Master 2 Internship

Title: **Real time and Multipoint measurement of Interfacial Properties via structured illumination**

Type: **Experimental**

Supervisor(s): **Dr Ulysse DELABRE, Dr Jean-Pierre DELVILLE**

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PhD funding (if any): *Funding to continue in PhD will be considered.*

Project: Understanding and characterizing soft systems—ubiquitous in materials science and biophysics—requires precise knowledge of their rheological and interfacial properties, such as viscosity and surface tension. These properties are not always uniform: many dynamic processes, like the solute or thermal Marangoni effect and surfactant-driven interfacial motion, are governed by spatial variations in these same interfacial parameters. Yet, capturing these interfacial variations remains a significant experimental challenge—especially at the micrometric scale, where traditional methods fall short, and in out-of-equilibrium systems, where many fundamental questions are still unresolved. This project aims to tackle this challenge by developing an **innovative, non-invasive optical technique** capable of simultaneously measuring interfacial properties **in real time and across multiple points** of a micrometric interface. The final goal of the project is to achieve the **first-ever 2D mapping** of interfacial properties in non-equilibrium systems—a breakthrough that could revolutionize how we understand and control interfacial dynamics at small scales. To do this, we will harness **optical radiation pressure** [1-3]– based on photon momentum transfer - to probe the rheological behaviour of 2D thin films at nanometre scale.

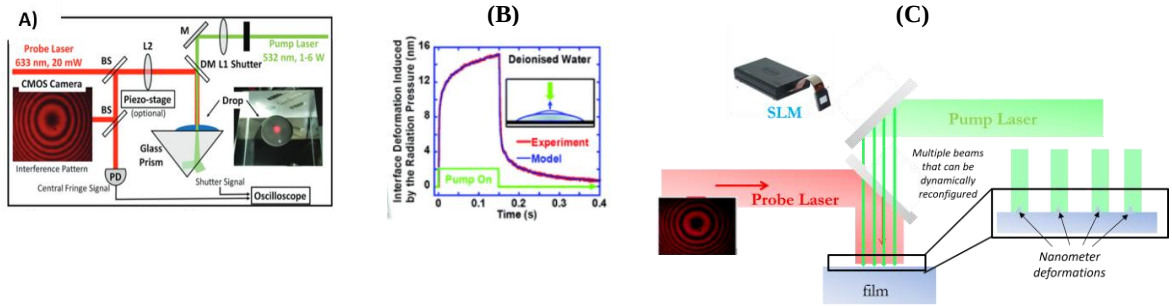

Figure: (A-B) Actual Setup and Example of the nanometer deformation induced by optical radiation pressure[1]. (C) Sketch of the new optical setup with a Spatial Light Modulator to generate N pump beams that will deform the interface locally. A probe beam (red laser) is used to detect the interface deformation.

During this Master's internship, the objectives are: 1) to develop an image analysis software capable of detecting deformations at any point along an interface. 2) to design and implement an optical setup utilizing a spatial light modulator (SLM) to dynamically control in space and time the locations of pump beams.

This Master's internship is highly interdisciplinary, combining optics (laser manipulation and interferometry), soft matter physics, image processing, and data analysis. Funding to continue in PhD will be considered.

References:

[1] **Contactless thin-film rheology unveiled by laser-induced nanoscale interface dynamics**. Soft Matter, 16(34), pp.7904-7915, Verma, G., Chesneau, H., Chraïbi, H., **Delabre, U.**, Wunenburger, R. and Delville, J.P., 2020.

[2] A versatile interferometric technique for probing the thermophysical properties of complex fluids. Light: Science & Applications, 11(1), p.115. Verma, G., Yadav, G., Saraj, C.S., Li, L., Miljkovic, N., Delville, J.P. and Li, W., 2022