Master 2 research internship in Integrated Structural & Cell Biology in Grenoble

Supervisor(s):
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Host laboratory:
LPCV www.lpcv.fr

Host group/team:
Cytomorpholab

Title of the M2 research internship:
Reconstitution of cytoskeleton-based living materials for information tasks

Project summary:
Understanding the basic principles of what is defining life is still an unresolved question, with broad applications from the field of fundamental sciences and origins of life to the applied field of synthetic cells design. Recent definition by Stuart Bartlett suggested that a living state is defined by four processes: dissipation, autocatalysis, homeostasis and learning (Bartlett & Wong, 2020). Cytoskeleton is of a primary importance for cell functions and has the property to generate large-scale assemblies from nanometer-scale proteins. It is therefore reasonable to think that cytoskeleton could behave as a "living material"(Banerjee et al, 2019).
We recently used the actin-based motility assay (where a polystyrene bead is propelled by actin polymerization) to study the basis of actin dynamics in a closed environment (Colin et al, 2023). This system consumes energy (out-of-equilibrium), is autocatalytic and is able to reach homeostasis. However, we did not explore if this system fulfills the fourth element of the living state: information. Therefore, the objective of this internship is to understand if beads propelled by actin at steady state can convey information. More precisely, what are their ways of conveying information? What are the minimal ingredients for this collective to convey information?

The experiments will be the following: (1) High number of beads in unconfined environments (variation of bead density and bead diameter). (2) High number of beads in a confined environment (simple environment like microwells of various sizes, and more complex environments like gradients, maizes etc.). Cross-correlations and fluxes will be measured in order to evaluate the existence and the strength of the collective behavior.
The selected student will have a unique opportunity to be part of an internationally renowned team, working in a creative and lively environment, providing access to state of the art techniques (microfabrication techniques, advanced microscopy, biophysics).

Keywords:
in vitro reconstitutions, actin cytoskeleton,

Relevant publications of the team:
- Colin A., Kotila T., Guérin C., Orhant-Prioux M., Vianey B., Lappalainen P., Mogilner A., Théry M., Blanchoin L. Recycling limits the lifetime of actin turnover. EMBO Journal, 2023

- Colin A.*, Orhant-Prioux M.*, Guérin C.*, Savinov M.*, Scarfone I., Roux A., De La Cruz E., Mogilner A., Théry M., Blanchoin L. Friction patterns guide actin network contraction. PNAS, 2023

- Gelin M., Schaeffer A., Gaillard J., Guérin C., Vianay B., Orhant-Prioux M., Braun M., Leterrier C., Blanchoin L., Théry M. Microtubules under mechanical pressure can breach dense actin networks. Journal of Cell Science 2023

- Yamamoto et al., Actin Network Architecture Can Ensure Robust Centering or Sensitive Decentering of the Centrosome. The EMBO Journal 2022

- Kučera et al., Actin–Microtubule Dynamic Composite Forms Responsive Active Matter with Memory. PNAS 2022