M2 internship: Enhanced nutrient uptake by microswimmers under flows

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Subject

One of the most basic needs of any living organism is to find enough nutrient in its environment to survive. Microorganisms inhabit a large diversity of environments, from oceans to soil to animal hosts. In contrast with well-controlled lab settings where these organisms are in a quiescent fluid, real-life environments like the ocean exhibit permanent flows. Such flows carry the organisms around, and, importantly, can also enhance their nutrient uptake by increasing transport towards them compared to pure diffusion. The relationship between the enhanced nutrient intake and the outer flow has been theoretically derived years ago [1, 2], see Fig. 1. Yet, to date, no quantitative experimental measure of the enhanced nutrient uptake in the presence of flows exist.

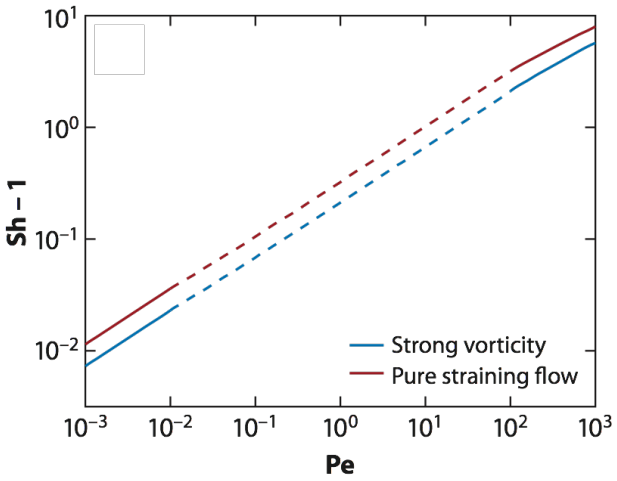

Figure 1: Theoretical enhancement of nutrient uptake as a function of external flow. The graph plots the Sherwood number (Sh) as a function of the Péclet number (Pe). The Sherwood number shows the relative increase of nutrient uptake in a flow compared to a purely diffusive uptake. The Péclet number is an indication of the magnitude of the external flow. Graph taken from [2].

In this internship, we will use a droplet microfluidic setup to encapsulate microorganisms and subject them to external flows, while monitoring the uptake of fluorescent compounds or fluorescent microbeads. The droplet microfluidic setup will allow to perform hundreds of experiments in parallel. The obtained experimental results will be systematically compared to existing theories. These results will strengthen our understanding of transport at low Reynolds numbers, sharpen our picture of marine ecosystems, and be useful in the design of more efficient bioreactors.

References

[1] L. Karp-Boss, E. Boss, and P. Jumars, *Oceanogr. Mar. Biol.* **34**, 71 (1996)

[2] J. S. Guasto, R. Rusconi, and R. Stocker, *Annu. Rev. Fluid Mech.* **44**, 373 (2012)