Proposition de stage de Master 2
Institut de Physique de Nice — CNRS - UMR 7010

Characterization of interactions between a plant root and its pathogen

Topics: microfluidics, biophysics of microorganisms, time lapse microscopy, data analysis

Context: Oomycetes are major plant pathogens that significantly affect various crops among which most of agronomic species and varieties. It is therefore important to better characterize the mechanisms that govern plant-oomycete interactions in order to propose new methods of control that are adapted and environmentally friendly. Plants and microorganisms establish a molecular dialogue throughout infection. In the soil, the roots secrete a set of molecules that can constitute signals perceived by pathogens to initiate the infectious cycle. In this context, we are studying the interaction between the model plant *Arabidopsis thaliana* and the telluric oomycete, *Phytophthora parasitica* in order to characterize the root signals perceived by the pathogen. *P. parasitica* produces infectious particles called *zoospores* that swim in the soil to reach and infect the roots.

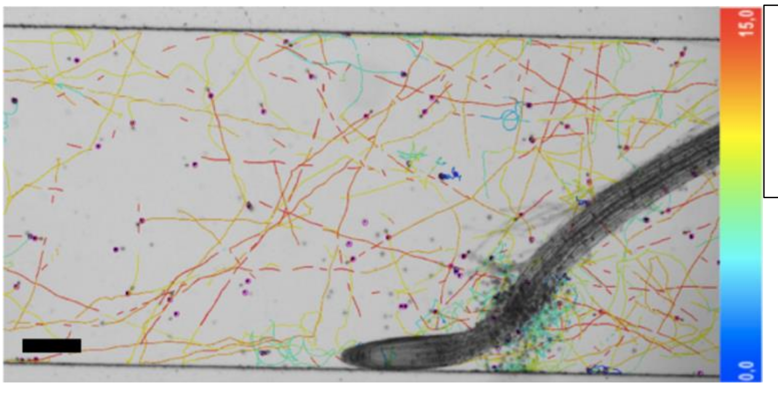
We have developed since few years, an **interdisciplinary approach** together with **plant biologists** (Agnes Attard and Eric Galiana at ISA) and **physicists** (Céline Cohen et Xavier Noblin in INPHYNI). This collaboration allows to characterized zoospores as a **new type of micro-swimmers** (Tran et al.), and studied how they response to ionic gradients **using microfluidic devices** (Galiana et al.).

The present master work is a part of the evolution of this research project. More precisely, two master students (one physicist in INPHYNI and one biologist in ISA) will be recruited and will work together during the internship. Each MASTER student will broaden his field of expertise through different experiment developed in each laboratory. It is financed by Academy 4 of UCA JEDI IDEX.

Objectives: It has been shown that zoospores accumulate at a specific zone on the plant root before the penetration and infection. **Our project aims to determine how the ionic fluxes emitted by the roots can constitute a signal that drives zoospores and allow infection. The Master's student work from the physics point of view will focus on:**

Imaging the zoospores in the presence of a root, in specific microfluidic devices. Based on previous work (Massalha *et al*., 2017) and on unpublished preliminary assays performed in the lab (Fig 1.), the student will lead all the processes from the design to the fabrication of the set-up in clean room. He will also be in charge of trajectory analysis, speed and zoospore density distribution measurement and statistical analysis. He will dispose of an ultra fast camera and an inverted microscope.

We will study: **1/ The effect of the presence of the root** and **2/ the effect of inhibitors or activators of proton pumps on the movement of the zoospores**, by comparing the kinetic parameters of zoospore movements with or without drug treatment.



Preliminary results: zoospores were introduced in a basic microfluidic device in the presence of a root. The cells were tracked and analyzed with ImageJ. The color bar indicate velocity in arbitrary units. Bar: 100 µm.

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• Tran, Galiana, Peruani, Thomen, Cohen, Orange, Noblin. To be submitted

• Galiana E, Cohen C, Thomen P, Etienne C, Noblin X. 2019 Guidance of zoospores by potassium gradient sensing mediates aggregation. J. R. Soc. Interface 16: 20190367.

• Hassan Massalha, Elisa Korenblum, Sergey Malitsky, Orr H. Shapiro, and Asaph Aharoni. 2017. Live imaging of root–bacteria interactions in a microfluidics setup. PNAS 114 (17) 4549-4554