MICROPHASE SEPARATION OF LIVING CELLS

LABORATORY : Institut Lumière Matière

LEVEL : M2
TEAM(S) : LIQ@INT

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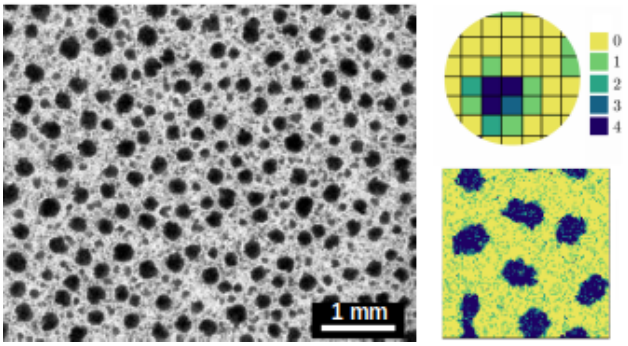
KEYWORD(S) : Statistical-Physics / Simulations / active-matter

SCIENTIFIC CONTEXT :

Keywords. Active matter, statistical physics, biophysics, numerical simulations

Context. **Self-organization** of cells is central to biological systems and understanding the underlying mechanisms is a long-standing quest. Recent experiments on the model organism Dictyostelium discoideum show that those motile cells **can self-assemble into compact domains** (Figure 1). The mechanism, which relies on Dicty's response to oxygen gradients, is in fact akin to microphase separation [1]. This equilibrium phenomenon induces the **formation of domains through competing interactions**, usually a short-range attraction opposed by a long-range repulsion. Over the last 40 years, microphase separation was reported in physical systems such as magnetic films, liquid crystals and copolymers, but never in living cells. The experiments of Figure 1 thus raise a host of questions.



Experiments (left) and simulations (right) of microphase separation

MISSIONS :

Goal. We wish to understand the microphase separation of cells using **numerical modeling**. Our mesoscopic simulations describe individual cells, accounting for adhesion, oxygen consumption and motion toward oxygen-rich regions. The simulations so far can only explain the domain size. All other facets of the microphase separation remain to be explored. In particular, we wish to unveil the possible **morphologie**s and the **dynamic properties** of the surprisingly mobile domains.

Internship. The student will exploit and expand an existing simulation code. A taste for statistical physics and numerical techniques is desirable. No background in biology is required.

Environment. The intern will join the Liquides et Interfaces team and collaborate with the Biophysics team, two large groups with an array of experimental and modeling techniques to investigate soft, active and living matter.

OUTLOOKS :

PhD thesis. Continuation as a **PhD is possible,** with "bourse ministère"

BIBLIOGRAPHY :

[1] Microphase separation of living cells. Carrère et al, Nature Communications (2023)

See complete offer at

http://ilm-perso.univ-lyon1.fr/~fdetcheverry/stage/stageM2these_microphaseseparation.pdf

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