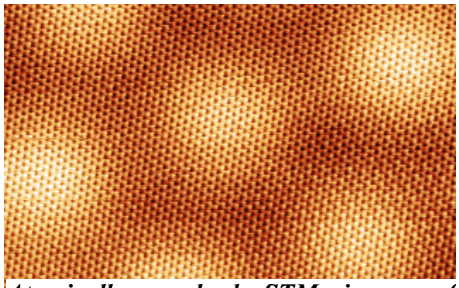
INSTITUT NEEL Grenoble

Proposition de stage Master 2 - Année universitaire 2022-2023

Local study of superconductivity in Magic Angle Twisted Bilayer Graphene

Stacking two graphene layers with a rotation between them creates a moiré which drastically modifies the Dirac cones. The Fermi velocity reduces for twist angles lower than 10° and even cancels around a magic value of 1.1°. Since electrons are no longer allowed to move, Coulomb energy becomes the relevant energy scale and drives the system twoards new collective states of matter such as correlated insulating behaviour, orbital magnetism or superconductivity as evidenced by recent experiments [1,2]. The detailed mechanisms for the emergence of these phases and their connection with the new band topology are still unclear.

The aim of this project is to constrain the theoretical scenarios by providing new experimental measurements of Magic Angle Twisted Bilayer Graphene (MATBLG) at the local scale using Scanning tunneling Microscopy and Spectroscopy (STM/STS). We have previously demonstrated that MATBGLs are highly inhomogeneous owing to ubiquitous local relative strains between the layers (heterostrain) [3]. We will study the influence of these inhomogeneities on the strongly correlated phases. In addition, the local electronic properties such as the local superconducting energy gap will be correlated to the global ones such as the critical temperature by performing simultaneous transport measurement. The experiments will be performed using a milliKelvin STM operated by the joint STM group in Grenoble (Néel/CNRS and IRIG/CEA). The analysis will be done in collaboration with theory groups in France and Europe.



Atomically resolved STM image of twisted graphene layers. The short-range period is atomic and the long-range period corresponds to the moiré. V_b=100 mV, i_t=500 pA.

We are looking for a motivated candidate with interest in experimental physics and a strong background in condensed matter physics who will be involved in all aspects of the research from the fabrication of samples to their measurements with state of the art very low temperature scanning tunneling microscope and the analysis of measurements.

[1] Y. Cao *et al.*, Nature **556**, 43 (2018)

[2] X. Lu *et al.*, Nature **574**, 653 (2019)

[3] F. Mesple *et al.*, Phys. Rev. Lett. **127**, 126405 (2021)

Collaboration and networking: The work bases on an experimental collaboration between IRIG/CEA (V. Renard), Inst. Néel (C. Winkelmann), C2N (R. Ribeiro Palau), as well as several theory groups.

Required skills: MSc level in Physics or Applied Physics. Prior experience in low temperature physics, surface science or nanoelectronics is a plus.

Starting date: 2023

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Plus d'informations sur : http://neel.cnrs.fr/spip.php?rubrique49