Pattern formation in localized photo-controlled bioconvection

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Many micro-organisms display taxes which are movements in response to stimuli, away or towards the stimuli sources. For example, many photosynthetic micro-organisms display phototaxis which enable them to optimize their light environment. In suspension of photosynthetic and phototactic micro-algae *Chlamydomonas Reinhardtii* (CR) (Fig. 1a), it was recently demonstrated [1] that using a localized light beam (Fig. 1b) to attract and accumulate cells could induce localized photo-controlled bioconvection. Bioconvection is a hydrodynamic phenomenon in suspension of motile micro-organisms which are heavier than water. The accumulation of micro-organisms due to their biased swimming creates density gradients that can be unsable. Then, self-generated macroscopic convection flows can arise with associated concentration patterns.

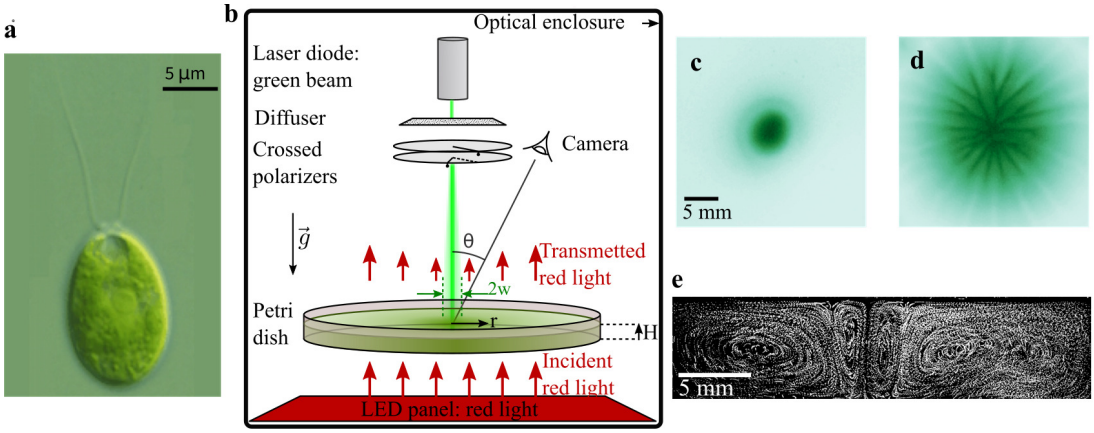

Figure 1. a, CR single cell **b,** A thin layer of a suspension of CR cells lays in a horizontal Petri dish. A green laser beam is used to attract CR. The concentration field is accessed by a top view of the transmitted red light coming from below. **c, d,** Colorized top views of the concentration field on the red channel. **e,** Side view fluoresence imaging of the flow field in a 2D geometry

It was shown [1] that localized photo-controlled bioconvection appears far below the expected Rayleigh number for spontaneous (without light excitation) bioconvection. Here, first we study the associated concentration patterns when increasing the beam width and the Rayleigh number. We show that the concentration field exhibits remarkable symmetry breaking from round patterns (Fig. 1c) to more complex patterns (Fig. 1d). We are also developing a fluorescence imaging system allowing us to track small passive tracers to visualize fluid flows in addition to the concentration field (Fig. 1e). This will help us to better understand the relationship between the bioconvection flows and their associated concentration patterns.

References

1. J. Dervaux, M. Capellazzi Resta, & P. Brunet, Light-controlled flows in active fluids, *Nature Physics*, **13**, 306–312 (2017).