

Physical and biological drivers behind bacterial collective motion

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Bacteria are active microscopic swimmers that constantly interact with their neighbors. When many cells move together, complex collective behaviors can emerge, from swirls and jets to global alignment. Understanding how these patterns arise from single-cell properties is a central question at the interface between physics and biology.

Internship objective

This internship aims to characterize the single and collective motility of bacterial cells at low and intermediate densities. The student will:

- Measure the distribution of swimming speeds in populations of motile bacteria,
- Quantify how cell motility depends on the local spatial arrangement of neighbors,
- Compare two species with distinct motility strategies: *Pseudomonas aeruginosa* (well established in the lab) and *Bacillus subtilis* (to be set up during the internship).

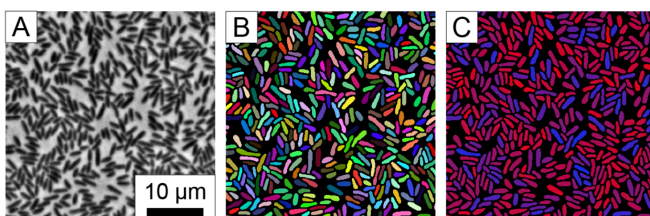
The project will shed light on the physical and biological factors driving collective motion in bacterial communities.

Approach

The internship will be fully experimental and include:

- Cultivation of *P. aeruginosa* and *B. subtilis* on agar substrates,
- High-resolution phase-contrast microscopy of bacterial motion,
- Use of advanced image analysis tools (including deep-learning-based segmentation and tracking),
- Quantitative analysis of motility and spatial organization.

We are looking for a motivated Master 2 student in physics, soft matter, biophysics or a related field, with an interest in experiments and quantitative image analysis. No prior microbiology experience is required: the techniques will be taught in the lab. The internship could lead to a PhD, through concours de l'EDPIF.



Experimental data visualization. A: Phase-contrast microscopy image of swimming bacteria swimming in a dense 2D setting. B: Segmentation and tracking output. Each cell is identified by an arbitrary color. C: Bacterial motility map based on Mean-Squared-Displacement over a 1-second sliding window; blue colors denote slower motion, while red colors indicate rapid motion.