Laboratory for Optics and Biosciences

ECOLE POLYTECHNIQUE

INSERM U1182 - CNRS UMR7645 - IP Paris

Master's Project

Supervisor:

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Project location: Ecole Polytechnique (Palaiseau)

Title: New approaches to multicolor 3D STORM Microscopy

Summary

Super-resolution microscopy methods have recently allowed us to visualize biological structures using fluorescence microscopy down to the nanometer scale circumventing the microscope resolution limit. In particular, STORM [1], a type of single-molecule localization microscopy that relies on blinking fluorescent dyes imaged in an adapted chemical environment is a powerful and popular technique due to the use of standard dyes and standard inverted microscopes. However, extending this single-color 2D approach to multicolor 3D imaging is limited by the difficulty to obtain equally good images in the different color channels and can work away (up to 10-15 micrometers) from the coverglass across the cell thickness [2,3].

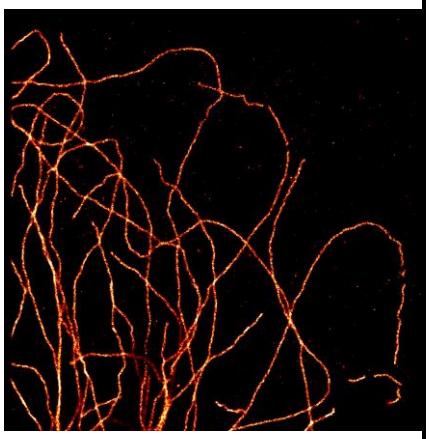

Figure 1 2D STORM image of microtubules in a fixed Cos7 cell using a novel imaging buffer

During this project, the student will develop new approaches for multicolor 3D-STORM. In particular, we identified a new environment that is particularly suitable for a variety of red dyes and want to see if multicolor imaging with green and/or far-red dyes is suitable. In parallel, the student will implement a novel 3D algorithm [4] that enables robust imaging deep inside biological samples.

This project is mostly experimental and combines aspects of sample preparation (cell biology, immunochemistry, and chemistry), microscopy, and image/data analysis (ImageJ /Python/ Matlab). It is well suited for a student with a background in Physics interested in interdisciplinary work.

References:

[1] Huang, Bo, et al. "Three-dimensional super-resolution imaging by stochastic optical reconstruction microscopy." Science 319.5864 (2008): 810-813.

[2] Nicolas Olivier, Debora Keller, Pierre Gönczy, Suliana Manley. "Resolution doubling in 3D-STORM imaging through improved buffers." PloS One 8.7 (2013): e69004.

[3] Nicolas Olivier, et al. "Simple buffers for 3D STORM microscopy." Biomedical optics express 4.6 (2013) [4] Xu, Fan, et al. "Three-dimensional nanoscopy of whole cells and tissues with in situ point spread function retrieval." *Nature Methods* 17.5 (2020): 531-540.

Possibility of a PhD ? : Yes (Depending on funding)