Mesoscopic Transport and Twistronics in Gate-defined Van der Waals Nanostructures

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Layers of two-dimensional materials stacked with a small twist-angle give rise to beating periodic patterns on a scale much larger than the original lattice, referred to as a "moire superlattice". As the twist angle approaches ~1.08 degree, isolated flat-bands emerge near zero energy. Correlated superconducting and insulating states were reported near the half-filling of such flat-bands. In this talk, we will discuss a higher-order moiré superlattice of moiré superlattices in a twisted-trilayer graphene architecture [1]. We report transport signatures of superconducting and correlated insulating states near the half filling of the moire of moire superlattice, at an extremely low carrier density on the order of ~1010 cm-2. We also show that the temperature dependence of v=-4 and v=4 states are semi-metallic, distinct from the insulating behavior in twisted bilayer systems, demonstrating that moiré superconductivity may emerge from continuous and non-isolated flat-bands. Towards further understanding and utilizing the rich underlying physics in twisted-trilayer-graphene, we will also talk about our recent effort in building gate-defined nanostructures to locally manipulate charge carriers with electrostatics in graphene [2].

References

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[2] Gate-tunable Veselago Interference in a Bipolar Graphene Microcavity, Xi Zhang*, Wei Ren*, Elliot Bell, Ziyan Zhu, Kenji Watanabe, Takashi Taniguchi, Efthimios Kaxiras, Mitchell Luskin, Ke Wang, ArXiv: 2106.09651 (2021).