

Master 2 Internship in Soft Matter Physics

Biophysics of Zoospore Microswimmers

Institut de Physique de Nice, MIMIC Team

Our team, in collaboration with plant biologists from INRAE Sophia Antipolis, studies the microswimmer *Phytophthora parasitica*—a plant pathogen responsible for diseases such as mildew, which cause billions in agricultural losses each year [1]. In its motile form, the **zoospore**, this pathogen uses chemotaxis to navigate chemical signals and infect plants.

In previous work, we used microfluidics to study the collective movement of these microswimmers in chemical gradients [2], around living plant roots [3], and with other soil-dwelling species [4]. We also characterized the physics of their swimming in unconstrained liquid environments [5].

Internship Focus: Investigating Zoospore Swimming and Chemotaxis

Four different research projects are available for you to choose from for a Master's 2 internship:

1. **Collective Swimming Dynamics:** Explore how neighboring zoospores influence individual swimming behavior through microfluidic experiments and trajectory analysis.
2. **Chemotaxis and Plant Interaction:** Extend our study of zoospore kinetics near plant roots using plant mutants, combining microfluidic experiments and trajectory analysis.
3. **Flow measurements around roots:** to identify the origin and assess the significance of the main flows: those resulting from direct exchanges between the root and the surrounding fluid, as well as residual flows in the channel (pervaporation through the PDMS channel and the pressure differences between the inlet and the outlet).
4. **Data Analysis with Deep Learning:** Develop deep learning methods to infer interaction potentials from trajectory data, with applications to zoospore-root interactions.

Benefits of the Internship:

- Interdisciplinary research at the intersection of physics, biology, and data science.
- Hands-on experience with advanced microfluidic techniques and computational tools.
- Opportunity to contribute to research with direct agricultural and environmental impact.

References

- [1] <https://inphyni.univ-cotedazur.fr/sites/mimic/recherche/micro-nageurs-phytopathogenes>
[2] Galiana et al., (2019) Interface 16(157) 20190367, 10.1098/rsif.2019.0367
[3] Cohen et al. (2025) Phys. Rev. E. <https://journals.aps.org/pre/abstract/10.1103/PhysRevE.111.024411>
[4] Lupatelli et al. (2023) Computational and Structural Biotechnology **21** 5640
[5] Tran et al. (2022) eLife <https://elifesciences.org/articles/71227>.

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