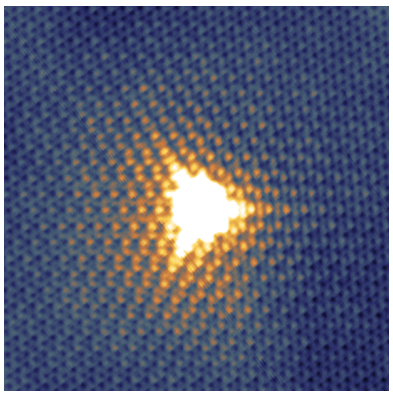
Institut de Recherche Interdisciplinaire de Grenoble

Pheliqs
Quantum Physics & Engineering

PhD thesis Project

Probing the band structure of topological 2D materials with quasiparticle interference

STM image of a hydrogen atom grafted on the surface of graphene. Quasiparticle interferences can be seen to extend far beyond the impurity, modifying the apparent topography.



Conducting electrons screen defects by forming an oscillation of local density of states around the defect. This phenomenon was uncovered by Jacques Friedel in the 1950's [1]. It is now known as quasiparticle interference since it can be understood as the interference between electronic waves hitting the defect and their reflection. The scanning tunneling microscope (STM) has allowed visualizing these oscillations in the real space and learn a lot about the Fermi surface of materials. Indeed, the quasiparticle interference patterns have a period related to Fermi wavelength and their Fourier transform can allow reconstructing the Fermi surface. The full energy dispersion $E(\boldsymbol{k})$ of the material can thereby be deduced from a sequence of energy-resolved local density of states maps measured by STM.

We have recently shown that using quasiparticle interference one can also measure graphene's Berry phase [4,5], which is a topological property. This established quasiparticle interference as a new experimental tool for determining the topological properties of materials, which are otherwise difficult to measure. The present research project aims at developing this technique and applying it to new graphene-based materials, like twisted bilayer graphene, proximity-induced superconducting graphene, rhombohedral graphene etc.

We are looking for a motivated Phd candidate with a strong background in condensed matter physics and interested in low temperature scanning tunneling microscopy. The candidate will be involved in all stages of the project, from sample preparation to the STM measurements and interpretation. She/he will participate to a long-term collaboration with Madrid University (travels to be expected). The experimental work will be backed up by theoretical input from the University of Bordeaux and Cergy Pontoise.

[1] J. Friedel, Nuovo Cimento **7**, 287 (1958)
[2] M. Crommie et al., Nature **363**, 524 (1993)
[3] G. Rutter et al., Science **317**, 219 (2007)
[4] C. Dutreix et al., Nature **574**, 219 (2019)
[5] Y. Guan et al., arXiv:2307.10024 (2023)

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To apply for this position, send your application (including CV) by e-mail to: vincent.renard@cea.fr & clemens.winkelmann@grenoble-inp.fr

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