Master in Photonics – "PHOTONICS BCN"
ERASMUS+ "EUROPHOTONICS"

MASTER THESIS PROPOSAL

Dates: April - September 2020

Laboratory : Single Molecule Biophotonics
Institution: ICFO-The Institute of Photonic Sciences
City, Country : Castelldefels, Spain

Title of the master thesis: Software analysis algorithms to reconstruct the nanoscale complexity of focal adhesions

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Keywords : Super-resolution Microscopy, Single Molecule Localization, Focal Adhesions, Software analysis algorithms

Summary of the subject (maximum 1 page) :

Focal Adhesions (FA) are attachment points of a cell to the substrate. They are mechanosensitive complexes that allow cells to assess its external environment and relay information to the cells interior aiding in processes such as migration and proliferation. FAs consist of clustered mechano-sensitive receptors, called integrins, that connect the external and internal environment of the cell. These clustered integrins associate with a dynamic protein complex linking the cytosolic domain of integrins with the actin cytoskeleton. In contrast to the established view that FAs are homogenous micron-scale protein assemblies, recent super-resolution imaging and single molecule dynamic results, including those from our group, are challenging this view.

Using different forms of super-resolution optical microscopy (single molecule localization methods such as STORM, but also STED nanoscopy) we have recently discovered that main protein actors involved in FAs, i.e., integrins, paxillin, talin and vinculin, are organised in segregated nanoclusters within FAs. These data indicate a highly complex spatiotemporal

organization within FAs with different proteins forming nano-hubs of activity. Yet, analysing all the data obtained by these cutting-edge techniques to derive quantitative and relevant information is challenging and cumbersome.

The goal of this Master Project is to apply and/or develop suitable software algorithms (either based on MatLab or Python) to quantitatively analyse multi-colour super-resolution images of focal adhesions. The student will explore different currently existent algorithms and will test their performance & limitations on both *in-silico* generated data as well as true-experimental data. He/she will also develop new approaches to quantify data in an automated fashion, incorporating parameters that are not included in current algorithms, such as: selected image segmentation according to FA size and/or cell location, proximity between different protein complexes, extracting association and dissociation rates from multi-colour single molecule data, correlations between nanoclusters sizes and their nanoscale spatial proximity, etc, etc.

Within the group, the student will be able to actively participate in a joint effort that brings together advanced super-resolution and single molecule dynamics tools together with cell biology and biophysics. This project is embedded within a current advanced ERC grant in nano-mechanobiology led by Garcia-Parajo, and thus results of the project will have the potential of making a strong contribution to Science.

Additional information:

* Required skills : The student should have good skills in programming using different software algorithms (preferably MatLab and/or Python), and affinity for statistical physical processes. Experience in Cell Biology is not required, but the student should show genuine interest in understanding biology from a biophysical & quantitative perspective.

* Miscellaneous: