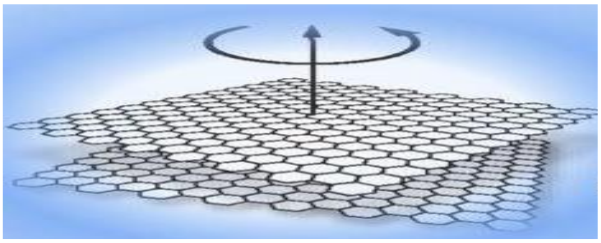
Master 2: ***International Centre for Fundamental Physics***
INTERNSHIP PROPOSAL

Laboratory name: Matériaux et Phénomènes Quantiques
CNRS identification code: UMR 7162
Internship director'surname: Yann Gallais
e-mail: yann.gallais@u-paris.fr Phone number: 01 57 17 69 89
Web page: https://mpq.u-paris.fr/?-Spectroscopie-de-QUAsi-Particules-SQUAP-
Internship location: Batiment Condorcet, Université Paris Cité, 75013 Paris
Thesis possibility after internship: YES
Funding: YES If YES, which type of funding: ANR grant

Optical probe of Moiré engineered 2D superconducting materials

Transition metal dichalcogenides (TMDs) have recently attracted significant interest because they allow the exploration of novel quantum phenomena down to the 2D limit. Of particular interest for the present project are metallic TMD like $NbSe_2$ which displays various quantum phases like Superconductivity (SC) and charge density wave (CDW) states. In addition, the possibility of creating Van der Waals heterostructures (VdW) by vertically stacking 2D materials provide a fertile playground to engineer novel properties and devices. Indeed, quantum interference effects between sheets of the 2D TMD with a twist angle allows an unprecedented control of the effective electron kinetic energy scale, driving the system to an interaction dominated regime and drastically enhancing anisotropies, thus providing a pathway to engineer SC properties at the 2D scale.



Twisted layers yielding a Moire pattern that can tune drastically the 2D material's properties.

During the internship, the student will initiate the fabrication of TMD-based VdW heterostructures displaying SC properties using exfoliation techniques. Samples of $NbSe_2$ will be fabricated and characterized as a function of thickness and twist angle. The obtained samples will be first measured by transport measurements to assess their presence of SC and its critical temperature. Going beyond traditional transport measurements, an originality of the project will be the use of low temperature spectroscopic techniques with micron-size spatial resolution like Raman scattering to probe the SC state.

References :
D. M. Kennes et al. Nature Physics, 17, 155 (2021)
R. Grasset et al. Physical Review Letters 122, 127001 (2019)
Y. Yoshikawa et al. Nature Physics (2021)

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