Master 2 internship proposal

Physique et Mécanique des Milieux Hétérogènes

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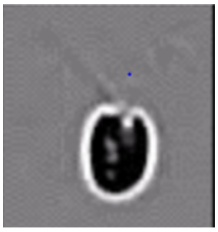
Internship location: Barre Cassan A1, campus Jussieu, 7 Quai Saint Bernard, 75005 Paris

Driving an algae with light,



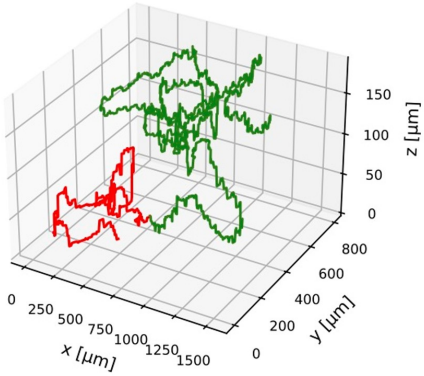


Figure - *(left) Mono-cellular algae chlamydomonas reinhardtii propelling with a frontal set of two flagella. (Right) Reconstruction of its swimming trajectory by Lagrangian tracking with a 2-colour beam-splitter technique. The algae starts under red illumination at t=0, then a green light is switched on at t=16 s, inducing a phototactic response: the algae moves towards the upper wall.*

A 3D Lagrangian tracking technique was built in the PMMH Laboratory to follow for very long times in 3D, fluorescent objects such as colloids or motile bacteria. Furthermore, a "two-colours" extension of this technique was set to track the body in one color (fluorescence in green) and visualize at the same time in another channel, the flagella dynamics (in red). Recently we have shown that algae can also be tracked for long times using the natural auto-fluorescence excited in red, a color neutral to phototactic response. **Towards motion-control:** the two color technique lets the possibility to excite in another color channel where the micro-organism displays a phototactic response. On the figure we present a preliminary experiment where the algae was tracked in red color and then received a blue color excitation driving it towards the upper wall (negative phototaxis). This observation opens the possibility to incorporate in the tracking algorithm a feed-back loop on the intensity of the excitation with respect to its position in the microfluidic cell and guide the microorganism in a desired direction. Trough a fundamental understanding of the phototactic response, the intern will develop a driving algorithms such to be able to localize the microorganism in a central location of the visualization cell and study the statistical features of his exploration process.

Reference

Run-to-tumble variability controls the surface residence times of E. coli bacteria. G. Junot et al., Phys. Rev. Lett., **128**, 248101 (2022).

Expected skills: This experimental project does not require any a priori knowledge in microbiology and is mainly based on video-visualizations under the microscope and image analysis, leading to statistical analysis.