Hydro-Dynamic Interactions in Swimming Algae

Master Graduation Project[1], Koen Muller

Laboratory for Aero and Hydrodynamics, TU Delft

Abstract

Collective behavior is abundant in nature, from flocks of birds down to coherent motion of microbes. At the small scale, microbes such as bacteria and algae, swim at low Reynolds number ($Re{\sim}10^{-3}$). As has been shown by the seminal work of Purcell (1977), low Reynolds number swimming gaits are limited to non-reciprocal shape transition. Recent experimental advances using 2D imaging techniques such as μPIV have shown that bacteria and algae indeed exploit the characteristics of Stokesian swimming. Respectively, for model types as bacteria and algae, the organism either pushes or pulls on the fluid concerning the mean far field in frame of the organism. Such different types of hydrodynamics imposed by the individual organism has large consequence on the collective behavior, such as swarming and flocking, but also nutrient transport around the organism. Studying the resulting motility of such micro-organisms in a fluid dynamics perspective, has potential to better understand the formation of antibiotic resistant biofilms, and harmful algae blooms, as well as for promising impact in the area of lab-on chip devices, process intensification, biofuel production, and microfluidic mixing. With novel considerations such as active/living fluids in the fluid mechanics community, there specific interest to understand consequences of control parameters such as confining geometry, types of swimming, and the cell density in a mesoscale continuüm point of view. In this work we focus on the green algae C. Reinhardtii, we are interested to gain understanding to what extend the imposed hydrodynamics of individual organism influence the motion of others, and how the motility is influenced by the presence of boundaries. We hope to gain new experimental insight in the motility of this micro-organism by means of 3D micro-fluidic imaging techniques.

[1] This graduation project supervised by Dr. Daniel Tam, and conducted in the group of Prof. Jerry Westerweel.