Following the water:
Flows through the gel beneath a growing bacterial colony

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Bacterial colonies on agar are usually studied from above, with the gel treated as a passive support and a nutrient reservoir. Yet a colony is a strong sink and source of water: cells take up water to grow, secrete osmolytes and surfactants that pull water out of the gel, and spread within a thin liquid film they produce themselves. Agar, which is about 98% water, is a porous medium, so this water has to come from somewhere. As the colony expands, water is drawn through the gel network toward the colony, the gel shrinks, and gradients of water content build up beneath and ahead of the colony front. These flows are almost never measured. Yet, they may still control colony expansion and the shape of the colony edge.

The goal of the internship is to map the water flow inside an agar gel during colony growth, and to relate it to colony expansion. Depending on the candidate's interests, the project combines:

- Flow visualisation in the gel: Embedding fluorescent tracers (beads, dextrans) in the gel. Following their displacement over hours with time-lapse microscopy, using particle image velocimetry, particle tracking, and photobleaching or photoactivation patterns.
- Gel deformation: Measuring gel deformation and the colony topography with optical interferometric profilometry. Connecting the volume lost by the gel to the measured flows.
- Controlled perturbations: Varying agar concentration (and therefore permeability), water availability, and the ability of cells to produce surfactants (mutant strains). Testing which ingredients drive the flow.
- Quantitative analysis and simple modelling: Image analysis with deep-learning segmentation and tracking tools developed in the lab. Order-of-magnitude comparisons with poroelastic and Darcy flow descriptions of the gel.

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.

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