Light-induced mixing in suspensions of photosynthetic micro-algae

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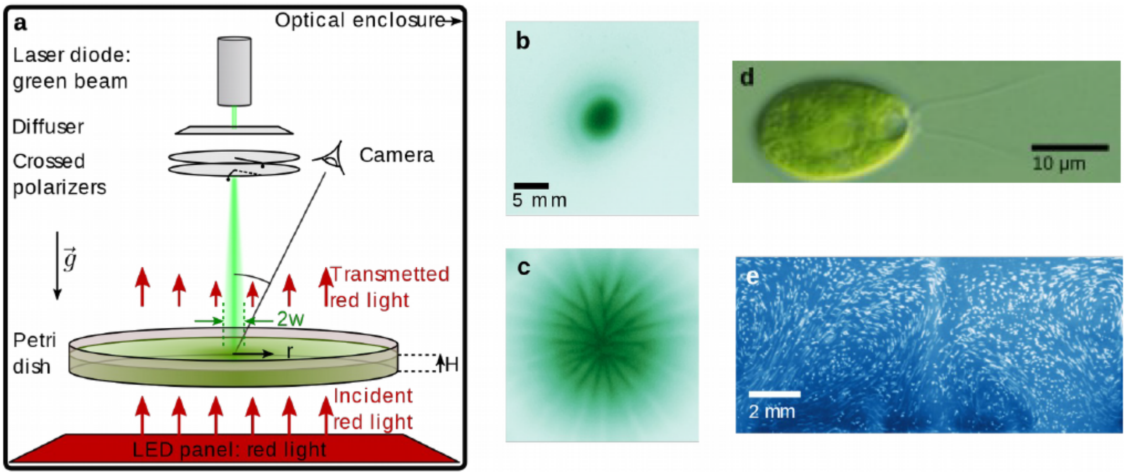
The use of photosynthetic micro-algae in photo-bioreactors relies on the ability to genetically engineer the cells to optimize biofuels production. Micro-algae can grow with simple growth requirements (light, sugars, simple nutrients, CO2). However, reaching high growth rates is still a challenge in the design of photo-bioreactors [1]; optimal growth should rely on a well-distributed access to those requirements, enabled by continuous mixing. In suspensions of motile micro-organisms which are heavier than water, collective swimming in a particular direction in response to physico-chemical stimuli creates density gradients which can generate macroscopic convection flows referred to as bio-convection. In suspension of phototactic micro-algae *Chlamydomonas Reinhardtii* (CR) (Fig-d), it was recently demonstrated [2] that using a localized light beam (Fig-a) to attract and accumulate cells induces localized photo-bioconvection. We have studied the associated concentration patterns when increasing the beam width. We have shown that the concentration field exhibits remarkable symmetry breaking from round patterns (Fig-b) to more complex patterns (Fig-c). We are currently developing a fluorescence imaging system allowing us to track small passive tracers in order to visualize fluid flows in real time (Fig-e).



We now aim to adapt the experimental setup in Fig-a to study the possibility of light-induced mixing in suspensions of CR and its effect on the growth-rate by using complex spatio-temporal light fields. In the laboratory, an optical system using a laser diode and mirrors mounted on motors has been developed in this perspective. During this internship the student will implement this optical system in the experimental setup and will control spatio-temporal light fields to enhance mixing in the suspensions. The student will also use different experimental tools to characterize the growth of CR under these conditions.

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References:

[1] C. Posten. *Design principles of photo-bioreactors.* Engineering in Life Sciences, 165-177 (2009).
[2] J. Dervaux, M. Capellazzi Resta and P. Brunet. *Light-controlled flows in active fluids.* Nature Physics, 13:306-312 (2017).