thus propulsion. Right – Preliminary results of streaming observed around a micro-swimmer tail.

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