CONDENSED MATTER SCIENCES SEMINAR

Dr Dahlia Klein

Weizmann Institute of Science

Host

Dr Cyprian Lewandowski

Title

Nanoscale Imaging of Potential Landscapes with the Atomic SET

Friday, April 11th, 2025

1st Floor – B101

15:00-16:00

Abstract

Electrons in a solid are governed by the periodic potential landscape of the lattice. The advent of moiré lattices has revolutionized our ability to engineer such landscapes on nanometer scales, leading to numerous groundbreaking discoveries. Despite this progress, direct imaging of these electrostatic potential landscapes remains elusive. In my talk, I will introduce the Atomic Single Electron Transistor (SET), a novel scanning probe utilizing a single atomic defect in a van der Waals (vdW) material as an ultrasensitive, high-resolution potential imaging sensor. Built upon the quantum twisting microscope (QTM) platform, this probe leverages its unique ability to form a scannable 2D interface between vdW layers. Using the Atomic SET, I will present the first direct images of the electrostatic potential in the canonical moiré interface of graphene aligned to hexagonal boron nitride. Intriguingly, the magnitude of the measured potential significantly exceeds theoretical predictions, suggesting that current understanding may be incomplete. With a spatial resolution of 1 nm and a sensitivity to detect the potential of a few millionths of an electron charge, the Atomic SET opens the door for ultrasensitive imaging of charge order and thermodynamic properties for a range of quantum phenomena, including various symmetry-broken phases, quantum crystals, vortex charges, and fractionalized quasiparticles.

Bio

Dr. Klein received her B.A. in Physics, Biophysics, and Chemistry, along with an M.S. in Chemistry from the University of Pennsylvania in 2015. She then received a Ph.D. in Physics in 2021 at the Massachusetts Institute of Technology under the supervision of Prof. Pablo Jarillo-Herrero. During her Ph.D., she was part of the first team to discover two-dimensional (2D) magnets, giving rise to a new class of atomically thin materials. Since 2021, she has continued to study 2D quantum materials as a Koshland Fellow and Zuckerman STEM Leadership Postdoctoral Fellow at the Weizmann Institute of Science. In the lab of Prof. Shahal Ilani, she helped develop a unique type of scanning probe called the Atomic Single Electron Transistor (SET), which utilizes a single atomic defect to image the electrostatic potential in 2D materials with nanoscale resolution.