Master in Photonics – "PHOTONICS BCN"
Master ERASMUS Mundus "EuroPhotonics"

MASTER THESIS PROPOSAL

Starting full time from April 2024
Presentation at the end of July or beginning of September 2024

Laboratory: Neurophotonics & Mechanical systems Biology
Institution: ICFO
City, Country: Castelldefels, ICFO

Title of the master thesis: Measuring the frictional force of biomolecular condensates with microtubule cytoskeleton

Name of the master thesis supervisor and co-supervisor:
Michael Krieg
Email address: michael.krieg@icfo.eu
Phone number:
Mail address: AV CF Gauss 3, 08860 Castelldefels

Keywords: biomolecular condensates, microtubules, friction, optical trap, forces, mechanics

Summary of the subject (maximum 1 page):
Biomolecular condensates are dynamic, membraneless organelles found within cells, composed of a concentrated assembly of proteins, nucleic acids, and other biomolecules. These condensates form through phase separation, a process where certain molecules separate from the surrounding solution, leading to the creation of distinct compartments or droplets within the cell. These condensates have dfferent functions in the cell that can range from organizing cellular structure, sequester functional proteins, regulate biochemical reactions and integrate cellular signaling. The signaling function of these condensates is not properly understood. Our previous work showed that a protein called MEC-2 undergoes a phase separation and forms distinct biomolecular condensates inside touch receptor neurons of the genetic model C elegans. These neurons are responsible for the transduction of mechanical touch into a neurophysiological response, and critically depends on MEC-2 and an abundant microtubules cytoskeleton. Based on previous research and our own findings, we hypothesize that MEC-2 condensates and the microtubule cytoskeleton interact, and establish a velocity dependent friction force, that enables mechanotransduction at individual receptor sites. The purpose of this thesis is to construct an in vitro assay to measure the interaction force of MEC-2 and microtubules in an optical trap.

Objectives:
The objectives of this thesis is to understand how age and temperature influences the rigidity of biomolecular condensates. The successful candidate will be trained in operating the optical trap

autonomously and setting up experiments with provided purified proteins. The first objective is to visualize potential interaction and colocalization of MEC-2 condensates and purified microtubules using fluorescently labeled molecules in a confocal spinning disk microscope. In the second objective, the successful candidate will establish a dual optical trap assay in a dumbbell configuration that spans a single microtubules. The aim here is to measure the interaction of the microtubule with MEC-2 condensates and infer frictional force during the relative movement of both components.

Backgroundd reading:
https://www.nature.com/articles/s41556-023-01247-0
https://www.biorxiv.org/content/10.1101/2023.10.17.562595v1
https://journals.biologists.com/jcs/article/135/15/jcs259355/276247/Exploring-cell-and-tissue-mechanics-with-optical

Additional information (if needed):
* Required skills: basic understanding of biology and biochemistry; polymer biophysics; experimental science/lab techniques
Desired: Previous exposure to optical trapping or mechanobiological research
* Miscellaneous: