Many photosynthetic micro-organisms are able to detect light and move toward optimal intensities. This ability, known as phototaxis, plays a major role in ecology by affecting natural phytoplankton mass transfers and has important applications in bioreactor and artificial microswimmers technologies. We have shown [1] that this property can be exploited to generate macroscopic fluid flows using a localized light source directed (Fig-a) toward shallow suspensions of the phototactic microorganism *Chlamydomonas reinhardtii* (Fig-c). Within the intensity range of positive phototaxis, algae accumulate beneath the excitation light where collective effects lead to the emergence of radially symmetric convective flows. These flows can be used as hydrodynamic tweezers to manipulate small floating objects. At high cell density and layer depth, we have uncovered a new kind of instability wherein the viscous torque exerted by self-generated fluid flows on the swimmers induces the formation of traveling waves (Fig b and d).

The goal of this internship is to investigate experimentally and/or numerically these bioconvective flows. Thanks to the support of the ”Cellule Energie” of the CNRS, we are developing a fluorescence imaging system allowing us to visualize fluid flows in real time. By taking advantage of the versatility of dynamically controlling a light intensity field, we aim at generating and studying the stability of complex fluid flows, such as laminar chaotic flows.


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