[QMS2020 plenary talk]

Spectroscopic Studies of Correlated Electronic States in a Moiré Superlattice

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Magic-angle twisted bilayer graphene (MATBG) exhibits a rich variety of electronic states, including correlated insulators, superconductors, and topological phases. We have developed gate dependent scanning tunneling microscopy and spectroscopy measurements that enables us to study the electronic properties of MATBG as function of carrier concentration. When the flat bands of this system are partially full, at which correlated insulator and superconductivity are observed, our spectroscopic measurements show direct signatures of strong electronic correlations. [1] We show that these signatures cannot be captured by a mean field model of the interaction and require using Hubbard-type model to understand. Further high-resolution measurements reveal a cascade of transitions within this highly correlated state occurring as a function of carrier density, at each integer filling of the moiré flat bands—where insulating phases emerge at low temperatures. These transitions are a direct consequence of Coulomb interactions and spin/valley quantum degeneracy of this systems, which split the degenerate flat bands into Hubbard sub-bands. [2]. I will describe these studies as well as our ongoing efforts to probe the nature insulating and superconducting states In MATBG using a millikelvin STM system.

[1] Xie, Y. et al. Spectroscopic signatures of many-body correlations in magic-angle twisted bilayer graphene. Nature **572**, 101–105 (2019).

[2] D. Wong, et al. “Cascade of transitions between the correlated electronic states of magic-angle twisted bilayer graphene,” arXiv:1912.06145.