

INTERNSHIP PROPOSAL

Laboratory name: C2N – Centre de Nanosciences et Nanotechnologies
CNRS identification code: UMR 9001
Internship director's surname: J.C. Girard/H.Aubin
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Phone number: 0170270644
Web page: [PHYNANO](#) group
Internship location: C2N, 10 boulevard Thomas Gobert, 91120 Palaiseau

Thesis possibility after internship: YES

Funding: NO (not identified yet)

If YES, which type of funding:

Scanning Tunnelling Microscopy and Spectroscopy (STM/STS) of two-dimensional topological and correlated van der Waals heterostructures

Two-dimensional van der Waals heterostructures formed by graphene and/or transition metal dichalcogenides (TMDCs), have become a captivating platform for exploring the interplay between strong electronic correlations and non-trivial band topology[1]. The recent discovery of **fractional quantum anomalous Hall insulators** at zero magnetic field, in a moiré heterostructure of rhombohedral pentalayer graphene aligned with hBN[2], is of intense interest as its non-Abelian anyonic excitations could be used for decoherence-free quantum computation.

The project aims to study, by STM in ultra-high vacuum and low temperature (4.2 K), bilayer graphene (AB-G) and rhombohedral graphene (ABCA-G) heterostructures aligned with hexagonal boron nitride (hBN) and in proximity to TMDCs like WSe₂. The research will focus on understanding the emergence of topological band structures in these materials.

In addition to STM, the student will have the possibility to participate to the microfabrication of the heterostructures supervised by R. Ribeiro in the PHYNANO group, learn to work in a clean room environment and perform transport measurements.

[1] D. M. Kennes *et al.*, Nat. Phys. **17**, 155 (2021).

[2] Z. Lu *et al.*, Nature **626**, 759 (2024).

Techniques/methods in use:

STM/STS in ultra-high vacuum (UHV) and cryogenic conditions (4.2 K)

Applicant skills: Experimentalist interested by experiments in UHV and cryogenic conditions and/or the fabrication of van der Waals heterostructures.

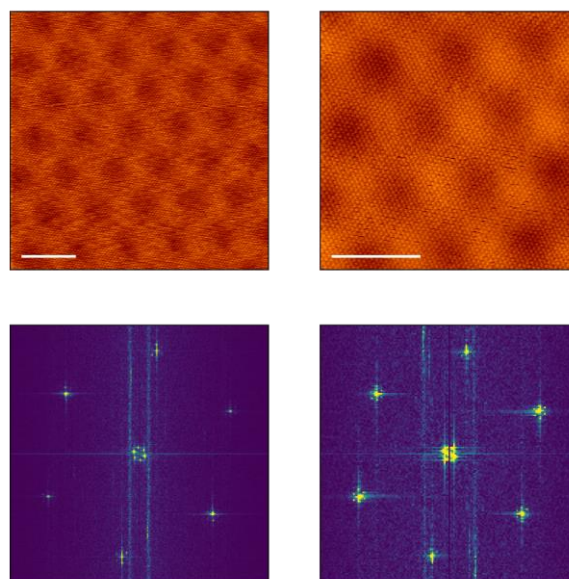


Figure: Top : STM images of a moiré lattice obtained by aligning a bilayer of graphene with an hBN substrate. The white scale bar is 5 nm long. Bottom: 2D Fourier transform of the top images. The Fourier transforms show the Bragg peaks of both the atomic lattice and the moiré lattice.

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