SPPIN SAINTS-PERES Paris Institute for the Neurosciences

Université de Paris

SINGular imagING Group

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Institut Langevin ONDES ET IMAGES

Internship offer

Polarized super-resolution fluorescence microscopy

Super-resolution microscopy has revolutionized life science by allowing structural and functional optical imaging down to the nanometer scale. Single-Molecule Localization Microscopy (SMLM) has become the most popular solution, best suited for imaging thin transparent objects as encountered in cellular biology. In addition to providing 3D localization, polarization-resolved SMLM has demonstrated the possibility to reveal the molecular orientation of the molecules [1]. The main limitation of traditional SMLM is its weak resilience to the presence of optical aberrations induced by both the optical system and the sample. The axial localization of the individual molecules is especially challenging. Among other techniques, 3D localization by wavefront sensing has demonstrated improved performances in the presence of aberrations [2].

In this context, given the need for a simple sintrument, the *singular imaging group* has developed an novel single-shot full-Stokes polarimetric wavefront imager [3], enabling simultaneous 3D nano-localization and molecular orientation determination.

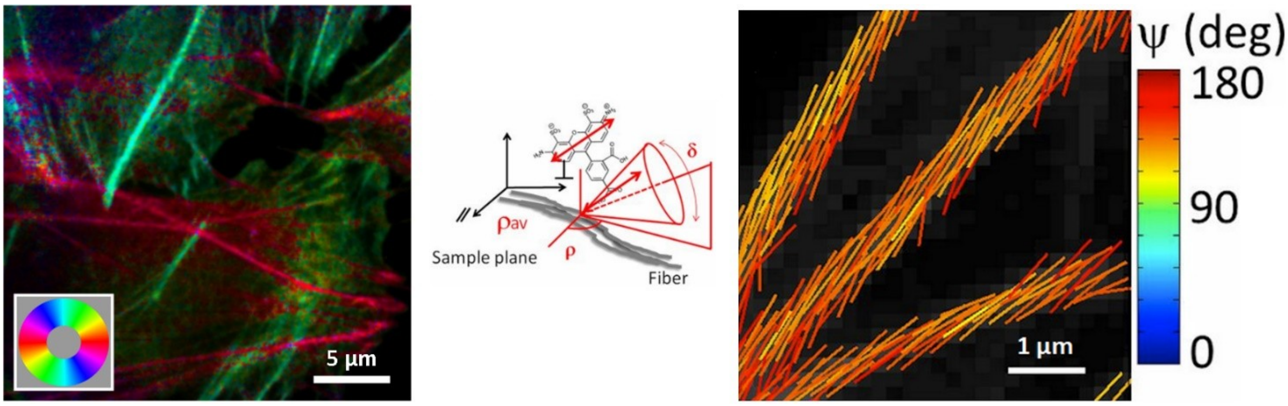

Figure: (Right) Ensemble polarization-resolved fluorescence image of actin filaments reporting in-plane molecular orientation ***using our instrument****. (Center) Schematic representation of a fluorophore dipole attached to a protein fiber. (Right) Single molecule polarization-resolved fluorescence image reporting in-plane molecular orientation (stick orientation) and wobbling angle (colormap). S. Brasselet et al. Nat. Com. 11,5307 (2020).*

The objective of the internship project is to characterize the robustness of polarimetric wavefront imaging to optical aberrations for SMLM applications.

As an intern, you will have to:

- Conduct experimental work with the polarization-resolved super-resolution microscope
- Develop numerical simulations mimicking the behaviour of the system under varying conditions
- Investigate the fundamental and technical limitations of the method by analyzing and comparing the experimental and simulation results

The candidate should be motivated to work in experimental optics, data processing. A solid theoretical background in wave physics is necessary, and basic programming skills (e.g., Python/Matlab) are required.

The internship is designed to evolve into a PhD project.

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[1] S. Brasselet and M. Alonso, *Polarization microscopy: from ensemble structural imaging to single-molecule 3D orientation and localization microscopy,* **Optica 10(11),** 1486 (2023)
[2] P. Bon, J. Linarès-Loyez, M. Feyeux, K. Alessandri, B. Lounis, P. Nassoy & L. Cognet, *Self-interference 3D super-resolution microscopy for deep tissue investigations,* **Nat. Methods 15,** 449–454 (2018)
[3] B. Blochet, G. Lelu, M. Alonso, and M. Guillon, *Quantitative polarimetric wavefront imaging***, Optica 12**, 907-913 (2025)