TAILORING THE CONFIGURATION OF COLLOIDAL ASSEMBLIES WITH OPTICAL FORCES

LABORATORY : Institut Lumière Matière
IN COOPERATION WITH : Institut Lumière Matière

LEVEL : M2
TEAM(S) : MMCI

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KEYWORD(S) : modelling / Opto-mechanics / non-equilibrium colloidal physics

SCIENTIFIC CONTEXT :

Opto-mechanical coupling, i.e. the interaction between light and mechanical motion, is a fundamental principle that opened the way to the optical manipulation of tiny objects [1] and is at the heart of several leading-edge fields, such as quantum simulations with cold atoms [2] and cavity opto-mechanics [3]. The existence of attractive or repulsive forces between two or more submicron-scale particles under light excitation is one of the most remarkable phenomena on the topic. These “cohesion forces” arise because particles are excited not only by the incident field but also by the field that they induce via light scattering. Subject to these optical forces, the particles reorganize into static or dynamic configurations specific to their optical properties and the coherent illumination [4]. These developments open up exciting new opportunities to control (tailor) the arrangement of colloidal assemblies at will, with a wide array of possible applications, by emitting an adequate incident optical field.

MISSIONS :

This project aims at exploring this original opto-mechanical pathway for the tailoring of complex colloidal systems, by means numerical simulations. Relying on existing codes developed within the team, the student will develop a numerical platform to simulate the dynamics of large assemblies of small particles under coherent light excitation. More precisely, (s)he will
(i) further develop and exploit a code to compute the optical forces exerted on each particle of a complex assembly
(ii) simulate the dynamics of colloids under these forces and determine the stable configurations, depending on the excitation characteristics (wavefront, wavelength, polarization)
(iii) turn to the inverse problem of determining an adequate excitation given a target configuration, via machine-learning techniques.

The ideal candidate has a keen interest in numerical modelling and a solid background in optics and/or the physics of complex systems. (S)he will be based at Institut Lumière Matière (CNRS & Univ Lyon 1) in Villeurbanne, close to Lyon.

OUTLOOKS :

The intern may be invited to apply for a PhD grant of Univ Lyon 1, if the internship is successful.

BIBLIOGRAPHY :

[1] O. M. Maragò, P. H. Jones, P. G. Gucciardi, G. Volpe and A. C. Ferrari, Nature Nanotechnol. 8, 807 (2013). [2] I. Bloch, Nature Physics 1, 23-30 (2005). [3] M. Aspelmeyer, T. J. Kippenberg and F. Marquart, Rev. Mod. Phys. 86, 1391 (2014). [4] P. McCormack, F. Han and Z. Yan, J. Phys. Chem. Lett. 9, 545 (2018).