INTERNSHIP PROPOSAL

Master 2 ICFP

Laboratory name: Centre de Physique Théorique (CPHT)
CNRS identification code: UMR 7644
Internship director'surname: Olesia DMYTRUK
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Internship location: CPHT, Ecole Polytechnique, Palaiseau

Thesis possibility after internship: YES
Funding: YES If YES, which type of funding: ERC

Light-control of topological materials

Controlling properties of the materials with light is a novel research direction in condensed matter physics that is sparked by the recent experimental advances in controlling chemical reactions, enhancing transport in semiconductors or even inducing superconductivity [1]. Topological materials play a particularly important role in this direction due to their robustness and their possible application in quantum technologies. Topological insulators and superconductors are examples of such materials. In our recent work, we have considered a prototypical model for topological behavior, the Su-Schrieffer-Heeger model, coupled to a single mode cavity [2]. We demonstrated that light can affect the topological properties of the system, including the finite-length energy spectrum hosting edge modes and the topological phase diagram.

The goal of this internship is to study how to use light to probe and control topological properties of quantum materials. The first step of the project is to compute the optical response of the quantum material within the Green's function formalism. This response contains signatures of topological properties of the material. The next step of the project is to solve the hybrid system addressing light and matter degrees of freedom on equal footing. This includes evaluation of the energy spectrum and other physical observables. This project relies on state-of-the-art analytical and/or numerical techniques of quantum many-body physics to address the hybrid light-matter system.

After successful completion of the internship there is a possibility to go on with a PhD and work on the ERC Project "Q-Light-Topo".

[1] F. Schlawin, D. M. Kennes, and M. A. Sentef, Cavity quantum materials, Applied Physics Reviews 9 (2022).
[2] Olesia Dmytruk and Marco Schiró, Controlling topological phases of matter with quantum light, Communications Physics 5, 271 (2022).

Please, indicate which speciality(ies) seem(s) to be more adapted to the subject:

Condensed Matter Physics: YES Soft Matter and Biological Physics: NO
Quantum Physics: YES Theoretical Physics: YES