M1/M2 internship proposal

Label-free optical imaging of bio lms at the liquid-air interface

General information

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Scienti c description

The bio lms are multicellular tissues made of bacteria and the matrix that they produce. In nature, most of the bacteria lives within bio lm bounded to a moist surface. Despite their prevalence a lot still remains to understand the mechanisms underpinning such bacterial self-organization. In particular, the signals and the genetics pathway spurring the formation of a bio lm at the air-liquid interface (or mat) are still poorly known. Recent progress in this eld (Ardre et al., J. Bact, 2019) decipher at the macroscopic scale the in uence of few important genes in this process. However, the gathering of more information at the mesoscopic scale would open avenues for a better understanding of the mate formation.

Currently, it is still di cult to provide a thorough 3D quanti cation of even simple biophysical parameters (such as bacteria density, speed, bio lm volume, etc...). In terms of optical imaging, the bio lm operates a transition from a transparent layer to a highly scattering volume, making it complicated to follow individual bacteria over the course of the bio lm formation. The most popular imaging techniques involve uorescence imaging, which is not very robust to scattering, and requires genetic manipulation of the bacteria.

Figure 1: The bio lm formation at the air-liquid interface.

Other recent techniques, such as transmission imaging or optical coherence tomography, rely on an intrinsic optical contrast, but fail to provide a su - cient 3D resolution to allow single cell imaging. At the Institut Langevin, we recently developed a new imaging technique, called dynamic full eld optical coherence tomography (D-FF-OCT) (J. Scoller et al., J. Biomed. Optics, 2019), that captures the intrinsic scattering contrast of biological objects thanks to a white light interferometer. It o ers an almost isotropic 3D resolution around 1 m, and can e ciently work in highly scattering samples.

This project aims to optimize a new version of the D-FF-OCT setup and quantify the bio lm formation at the air-liquid interface in a controlled environment. Then, image analysis tools could be developed to automatically quantify useful biophysical parameters and perform bacteria segmentation and classi cation. Finally, these parameters will be included in a biophysical model of bio lm formation. This project could be the start of a PhD project, given a funding is obtained with the student.

Figure 2: First observation of a bio lm with D-FFOCT.

Expected skills

The project is mainly experimental, and will involve the development of an optical microscope, as well as an incubator to control the bio lm environment. General knowledge in physics, and programming are expected, as well as strong interest for the the biophysics interface.