Internship proposal: Study of bacterial transport processes during the early stage of biofilm formation

Hervé Henry and Mathis Plapp, Laboratoire de Physique de la matière condensée, École Polytechnique, Palaiseau.
Contact: herve.henry@polytechnique.edu

Context:

Bacteria are widespread living monocellular organism and despite their simplicity they have the ability to adapt to dramatic changes of their environment and to live in extreme conditions. Among the mechanism that do allow them to survive to changing conditions (such as the apparition of antibiotics, or strong fluid flow), biofilm formation consists of the transition from a planctonic state where bacteria swim freely in water to a state where they form a gel like structure that is made of bacteria attached to each other through a polymeric matrix. The formation of this biofilm can only occur when the bacteria concentration is high enough. It is therefore necessary to understand how the interplay of the planctonic motion with the the environment can lead to the formation of aggregates. At the LPS Orsay, colleagues have conducted experiments that allow to measure the evolution of the bacterial concentration in a macroscopic system. While the agregation of bacteria at the interface with air can be reproduced with a simple mechanism involving the transport of oxygen from the water air interface and the Oxygen dependant behaviour of bacteria, some details of the experimental measures remain unexplained.

Objectives:

The aim of the internship will be to propose and test models that, based on simple physical consideration, allow to reproduce at least qualitatively the experiments. In a first stage the evolution of bacteria will be described in a fluid at rest. Thereafter a model that quantifies the effects of the fluid flow induced by bacteria at a macroscopic scale will be used to take into account the fact that bacteria are denser than water and can induce a fluid flow analogous to the Raileigh Benard convection. At this stage the effects of the flow on the spatial organisation of the bacteria and on the transport of oxygen will be evaluated.