Linking simulation to continuous mechanics of biological materials

Internship offer

Several biological materials are complex assemblies of semi-flexible filaments. They form out-of-equilibrium systems, driven by the consumption of chemical energy. Two lengthscales are usually considered to study the mechanics of these systems : the microscopic lengthscale (at the scale of single filaments) and the macroscopic lengthscale (at the material scale). The first is tackled using numerical simulations, while the second is addressed by continuum mechanics, e.g. active gels. However, bridges between the two representations are still lacking.

The project The goal of this project is to develop a generic method to connect the microscopic and macroscopic descriptions of biological materials. For this, the student will first address a simple system, in which continuous solutions are analytically available in some limits, and that can be simulated using an established simulation software, Cytosim. The student will then seek to use simulations to validate and expend the analytical model, and map continuous mechanical properties to the underlying microscopic parameters.

Methods The student is expected to understand and apply concepts from statistical and continuum mechanics. The simulation platform is already implemented, but being able to write analysis scripts will be an asset. To map continuous to discrete properties, the student will use recently developed theoretical tools based on information theory.

The lab The team "Cellular Spatial Organization" is an interdisciplinary team that hosts both theoreticians and experimentalists, and has gained a reputation on intracellular architecture and mechanics. We develop cutting-edge methods both experimental and theoretical. It is in an ideal scientific environment for a physicist interested in biological applications, being located in a biology institute with a strong focus on experimental biophysics, and neighbour to an experimental and theoretical physics institute. It is also conveniently located inside Paris at the intersection of several public transport networks.

Supervision The student will be mentored by Serge Dmitrieff : `serge.dmitrieff@ijm.fr`.
More information :

- `www.biophysics.fr` ; `https://twitter.com/bio_physics`
- `https://github.com/SergeDmi`

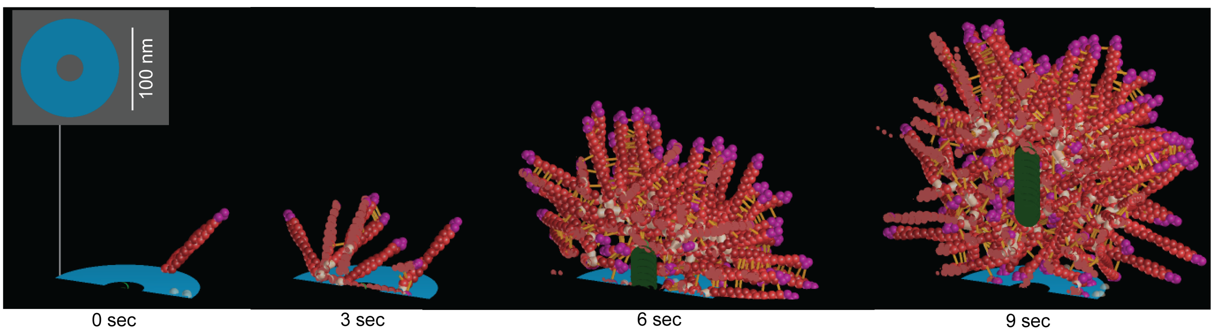

Figure 1: Overdamped Langevin simulation of actin filaments in yeast endocytosis. Actin filaments (red) polymerize at the nucleation disc (blue). Since actin is tethered to the vesicle (green), the polymerization of new filaments will pull the vesicle upwards. (+) ends of actin filaments are shown in purple.