Internship proposal
2nd semester of Master 2
2023-2024

Team: Biophotonic Materials and Bioimaging
Unit: Laboratory of Bioimaging and Pathologies (LBP) UMR 7021
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Fluorescence tools to characterize Liquid-Liquid Phase Separation

Liquid-liquid phase separation (LLPS) is a thermodynamically driven phenomenon during which a homogeneous solution de-mixes to form two separate liquid phases. One appears as dense droplet like structures dispersed in a second more diluted phase. During the last decade, LLPS has emerged as a fundamental phenomenon driving the assembly of intracellular biomolecular condensates also called membrane-less organelles (MLOs, e.g. nucleolus, Cajal bodies P bodies, stress granules). MLOs represent multicomponent system that displays droplet-like properties such as ability to flow and coalesce. Due to their transient and dynamic nature, these organelles play major roles in gene regulation and signaling pathways or serve as storage compartments making the biological material immediately available. Hence, MLOs internal environment is optimally tuned to ensure efficient biochemical reactions together with an optimal exchange rate with its external environment. Consequently, the deregulation of LLPS process is associated with pathologies including cancer, neurodegenerative and infectious diseases. At present, the biophysical understanding of LLPS, as a process orchestrating the MLOs assembly and internal organization, is only emerging and the experimental tools used to characterize the LLPS in vitro and in cellulo are limited.

The aim of the internship is to characterize the biophysical properties of model droplets with the help of environment sensitive dyes (solvatochromic probes and molecular rotors). By tuning the experimental conditions (temperature, protein and RNA concentration, pH, …), model systems will be used to correlate the optical properties of the dyes to physicochemical properties (hydration, local viscosity) of the reconstituted condensates. Their optical properties will be monitored by means of steady state and time resolved spectroscopy together with phase contrast and quantitative fluorescence microscopies. Based on the calibration performed with in vitro model systems, quantitative fluorescence imaging will be next used to measure, in living cells, the polarity and the viscosity of cellular organelles.

Required skills: the candidate must display a strong motivation for experimental work at the interface between physics and chemistry. Knowledge in fluorescence microscopy would be appreciated.

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