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Internship location: LPENS, 24 rue Lhomond, 75005 Paris

Thesis possibility after internship: YES Funding: NO

Probing internal phototactic states dynamics in the model micro-alga *Chlamydomonas reinhardtii*

Microalgae are living organisms that play a key role in the environment and can also be used for the sequestration of CO₂. At the physics laboratory of ENS (LPENS, UMR 8023) we aim in particular at understanding their collective motion as well as their individual behavior in response to light (phototaxis). We propose a M2 research internship and a PhD thesis aiming to probe the internal phototactic states dynamics of the model unicellular micro-alga *Chlamydomonas reinhardtii* (Fig. 1A). These algae can perform both positive and negative phototaxis (towards higher or lower light intensities respectively), but the decision-making process between these two states is still rather poorly understood, although essential for understanding the ecological dynamics of these globally important micro-organisms. Recent results in the group have established that the switch between these two states involves memory effects that can be used to localize cells in specific location of structured light landscapes (Fig. 1B) and that we aim to quantitatively probe with the use of dynamical light patterns using a Spatial-Light-Modulator (SLM, Fig. 1C) that allows to create any light pattern and to modulate them at relevant frequencies.

In this project, the student will use video-microscopy, simple optics, image analysis, basic microalgal culturing techniques, microfluidic techniques and data analysis as well as apply theoretical concepts (stochastic processes, statistical physics, etc). The internship can be followed with a PhD (funded through a doctoral scholarship to apply to). During the PhD the student will also have the opportunity to work on collective behaviours induced by phototaxis in populations of these micro-algae. This project is in collaboration with J.-F. Allemand (LPENS), Sylvain Gigan (LKB) and Gianni Jacucci (U. Calabria Italy).

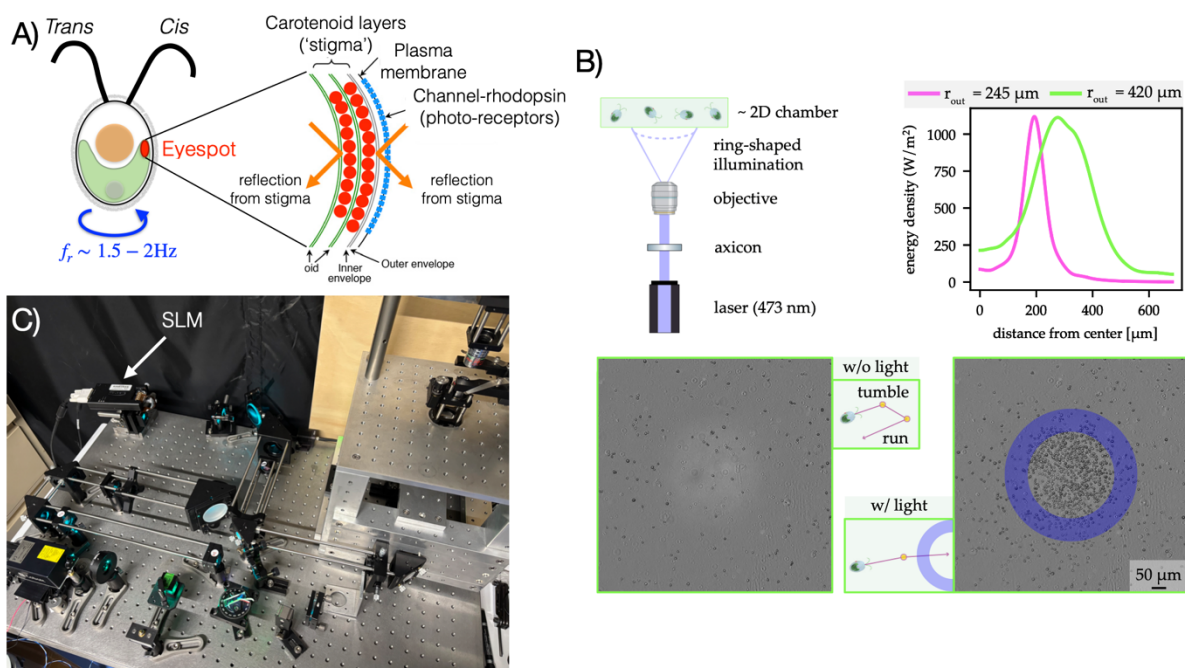


Fig.1. A) Schematics of a *Chlamydomonas reinhardtii* cell, which swims using its two front-mounted flagella and senses light with its eyespot. The eyespot scans the light environment as the cell spins along its swimming direction (at $\sim 1.5\text{-}2\text{Hz}$). B) A previous project has demonstrated the trapping of the cells in ring-shaped illumination patterns because of memory effects affecting the switch between positive and negative phototaxis. C) Picture of the current setup that makes use of a SLM to create dynamic light patterns (instead of the axicon in panel B).

Condensed Matter Physics: NO

Quantum Physics: NO

Soft Matter and Biological Physics: YES

Theoretical Physics: NO