INTERNSHIP PROPOSAL

(One page maximum)

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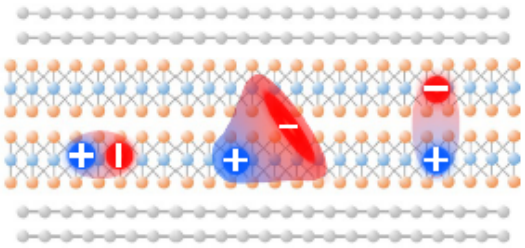
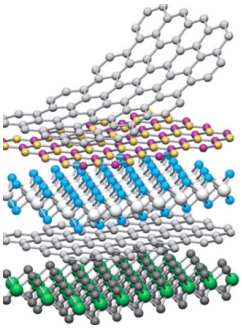
Internship location: Campus Paris-Saclay / Orsay

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

Ultrafast dynamics and emerging quantum phenomena in 2D materials

The search for novel collective quantum effects in electronic materials presents novel and unprecedented opportunities with the development of 2D materials and their heterostructures, where individual layers interact by weak van der Waals forces. These materials present unique optoelectronic properties that are very promising for their use as quantum photon emitters, essentially related to the confinement of electrons in two dimensions. When 2D materials are stacked, their lattice mismatch and relative angular misorientation (twist angle) may results in the formation of a moiré pattern, and can be at the heart of exciting emergent quantum phenomena ranging from strong correlations to superconductivity. Manipulating the out-of-equilibrium dynamics of these systems with ultrafast laser pulses offers the possibility of creating new, transient phases of matter, intrinsically different from the equilibrium state [1,2]. In particular, the quantum transport of excitons is controlled by their many-body inter-layer and intra-layer interactions [3-4], which can be studied and controlled with the ultrafast excitation.





All these effects can be directly observed thanks to new developments in various spectroscopies (photoemission, luminescence) employing ultrafast lasers and synchrotron radiation, providing the necessary comprehensive view of the reciprocal space for the study of excited states and topological properties of out-of-equilibrium 2D monolayers and junctions.

[1] N. Nilforoushan et al, Phys.Rev.R. 2 043397 (2020) (doi.org/10.1103/PhysRevResearch.2.043397)
[2] Z. Chen et al., PNAS 117, 21962 (2020). (doi.org/10.1073/pnas.2008282117)
[3] J. Zhang et al., Nano Letters 23, 1830-1835 (2023) (doi.org/10.1021/acs.nanolett.2c04701)
[4] Z. Chen et al., Commun. Phys. 4, 138 (2021) (doi.org/10.1038/s42005-021-00635-y)

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: NO