Master 2: ***International Centre for Fundamental Physics***

INTERNSHIP PROPOSAL: Simultaneous 3D localization and 2D orientation determination for single-molecules super resolution microscopy

Laboratory name: Laboratoire Physico Chimie Curie
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Internship location: Laboratoire Physico Chimie Curie, Institut Curie, 11 rue Pierre et Marie Curie, 75005 Paris

Thesis possibility after internship: YES Funding: Maybe

Title Simultaneous 3D localization and 2D orientation determination for single-molecules super resolution microscopy

Super-resolution (SR) microscopy have revolutionized our understanding of the biological processes at the molecular level. Imaging single molecules and localizing their center with high precision allows the reconstruction of pointillist image of the sample with a resolution beyond the diffraction limit [1,2,3]. In order to capture the 3D nanoscale morphology of the whole cell, multifocus microscopy (MFM) has been proposed to instantaneously acquire the 3D localization of single molecules (SM) in cells within a volume of a few micrometers [4,5]. Still additional information such as molecular orientation can provide supplementary information relating the local molecular organization and arrangement to the biological function. One strategy to recover the orientation of single molecules is by polarimetric measurement [6]. A polarization-splitting scheme combined with SMLM allows to determine both the 2D localization and orientation of SM.

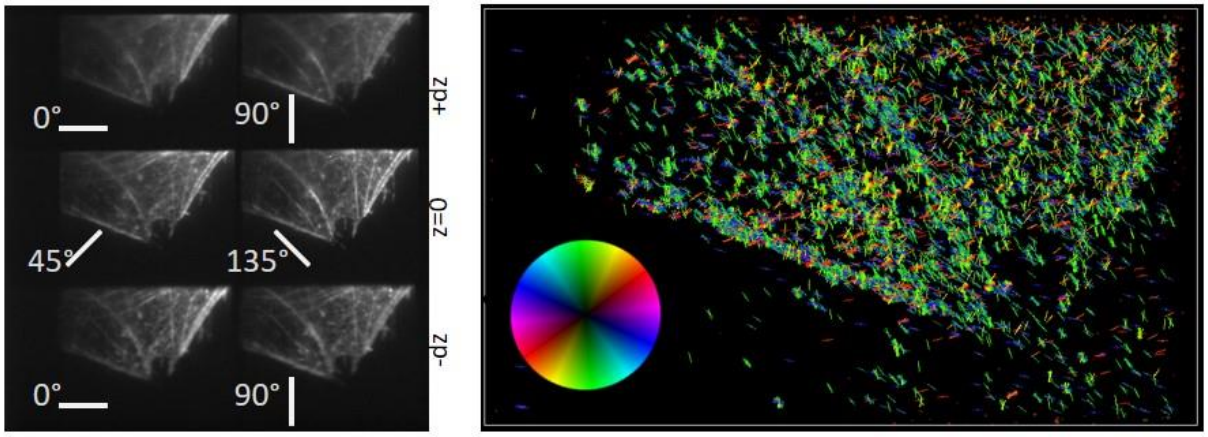

Figure 1: (Left) Polarimetric projection of the multiplane images of actin filament on different polarization directions. (Right) Single molecule localization and orientation retrieval of the same field of view (Color code for the SM orientation).

The aim of this internship is to retrieve the orientation measurement simultaneously with 3D positional information of single molecules in biological samples. The method will rely on combining MFM with polarization measurements at the different focal plane.

References:

[1] Betzig, E., et al. Science, 2006. [2] Rust, M.J., et al. Nat Methods, 2006. [3] Schnitzbauer, J., et al. Nat Protoc, 2017. [4] Hajj, Bassam et al. PNAS 2014. [5] Hajj, Bassam et al. Scientific Reports 2017. [6] Rimoli, Caio et al. Nature Communications 2022

Techniques/methods in use: Optical microscopy, data analyse
Applicant skills: Optics, Physics, Math

Please, indicate which speciality(ies) seem(s) to be more adapted to the subject:

Condensed Matter Physics: NO Soft Matter and Biological Physics: YES
Quantum Physics: NO Theoretical Physics: NO