Swimming of a confined micro-alga in the presence of a phototactic signal

Badr Ahmad[1], Argoul Françoise[1], Allard Antoine[1]

1 Univ. Bordeaux, CNRS, LOMA, UMR5798, Talence, France

In their natural environment, the motility of microswimmers is controlled by many different factors. A widely used algal model that deals with such signals, *Chlamydomonas Reinhardtii (CR)*, adapts its swimming strategy by sensing chemical gradients, probing its mechanical environment, or detecting light[1]. For the latter, the ability to swim according to light cues is known as phototaxis, a crucial phenomenon for many photosynthetic micro-organisms, allowing them for instance to seek optimal light conditions for photosynthesis, which converts light into chemical energy for the cell [2–4]. In a free environment and in the presence of such phototactic light, wild-type CR tends to swim towards the light signal for a certain period of time, before swimming away from it[4]. While these experiences suggest that phototaxis and photosynthesis are qualitatively linked, their relationship has not yet been quantified.

We study the motility of CR in a confined environment in the presence of a light signal. This is done by partially illuminating the environment available to the algae, in a PDMS chip with phototactic light. Individual algae are trapped in a dumbbell-like two-state system, where they can only swim in a lit well, or a dark one, both connected by a narrow tunnel. A first goal is to look for swimming tendencies in the presence of these different signals, and to observe how changing parameters (diameter of the well, length and width of the tunnel, …) would affect them.

Preliminary results seem to show that the position probability density of CRs seems to be higher at the edges of the wells or inside the tunnel than in the wells, far from the walls, similar to the results found by Ostapenko et al.[5] The second goal of our work will be to assess whether the phototaxis of CRs is related to their photosynthetic activity and to quantify it.

1. Hoober, J. K. The Chlamydomonas Sourcebook. A Comprehensive Guide to Biology and Laboratory Use. Elizabeth H. Harris. Academic Press, San Diego, CA, 1989. xiv, 780 pp., illus. $145. *Science* **246**, 1503–1504 (1989).

2. Dervaux, J., Resta, M. C. & Brunet, P. Light-controlled flows in active fluids. *NATURE PHYSICS* **13**, (2017).

3. Eisenmann, I. *et al.* Light-induced phase separation with finite wavelength selection in photophobic micro-algae. Preprint at https://doi.org/10.48550/arXiv.2401.08394 (2024).

4. Arrieta, J., Barreira, A., Chioccioli, M., Polin, M. & Tuval, I. Phototaxis beyond turning: persistent accumulation and response acclimation of the microalga Chlamydomonas reinhardtii. *Sci Rep* **7**, 3447 (2017).

5. Ostapenko, T. *et al.* Curvature-Guided Motility of Mcroalgae in Geometric Confinement. *Phys. Rev. Lett.* **120**, 068002 (2018).