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

INTERNSHIP PROPOSAL: Mutlicolor & Multifocus microscopy for single molecule imaging

Laboratory name: Laboratoire Physico Chimie Curie
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Thesis possibility after internship: YES Funding: MAYBE

Title Mutlicolor & Multifocus microscopy for single molecule imaging

The ability to control the wavefront at the output of an imaging system allows to correct the imaging system optical aberration but also to impose a controlled deformation to encode specific information in the recorded images. Diffractive optical elements (DOE) provide an efficient mean to manipulate light. When placed in the back focal plane of the microscope objective, DOE were shown to generate a controlled PSF shape allowing to retrieve useful information such as the position and orientation of single molecules [1].

In multifocus microscopy (MFM) for instance [2,3], a DOE is placed in the back focal plane. It plays two roles: first, it splits the emission into a specific array of equal-intensity diffraction orders, and second it applies a specific deformation of the wavefront in each diffraction order. The grating splits the emission into several paths while imposing a specific defocusing or focusing power to each. In MFM multiple imaging planes are thus formed side by side on the same camera allowing a fast and sensitive volumetric imaging of biological samples. Still the wavelength-dependent diffraction properties of DOE can limit the use of MFM for multicolor applications [3]. The purpose of this internship is to explore new methods for the realization of achromatic DOE [5]. In addition, the use of DOE as a mean to detect and identify different fluorescent species with distinct spectral properties will be explored. Such developments will be further tested for single molecule imaging in real biological systems. We aim to study the molecular organization and interplay of several nuclear factors that are involved in nuclear organization.

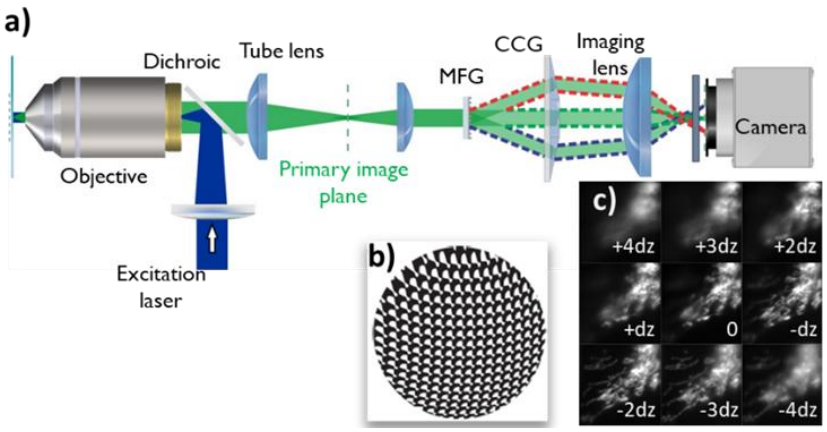

Figure 1 *a) MFM setup, MFG: multifocus grating, CCG: chromatic correction grating. b) The DOE used in MFM imaging. c) A typical image using MFM showing the 9 different focal planes as they appear simultaneously on the same camera*

Skills:
Knowledge in Optics and physics. Scripting in MATLAB or Python. Good motivation and desire to learn are important.

Interested candidates can send their CV and motivation to bassam.hajj@curie.fr

References:

[1] Pavani et al. PNAS (2009). [2] Abrahamson et al. Nature Methods (2013). [3] Hajj et al. PNAS (2014). [4] Hajj et al. Scientific reports (2017). [5] Orange-Kedem et al. Nature communication (2021)

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