Sujet de thèse

Laboratoire: Institut Fresnel

Co-Directeurs de thèse: Miguel Alonso, Sophie Brasselet
miguel.alonso@fresnel.fr, sophie.brasselet@fresnel.fr
Institut Fresnel, Domaine Universitaire de Saint Jérôme, 13397 Marseille

Nanoscale polarized imaging in 3D

The MOSAIC team at Institut Fresnel has pioneered methods for monitoring the orientation of single fluorescent molecules in 3D, which has a great interest in super-resolution optical imaging of complex molecular structures. Super-resolution microscopy techniques allow to obtain a spatial resolution of 10 to 20 nm with an optical microscope, one order of magnitude lower than the diffraction limit reachable with classical microscopy. To retrieve both position and orientation of single fluorescent molecules, we have demonstrated different approaches based the manipulation of light polarization in the direct image plane or in the pupil detection plane of a fluorescence microscope. These approaches still present limitations, however, either because they cause strong deformation of the images, or due to potential loss of signal and/or ambiguity of the information provided. Nevertheless, they show a great promise to extend the read-out of orientation to the exploration of unknown polarizations at the nanoscale (such as shaped focussed beams used for optical trapping), using known nano-emitters (e.g. metallic nanoparticles) as nano-probes for local fields properties.

The goal of this PhD project is to extend the approaches developed previously by the group in order to arrive at optimal schemes for the imaging of nano-emitters that yield both their position and orientation in 3D, and to apply these methods to a larger set of situations, such as 3D complex molecular structures and complex 3D polarized fields. These tasks involve finding strategies to (1) report the position of single emitters in 3D and (2) measure the vectorial properties of their emitted fields in 3D, including the degree of their angular fluctuations. The student will implement experimental strategies based on direct or back focal plane manipulation in the detection path of the microscope, develop models to predict and optimize the behaviour of the system, and use signal theory tools to monitor the efficiency of the developed estimators.

liens : http://www.fresnel.fr/mosaic

References:

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2- V. Curcio, L. Aleman- Castaneda, T. G. Brown, S. Brasselet, M. A. Alonso, Birefringent Fourier filtering for single molecule Coordinate and Height super-resolution Imaging with Dithering and Orientation (CHIDO), arXiv:1907.05828 Nat. Communications 11 (1) (2020) DOI: 10.1038/s41467-020-19064-6