Visco-elastic properties of the cytoplasm

Internship offer

The cytosplasm is a visco-elastic material, the properties of which are paramount to cell physiology, and organism development. In large cells, such as sea urchin eggs, it is possible to sample cytoplasmic physical properties by displacing large objects (oil droplets, nucleus, spindles), e.g. by using magnetic tweezers. Using this technique in the case of Sea urchin eggs, we are able to show that the visco-elasticity of the cytoplasm allows the maintenance of the spindle position at the center of the cell, in the absence of active centration forces.

However, how these visco-elastic properties stem from the intra-cellular components (organelles and cytoskeleton for instance) remains ill determined.

The project The goal of this project is to develop a functional visco-elastic model of the cytoplasm. For this, the student will compare theoretical results to existing experimental results showing the kinetics of displacement of large objects in the cytoplasm, as well as the flow maps inside the cytoplasm. The student will then participate in designing experiments to identify the microscopic origin of cytoplasmic visco-elasticity.

Methods The student is expected to apply concepts from fluid dynamics and continuum mechanics. We will use the software Comsol as a simulation platform, but being able to write analysis scripts will be an asset. An interest in biology is paramount to the success of this project.

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.

More information Lab webpage:

- `www.minclab.fr` ; `http://www.minclab.fr`

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

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

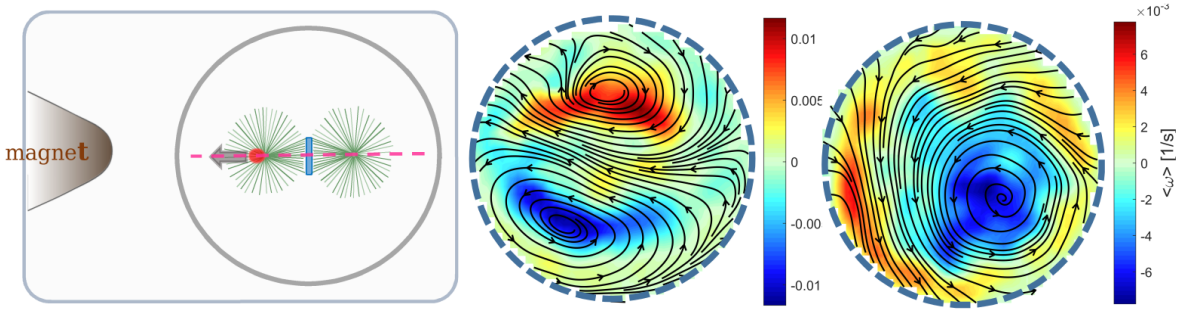

Figure 1: Left : schematic of the experimental setup : a magnet pulls on the magnetic beads attached to the spindle. Right : averaged flows in eggs obtained by PIV from pulling experiments.