Matthew Yankowitz

University of Washington

Tunable correlated and topological states in twisted graphene heterostructures

Abstract:

A wide family of atomically-thin van der Waals (vdW) materials can be mixed-and-matched to form heterostructures without the typical interfacial constraints of conventional crystal growth, providing a simple path towards realizing on-demand designer electronics. The twist angle between neighboring crystals acts as a fundamentally new degree of freedom in these structures, controlling an emergent moiré superlattice potential that modifies the electronic band structure and overall device properties. In van der Waals heterostructures composed of two rotated graphene sheets, the moiré pattern creates very flat electronic bands over a small range of twist angles. A variety of highly tunable correlated and topological states have recently been identified in these platforms owing to the quenched kinetic energy of charge carriers and the intrinsic Berry curvature of the flat bands. I will discuss our recent work investigating these states in three different twisted graphene platforms: twisted bilayer graphene (two rotated monolayer graphene sheets), twisted double bilayer graphene (two rotated sheets of Bernal-stacked bilayer graphene), and twisted monolayer-bilayer graphene. We observe an array of correlated insulating states, superconductivity, orbital ferromagnetism, and incipient quantum anomalous Hall states within these devices. Furthermore, I will show how we can achieve dynamic control over these states using a combination of the twist angle, charge doping, electric field, magnetic field, and pressure as experimental tuning knobs.

Bio:

Matthew Yankowitz is an Assistant Professor of Physics at the University of Washington, with a joint appointment in the Department of Materials Science and Engineering. He received his B.S. in Physics from Stanford University in 2011, and his PhD in Physics in Prof. Brian LeRoy’s group at the University of Arizona in 2015. He subsequently performed his postdoctoral work in Prof. Cory Dean’s group at Columbia University, and joined UW as an Assistant Professor in 2019. Research in Matt’s group at UW focuses the investigation and control of topology, correlations, and magnetism in 2D van der Waals heterostructures using a combination of electrical transport and scanning probe microscopy.