Magic continuum in twisted bilayer WSe_2: critical phenomena and phase transitions

Presenter:
Augusto Ghiotto
(Columbia Univ)

Authors:
Augusto Ghiotto
(Columbia Univ)

Lei Wang
(Columbia Univ)

En-Min Shih
(Columbia Univ)

Lede Xian
(Max Planck Institute for the Structure and Dynamics of Matter)

Daniel A Rhodes
(Columbia Univ)

Cheng Tan
(Columbia Univ)

Martin Claassen
(Simons Foundation)

Dante M. Kennes
(Max Planck Institute for the Structure and Dynamics of Matter)

Bumho kim
(Columbia Univ)

Yusong Bai
(Columbia Univ)

Kenji Watanabe
(National Institute for Materials Science)

Takashi Taniguchi
(National Institute for Materials Science)

Xiaoyang Zhu
(Columbia Univ)

James C Hone
(Columbia Univ)

Angel Rubio
(Max Planck Institute for the Structure and Dynamics of Matter)

Cory Dean
(Columbia Univ)

Abhay Pasupathy
(Columbia Univ)

Emergent quantum phases driven by electronic interactions can manifest in materials with narrowly dispersing, i.e. “flat", energy bands. Recently, flat bands have been realized in a variety of graphene-based heterostructures using the tuning parameters of twist angle, layer stacking and pressure, and resulting in correlated insulator and superconducting states. Here we report the experimental observation of similar correlated phenomena in twisted bilayer tungsten diselenide (tWSe2), a semiconducting transition metal dichalcogenide (TMD). Unlike twisted bilayer graphene where the flat band appears only within a narrow range around a “magic angle", we observe correlated states over a continuum of angles, spanning 4° to 5.1°. Hall measurements supported by ab initio calculations suggest that the strength of the insulator is driven by the density of states at half filling, consistent with a 2D Hubbard model in a regime of moderate interactions. At 5.1° twist, we observe evidence of superconductivity upon doping away from half filling, reaching zero resistivity around 3 K. This talk will focus on the critical phenomena and phase transitions in this system in an attempt to convey the uniqueness of its quantum phases.

Reference: arXiV: 1910.12147