Imaging bacterial adhesion forces

M2 research Project, LIPhy, Grenoble

Bacteria spend most of their life attached to surfaces, in multicellular organized communities called biofilms. Biofilms are highly cohesive and promote resistance to antibiotics, so that their prevention is an important challenge. The first step towards long-term surface contamination is the attachment of individual swimming bacteria to an immersed surface. Interestingly, recent results have shown that surface attachment is a signal that is sufficient to activate some bacterial behaviors such as virulence or biofilm formation [1]. This suggests that mechanical interactions play a key role in the life of bacteria. However, the way bacteria integrate mechanical signals is unknown, just as their specific response to a given mechanical environment.

We have developed imaging tools to measure *in situ* the forces exerted by bacteria adhering to a soft elastic substrate (Fig. 1) [2]. The technique consists in imaging simultaneously bacteria, as well as the deformation of the underlying substrate via embedded fluorescent microparticles. Forces can next be computed from bead displacements using linear elasticity theory. **The long-term goal of this project is to understand the relation between the mechanical environment of bacteria and their virulence.** To this aim, we will:

- First, characterize into details the forces applied by adhering bacteria on their substrate (amplitude, distribution and dynamics), for different strains of the pathogen *Pseudomonas aeruginosa.*

- Second, correlate these forces to (i) the efficiency of surface colonization and (ii) the phenotypic response of bacteria, visualized via well-chosen transcriptional fluorescent reporters (based on genes involved in virulence regulation pathways).

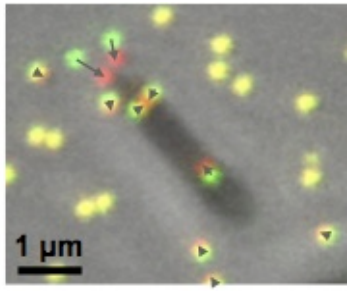

Fig. 1: Bacterium adhering on a polyacrylamide hydrogel. Deformation of the substrate is visualized thanks to embedded fluorescent microparticles. Initial positions of the beads are in green, current positions in red (Overlay in yellow). Grey arrows show the bead displacements due to the bacterium pulling on the substrate.

We are looking for candidates eager to work in a multidisciplinary environment, at the interface between physics, optics and biology. Some knowledge in basic programming and image analysis is a plus. This project can be continued as a PhD.

Contact : Sigolène Lecuyer (sigolene.lecuyer@ujf-grenoble.fr)
Delphine Débarre (delphine.debarre@ujf-grenoble.fr)

[1] Siryaporn, A., et al. (2014). "Surface attachment induces Pseudomonas aeruginosa virulence." Proc Natl Acad Sci U S A 111(47): 16860-16865.
[2] Duvernoy MC. (2015) "Mécanique de croissance d'une micro-colonie bactérienne", Thèse de doctorat de Physique, Université Grenoble-Alpes.