Master 2: *International Centre for Fundamental Physics*

INTERNSHIP PROPOSAL

(One page maximum)

Laboratory name: Jeunes équipes de l'Institut de physique du Collège de France
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Internship location: College de France

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

Light-Control of Nonequilibrium Quantum Matter

Summary (half a page maximum)

The increased control over light-matter interactions, both at the classical level as well as in the genuine quantum regime, has turned the electromagnetic radiation from a traditional spectroscopic probe to an invaluable tool to control and manipulate complex quantum many body systems in regimes far away from thermal equilibrium. In the realm of condensed matter physics recent progress with ultra-fast pump-probe spectroscopies has shown that classical radiation can be used to control quantum materials in a genuinely new way, by stabilizing transient states with remarkable electronic properties. Celebrated examples include light-induced superconductivity, long-lived metastable states with unusual metallic properties, or light- control of topological phases. An exciting new frontier is to take advantage of the quantum nature of light in solid state experiments to enhance transport, to dress, cool and control selected collective excitations of solids or to extract crucial material properties from the full study of the quantum light emitted. These experimental developments at the interface between condensed matter physics and quantum optics raise intriguing theoretical questions and allow to explore quantum many-body physics in uncharted territories far from thermal equilibrium.

The goal of this Internship and PhD project is to develop the tools and concepts to describe how to control the collective properties of strongly interacting electrons by means of classical and quantum electromagnetic radiation. This will be achieved using state of the art analytical and numerical techniques for quantum many body problems out of equilibrium, such as Keldysh field theory, time dependent variational wave functions, non-equilibrium extensions of Dynamical Mean Field Theories, and further developing them to include the coupling to light. At the classical level this will naturally translate in the study of periodically driven Floquet quantum many body problems, which are currently attracting interest in various contexts, while at the quantum level it will require to tackle the interplay between electrons, photons and non-equilibrium perturbations.

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