Master 2: ***International Centre for Fundamental Physics***

INTERNSHIP PROPOSAL

(One page maximum)

Laboratory name: Laboratorie de Physique des Solides
CNRS identification code: UMR 8502
Internship director'surname: Tizei, Luiz; Woo, Steffi;
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Internship location: LPS Orsay

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

Nanoscale exciton physics in 2D material

Spatially confined low dimensional structures, such as quantum dots (0D), nanowires (1D), atomically thin monolayers (2D) and interfaces (2D), are fascinating from a technological and a fundamental point of view. Their general interest stems from the possibility of manipulating physical properties by tuning dimensions and dimensionality. Successful applications of these objects often rely on the controlled creation, manipulation and characterization of excitations to carry information. Among many possible candidates, spin-valley excitations in transition metal dichalcogenides (TMD) have been considered as promising information carriers as they are easily controlled and manipulated by optical means using light polarization and wavelength. These are particularly interesting due to the valley- and spin- selection rules imposed by the lack of inversion symmetry and the large spin-splitting observed in monolayer TMDs.

In these systems, the role of heterostructures (vertical and lateral) and defects is not fully understood. This is due, in part, to the limited spatial resolution available in full optical techniques. To surpass this limit electron spectroscopy techniques are the best candidates, such as electron energy loss spectroscopy (EELS, a nanoscale analogue of optical absorption). Recently, experiments in few groups around the world, including at the LPS, have demonstrated the ability of EELS to detect spin-valley excitons in TMDs.

The objective of this master internship is to understand the dispersion relation of excitons as a function of their wave vector, using momentum-transfer resolved EELS, in monolayer TMDs. This project is inserted within the research line of an ANR project (SpinE, financed and starting on 01/2021), which includes a PhD grant. SpinE is aimed at controlling in the time domain spin-valley excitons using pump-probe (laser-electron beams) experiments in a state-of-the-art electron microscope recently installed at the LPS, Orsay (ChromaTEM microscope, TEMPOS project).

The internship project involves mostly experiments and data analysis (Python knowledge or wish to learn is a requirement), with the possibility to collaborate with theoreticians (at the LPS and elsewhere in the region) on the subject.

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

Condensed Matter Physics: YES Macroscopic Physics and complexity: NO
Quantum Physics: YES Theoretical Physics: YES