CONDENSED MATTER SCIENCES SEMINAR

Professor Eslam Khalaf

Harvard University

Host

Dr Oskar Vafek

Title

Bridging Hubbard and quantum Hall physics in twisted bilayer graphene

Friday, March 22nd, 2024

1st Floor – B101

15:00-16:00

Abstract

Early on it was noticed that twisted bilayer graphene has elements in common with two paradigmatic examples of strongly correlated physics: Hubbard physics and quantum Hall physics. Indeed, twisted bilayer graphene hosts flat topological bands, but these bands host concentrated charge density, experimental signs of fluctuating magnetism, and signs of unconventional superconductivity. The emergence of fluctuating moments is particularly surprising, as localized Wannier states do not exist in topological bands. I will discuss a model for the twisted bilayer graphene flat bands that centers the concentration of charge density and, relatedly, the concentration of Berry flux. After establishing good quantitative agreement with more microscopic models, I will show how the model hosts parametrically decoupled flavor moments. These flavor moments are tied to Wannier states that are power-law delocalized, with infinite localization length, that nonetheless have parametrically small overlap with each other. I will conclude by discussing some experimental implications for this picture.

Bio

Eslam Khalaf got his PhD in 2017 from the Max Planck institute working on problems of topology and localization for which he was awarded the Otto Hahn medal by the Max Planck Society. Between 2018 and 2022, he was a postdoctoral fellow at Harvard working on problems of topology and correlations, particularly in the context of moiré systems. In fall 2022, he started an assistant professor position at the University of Texas at Austin. In fall 2023, he moved back to Harvard for an assistant professor position.