INTERNSHIP PROPOSAL

Laboratory name: Laboratoire Matériaux et Phénomènes Quantiques (MPQ)
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Thesis possibility after internship: YES
Funding: YES If YES, which type of funding: ANR

Atomic Scale Study of Charge Density Waves and Electronic Coupling in 2D Transition Metal Dichalcogenides

Two-dimensional (2D) materials have emerged as a fascinating field of research due to their unique properties, which often differ significantly from their bulk counterparts. Among these, transition metal dichalcogenides (TMDs) are particularly interesting as they host a wide range of unusual electronic ground states, including superconductivity, Mott insulating phases, and charge density waves (CDWs). CDWs are electronic phases characterized by a spatial modulation of the electron density, often associated with the opening of a bandgap in metallic materials. While CDWs are well understood in one-dimensional systems via the Peierls mechanism, their origin and behavior in 2D materials remain open questions and are the subject of intense research.

The aim of this internship is to investigate the interactions between CDWs and their atomic-scale environment, using scanning tunneling microscopy and spectroscopy (STM/STS) at low temperature in ultra-high vacuum. Our group has recently shown that CDW can be manipulated by a local excitation with an STM tip [1] (see Figure 1). In this project, the intern will probe the local electronic properties of single-layer TMDs and TMD heterostructures, focusing on the influence of defects, interfaces, and neighboring CDWs. This work will provide insights into the coupling of CDWs with their surroundings and the role of atomic-scale perturbations, contributing to a forefront research in 2D quantum materials.

A PhD thesis, funded by the ANR project Equa2ion, is expected to start following the internship.

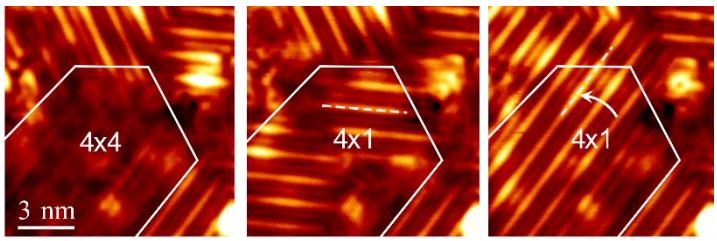

Figure 1: Successive STM images of VTe2 monolayer where CDWs are manipulated by local excitation. From left to right, a 4x4 phase is switched to 4x1 and the 4x1 phase is rotated [1].

[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