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: Deciphering the mechanics of biomolecular condensates

Name of the master thesis supervisor and co-supervisor:
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Keywords: biomolecular condensates, rheology, 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. However, often, the properties of these condensates are subject to alterations in many diseases. Abberrant phase transitions from a soft, liquid pool to a hard, solid pool are thought to underly much of a plethora of neurodegenerative diseases. In those cases, these rigidity transitions lead to the formation of insoluble amyloids, visible as prominent fibrillarion and plaques. Thus, identifying factors the contribute to and promote these rigidity transitions are of utmost interest to basic cell biohysics, but also pharmacological sciences, as these factors could lead to clinically relevant interventions. In this project, we aim to characterize the rigidity transition of common condensates and how they are affected by time, temperature and external interventions.

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. Using our recently developed TimSOM technique to measure mechanical properties of cells and protein blends, we will compare the time course of our measurements with published literature. The second objective

is to express the proteins forming the condensates inside living cells and directly measure their rigidity phase transition in the context of the living cytoplasm.

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: