LPENS
LABORATOIRE DE PHYSIQUE DE L'ÉCOLE NORMALE SUPÉRIEURE

Laboratoire de Physique de l'ENS,
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Internship offer

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Intership Location: LPENS, UMR 8023, 24 rue Lhomond, 75005 Paris

Keywords: Quantum Dots, Graphene, HgTe nanocrystals, Terahertz, Ultrafast phenomena

Non-equilibrium dynamics of carriers in quantum dots using mid infrared pump-THz probe spectroscopy

Semiconductor quantum dots have attracted considerable attention due to their unique properties that are directly related to their nanoscale structures. Their potential for the development of advanced quantum devices such as quantum sensors and single photon emitters has been largely demonstrated in the visible and near infrared range. However, very little work has been focused to date on the potential of quantum dots for THz technology.

Our group has recently demonstrated that graphene quantum dots [1] and HgTe nanocrystals [2] are promising zero-dimensional material systems for the THz spectral range. Indeed, they possess a broad THz absorption resonance, which relies on intraband transitions. Understanding and controlling the dynamics of carriers in these quantum dots is essential for their implementation in advanced optoelectronic devices.

The aim of the internship is to explore the dynamics of non-equilibrium carriers in graphene quantum dots and HgTe nanocrystals using a mid-infrared pump-THz probe experiment. The candidate will probe the dynamics of carriers photoexcited directly on the energy states that are involved in the THz intraband transitions. The possibility to bleach the intraband absorption and to induce plasmonic effects at high pump fluence will be studied. The candidate will further perform microscopic modelling of the carrier dynamics to identify the main physical mechanisms involved in the carrier relaxation and recombination.

This internship may be pursued by a thesis. Further developments in the PhD project include the development of THz sources/amplifiers based on these quantum dots inserted in THz cavities/waveguides and the exploration of other materials such as topological insulators.

[1] E. Riccardi *et al.* Nano Letters 20, 5408 (2020)
[2] T. Apretna *et al.* Nanophotonics, 10, 2753 (2021)

Methods and techniques: femtosecond lasers, pump-probe experiments, time domain THz spectroscopy, Matlab/Python

Possibility to go on with a PhD ? YES
Envisaged fellowship ? Research Grant