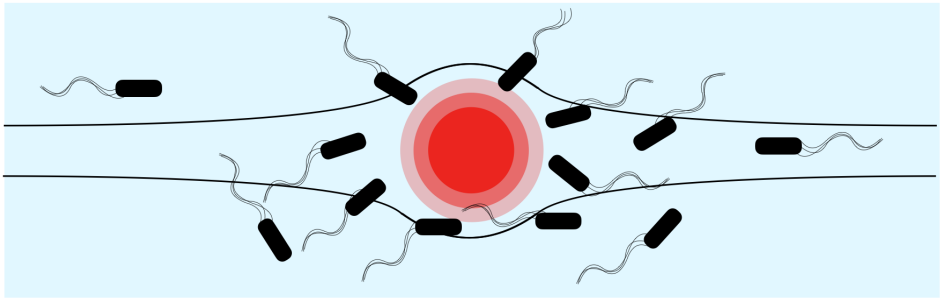
Proposal for a Master 2 internship

The air-flow rush: How do bacteria navigate complex oxygen-flow environments?

with Carine Douarche (**carine.douarche@universite-paris-saclay.fr**)
Laboratoire FAST, Université Paris-Saclay, CNRS 91405 Orsay, France
& Sophie Marbach (**sophie.marbach@sorbonne-universite.fr**)
Laboratoire PHENIX, Sorbonne Université, CNRS Paris, France

To promote healing and recolonization of degraded soils, it is essential to understand how microorganisms navigate these environments and establish themselves sustainably. To colonize a new environment, certain species of bacteria require a fluid medium containing nutrients and oxygen. However, in soils, these environmental conditions are intrinsically complex: fluids circulate within a porous matrix where oxygen and other nutrient sources are heterogeneously distributed. Bacteria detect these gradients and bias their swimming motion to find the most favorable environment. The question then is to understand the couplings between swimming, gradients, and flows: how do fluid flows modify chemical gradients, which in turn modify bacterial navigation? What are the feedback loops of bacterial consumption in these complex environments? And how do they affect the navigation of an entire colony, under more or less dense bacterial conditions? The problem is intrinsically multi-scale, from concentration gradients at the scale of a single bacterium to the large-scale colonization of millions of individuals.

To advance these questions, the objective of the internship is to develop a new microfluidic device coupled with an original analysis method to understand the behavior of bacteria in an oxygen gradient. The results of this study on the heterogeneous and collective dynamics of bacteria will broaden our understanding of microorganism colonization. The experimental part will be developed at the FAST laboratory, and the analysis of the dynamics of active suspensions will be developed in collaboration with the PHENIX laboratory.



References:

[1] M. Ardré, H. Henry, C. Douarche, M. Plapp (2015) "An individual-based model for biofilm formation at liquid surfaces" *Phys. Biol.* 12, 066015. DOI: 10.1088/1478-3975/12/6/066015
[2] J. Bouvard, C. Douarche, P. Mergaert, H. Auradou, F. Moisy (2022). "Direct measurement of the aerotactic response in a bacterial suspension" *Phys. Rev. E*, 106, 034404. DOI: 10.1103/PhysRevE.106.034404
[3] E.R. MacKay, S. Marbach, B. Sprinkle, A. Thorneywork, Arxiv 2023, https://arxiv.org/abs/2311.00647