INTERNSHIP PROPOSAL

Laboratory name: Laboratoire Matériaux et Phénomènes Quantiques (MPQ)
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Thesis possibility after internship: YES
Funding: YES type of funding: Doctoral school

Exploring Exotic Electronic States in 2D Transition Metal Dichalcogenides

Two dimensional (2D) materials have emerged as a fascinating field of research due to their unique properties that often differ significantly from their bulk counterparts. In the large familly of 2D materials, transition metal dichalcogenides (TMDs) ave garnered particular interest as they host a large variety of exotic electronic ground states such as superconductiviy, mott insulator and charge density wave (CDW). CDW is an electronic phase characterized by a spatial modulation of the electron density present in some metallic materials, often linked to the apparition of a bandgap in the electronic spectrum. While CDWs are well-understood in one-dimensional systems through the Peierls distortion model, their origin in 2D materials remains less clear. The coupling between CDWs in heterostructures and their interactions with local perturbation is even more enigmatic.
The primary goal of this internship is to shed light on the interactions between CDWs and their surrounding environment. Our group has recently shown that CDW can be manipulated by a local excitation with an STM tip [1] (see Figure 1). Here, we will investigate the coupling between two TMD materials exhibiting different CDWs and the coupling with atomic-scale defects, such as strong or weak pinning centers. To achieve this, we will use scanning tunneling microscopy and spectroscopy (STM/STS) to probe the electronic properties at the atomic scale in single-layer TMDs and TMD heterostructures.
This project is linked to a CNRS international research project with the National Taïwan University where sample synthesis is mastered. A PhD thesis is expected to start following the internship.

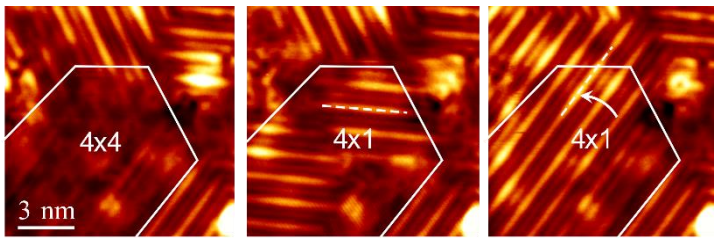

Figure 1: Successive STM images of VTe2 monolayer where CDWs are manipulated by local excitation. From left to right, a 4x4 phase is switched to 4x1 and the 4x1 phase is rotated [1].

[1] U. Chazarin et al., Spatially Extended Charge Density Wave Switching by Nanoscale Local Manipulation in a VTe2 Monolayer, Nano Letters 24, 3470 (2024)

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