Master 2 Internship

Title: **Active Matter and Soft Vesicles**

Type: **experimental**

Supervisor(s): Antoine Allard (LOMA), Laura Alvarez (CRPP) and Cristian Villalobos Concha (CRPP)

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PhD funding (if any):

Project:

Photosynthetic microorganisms contribute half of the world's oxygen production, consume carbon dioxide, and have a promising future in the production of chemical complexes and biofuels. Beyond their environmental and industrial relevance, they serve as important biological models for understanding microswimmer navigation strategies in complex environments. One key open question is how swimming microorganisms interact mechanically with soft, deformable boundaries such as artificial membranes. Such interactions can affect both cell navigation and membrane mechanics, offering a way to link active swimming with the physical properties of soft matter.

This project will establish an experimental framework to study the interaction between algae and giant unilamellar vesicles (GUVs, [1]). The student will track *Chlamydomonas reinhardtii* [2], a single-celled organism used as a model for studying swimmers, near vesicles while simultaneously measuring vesicle fluctuations. By tuning lipid composition and therefore bending rigidity, the study will reveal how membrane mechanics influence swimming behavior and, conversely, how swimmer activity perturbs vesicle dynamics.

The work will involve culturing algae, preparing vesicles, and using optical microscopy with imaging to extract both cell trajectories and fluctuation spectra. Microfluidic chambers will be used to control encounters between swimmers and vesicles. Image and data analysis will provide quantitative measures of motion and membrane mechanics. The internship will provide hands-on training in biology, vesicle preparation, microscopy, and data analysis, offering an interdisciplinary introduction to experimental biophysics.

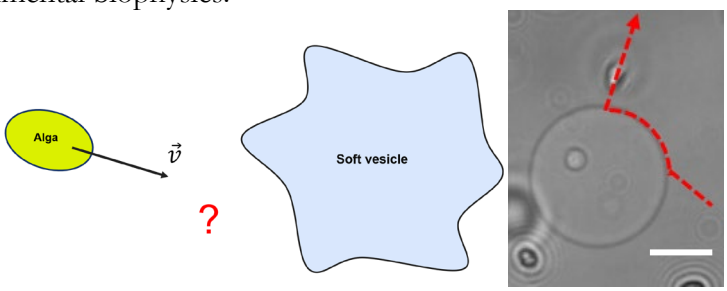

Figure 1: (Left) Summary of the project. (Right) Cell trajectory along a giant GUV. Scale bar: 20 μm.

Bibliography:

[1] Pécréaux et al., Refined contour analysis of giant unilamellar vesicles, The European Physical Journal E (2004)
[2] Harris, Chlamydomonas sourcebook., Academic Press San Diego (1989)