CASTS Talk

Hydrodynamics of phototactic microswimmers

2015 - 11 - 26 (Thu.)
15:20 - 17:00
308, Mathematics Research Center Building (ori. New Math. Bldg.)

Some microalgae are sensitive to light intensity gradients. This property is known as phototaxis: Thealgae swim toward a light source (positive phototaxis). Experimentally, we use this property to control the motion of microalgae within a Poiseuille flow using light [1]. The combination of flow vorticity and phototaxis results in a concentration of cells around the center of the flow thus creating a jet of micro-algae. Intermittent light exposure allows analysis of the dynamics of this phenomenon and the reversibility of the jet formation.In order to model this phenomenon, three-dimensional (3D) numerical simulations are performed on suspensions composed of puller-like microswimmers in a Poiseuille flow which self-orient themselves regularly in a given direction in order to mimic phototaxis [2]. Simulations are based on the numerical resolution of the flow equations at low Reynolds numbers discretized on a 3D MAC grid. The model reproduces very well the formation of the jet of swimmers by self-focusing. Simulations also predict an instability of the jet, which leads to its fractionation in clusters. We show that this instability is due to hydrodynamic interactions between microswimmers, which attract each other along the flow direction. This phenomenon is peculiar for pullers for which collective motions are usually not observed on such a short time scale.

[1] Xabel Garcia, Salima Rafaï and Philippe Peyla, Light control of the flow of phototactic microswimmer suspensions, Phys. Rev. Lett. 110, 138106 (2013)
[2] Levan Jibuti, Ling Qi, Chaouqi Misbah, Walter Zimmermann, Salima Rafaï, and Philippe Peyla, Self-focusing and jet instability of a microswimmer suspension, Phys. Rev.E90, 063019 (2014)

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