Master QLMN (Quantum, Light, Materials and Nano Sciences)

Proposition de stage / Internship proposal

Date de la proposition : 20/10/2026 — Academic year 2026/2027

Responsable du stage */ internship supervisor*:

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Nom du Laboratoire / laboratory: Centre de Nanosciences et de Nanotechnologies (C2N)

Etablissement / institution: CNRS / Université Paris-Saclay Code: UMR 9001

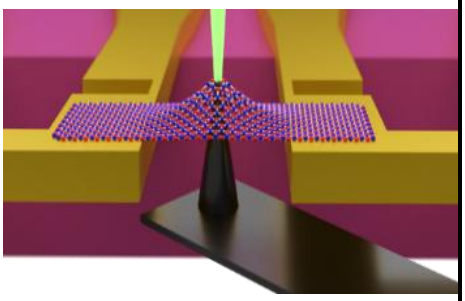
Site Internet / website: https://www.c2n.universite-paris-saclay.fr/

Adresse / address: 10, boulevard Thomas Gobert, 91120 Palaiseau, France

Lieu du stage / internship place: C2N, Palaiseau, France

Titre du stage / internship title: Strain and twist engineering of heat transport in 2D heterostructures

Résumé / summary



How does mechanical deformation affect heat transfer between atomically thin materials? Stacking two-dimensional crystals creates interfaces whose thermal properties depend on interlayer coupling and relative crystal orientation. Recent advances in quantum twisting microscopy allow such interfaces to be assembled and rotated in situ [1,2]. In parallel, our ongoing work uses Raman spectroscopy to resolve the temperatures of individual constituents in MoS_2/WSe_2 heterostructures encapsulated in isotopically distinct hBN, revealing large temperature differences between neighbouring layers.

This internship aims to determine how controlled indentation modifies interfacial heat transfer in a suspended 2D heterostructure. A probe will deform a membrane mounted on microheaters while optical spectroscopy monitors its thermal and mechanical response. Building on previous indentation experiments, the student will compare temperature distributions at different applied loads and investigate their relationship with strain and interlayer coupling. The originality of the platform lies in its simultaneous access to both sides of the suspended structure: mechanical contact from below and optical measurements from above. A probe carrying a 2D crystal will subsequently enable the formation of an adjustable interface, with relative rotation providing access to twist-dependent coupling and moiré structures. The platform is being developed for a cryogenic environment down to 4 K, while microheaters allow local sample temperatures approaching 900 K under suitable operating conditions.

Methods and techniques: Raman spectroscopy will provide constituent-resolved thermometry, accounting for strain, doping and spatial temperature variations. Photoluminescence will probe strain-induced changes in optical transitions, while second-harmonic generation may help determine crystal orientation. The student will gain experience in 2D material assembly, cleanroom fabrication, mechanical probing, low-noise electrical measurements and thermal modelling.

The expected outcome is a quantitative measurement of how indentation changes the temperature differences across the heterostructure, supported by modelling to distinguish interfacial heat transfer from contact-area changes and heat flow towards the supports. This will establish a basis for thermal measurements with rotatable 2D probes. A continuation towards a PhD is envisaged.

References

[1] J. Birkbeck et al., “Quantum twisting microscopy of phonons in twisted graphene”, Nature 641 (2025).

[2] M. Lee et al., “Revealing Electron–Electron Interactions in Graphene at Room Temperature with a Quantum Twisting Microscope”, Nano Letters 26, 4046–4052 (2026).

[3] L. Noubiwo et al., “High temperature gradient along a Vertical 2D heterostructure”, manuscript in preparation.

Possibility of a PhD: Yes. A continuation towards a PhD is envisaged.

Financement acquis / *Secured funding*	?	Nature du financement */Type of funding*	Not specified as secured
Financement demandé / *Requested funding*	?	Nature du financement */Type of funding*	ANR envisaged