# Marangoni-induced spreading of bacterial colony

Supervisors:
- Maxime Deforet (HDR, Laboratoire Jean Perrin, Sorbonne Université)
- Arnaud Antkowiak (HDR, Institut Jean le Rond D'Alembert, Sorbonne Université)

Bacterial populations form complex spatial structures that govern their ability to colonize environments. While motility through flagella or type IV pili is a well-known mechanism of bacterial spreading, certain bacteria can expand collectively by modifying their surroundings. In particular, the secretion of osmolytes and biosurfactants can generate fluid flows, enabling colony expansion even in the absence of motile appendages. However, the physical principles underlying this process remain poorly understood.

Recent observations in *Pseudomonas aeruginosa* reveal that non-motile mutants (lacking flagella and pili) can still spread across millimetric distances under specific conditions. This project aims to test a working hypothesis for this phenomenon: (1) water is drawn out of the agar gel due to osmotic imbalance, (2) biosurfactants generate an outward Marangoni flow, (3) this flow transports individual non-motile cells in a manner akin to pebble saltation in rivers, and (4) water eventually reabsorbs into the gel at the colony's boundary.

To validate this mechanism, we will combine microbiology experiments and fluid mechanics modeling. Using genetic mutants and controlled surfactant supplementation, we will manipulate flow onset and intensity. Multiscale imaging and optical profilometry will quantify water transport, agar deformation, and colony expansion. Theoretical modeling, based on thin-film equations and numerical simulations, will predict the onset of fingering instabilities and spreading dynamics.

This interdisciplinary project bridges microbiology and fluid mechanics, providing new insights into bacterial self-organization and environmental interactions. By integrating experimental data with predictive modeling, we aim to establish a framework for understanding non-motile bacterial spreading, with broader implications for biofilms, pathogen dispersal, and active matter physics.