

INTERNSHIP PROPOSAL

Laboratory name: Institut Jacques Monod

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Internship location: Institut Jacques Monod, 75013 Paris, France

Thesis possibility after internship: YES

Funding: NO

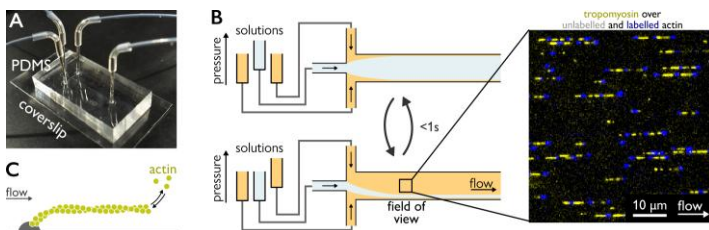
Study of Active Chiral Processes in Acto-Myosin Bundles

Topics actin cytoskeleton, molecular motors, biomechanics, in vitro, microfluidics.

Summary

Within every mammalian cell, the actin cytoskeleton forms networks composed of multiple filaments that support numerous fundamental cellular functions, such as cell division, motility, and intracellular transport. Myosin molecular motors use ATP hydrolysis to exert power strokes onto actin filaments. This phenomenon is up-scaled and applied to large assembly of filaments in actin networks inside cells, and leads to active chiral phenomena. These are at the base of many large scale processes, such as the asymmetric development of multi-cellular organisms. **Identifying the coupling between physico-chemical and geometrical parameters in acto-myosin networks to better understand active chiral processes is thus one of the most fundamental problem in biology.**

To investigate this we focus our effort on the study of the emergence of rotational chirality in polar actin bundles. **We propose bottom-up approaches to decipher individual molecular events and how they synergize to drive collective activity at the meso-scale.** We will combine original experimental design to study motor-filament interactions using minimal reconstitution systems, with purified proteins. We will use a combination of **fluorescence microscopy, microfluidics, and magnetic tweezers**, which allows us to precisely control biochemical conditions and apply physiologically relevant forces in order to quantify the interactions between the filaments and various regulatory proteins. This work will be carried in close collaboration with physicists (both experimentalists and theoreticians).



Reconstruction of Individual Actin Filaments in a Microfluidic Chamber

(A) Photo of the microfluidic setup. (B) Schematic of the microfluidic device. The pressure applied to each solution controls the flow rates within the chamber. Zoom: Typical image of actin filaments (blue) partially coated with a protein (yellow). (C) Schematic of an actin filament polymerized from a

spectrin-actin primer (gray).

We seek motivated and talented students with a background in physics, or biology/biochemistry, and with an interdisciplinary mindset. Candidates should be curious, and eager to discover original experimental approaches.

References

- Kools et al, Myosin-X sorts actin filaments into parallel bundles and tunes barbed-end dynamics, [bioRxiv](https://doi.org/10.1101/088888), 2016.
- Pochitaloff et al, Flagella-like beating of actin bundles driven by self-organized myosin waves, [Nature Physics](https://doi.org/10.1038/nphys2022), 2022.

Please, indicate which speciality(ies) seem(s) to be more adapted to the subject:

Condensed Matter Physics: YES

Soft Matter and Biological Physics: YES

Quantum Physics: NO

Theoretical Physics: NO