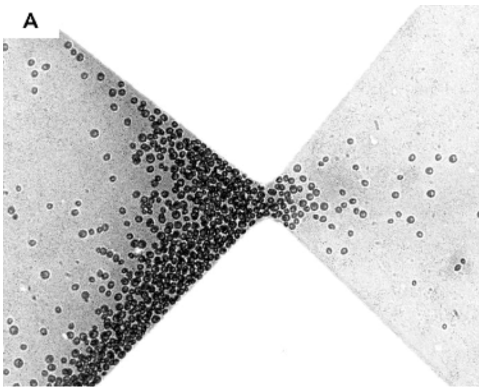
PhD offer :

A crowd of Microswimmers



Context :

The modeling of crowd movements has become a very active field of research, and deep debates still animate the community on how to model certain behaviors such as panic movements. In this case, the "faster-is-slower" effect plays a central role: it essentially indicates that, in certain situations for which the crowd is very dense, the will of the individuals is to increase their mobility in their effort to evacuate, which has the effect of blocking the entire evacuation process. A similar paradoxical effect is known as loss of capacity. The capacity of an exit door is defined as the maximum flow that can pass through it. This quantity is not a static value, but depends on the regime. The phenomenon of loss of capacity corresponds to a significant decrease in the actual flow upstream.

Project :

It has recently been established that the paradoxical effects observed in crowd dynamics persist in a very wide variety of systems: in a granular silo, in a suspension as well as for a flock of sheep or in a crowd of pedestrians. A physicist's approach therefore invites us to look for a common physical mechanism behind these measured observables. At a minimum, it would be desirable to succeed in defining classes of universality in this family of problems. In particular, a class of system could be that of the active suspensions which intrinsically involves hydrodynamic interactions between the agents. How microhydrodynamics will affect crowd dynamics is the question we will address in this project.

Thesis work:

The thesis work proposed here is experimental. It will analyze and quantify the behavior of micronagers (microalgae) put in evacuation situation. The geometry of microfluidic chips will be inspired by given architectural ensembles. The experiments involve cell culture, microfabrication, light field microscopy, image analysis and particle tracking and finally statistical data analysis.

Skills:
The candidate will have a background in physics / mechanics: soft matter, bases in hydrodynamics and mechanics of continuous media with a strong taste for the experiment.
Microfluidic experiments coupled with microscopic imaging will be performed. This involves microfabrication in a clean room (LIPHY). Data analysis will consist primarily of image analysis and particle tracking (LIPHY). This requires basic programming knowledge. In the lab, the programming language used for data analysis and image processing is Python.

Although the project involves working with a living organism, the notions of biology are not indispensable. Indeed, the training necessary to manage the cell culture is generally acquired in a few weeks (LIPHY).

Host teams :

The supervising team at LIPhy (Grenoble):

- **Salima Rafaï** (CNRS, CR), Experimenter Physicist, developed the experimental study of microalgae dynamics at LIPhy.
- **Philippe Peyla** (Grenoble University, Prof.) Numerical modelling based on hydrodynamics.

LMO and DMA partners (departments of Mathematics of Orsay and ENS):

- **Bertrand Maury** (Orsay University, Prof.) Numerical modelling of crowd dynamics
- **Sylvain Faure** (CNRS, IR) software development

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