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SEMINAR

Interacting Dirac fermions in graphene - based heterostructures

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Abstract:

Twisted graphene systems have drawn significant attention recently due to the discoveries of various exotic phenomena such as correlated insulators, unconventional superconductivity, and quantum anomalous Hall effects. Motivated by these exciting experimental progress, in this talk we first discuss the correlated ground states at integer and commensurate fractional fillings of the topological flat bands in both magic-angle twisted bilayer graphene and twisted multilayer graphene. In magic-angle TBG, we have unveiled the nature of various featureless correlated insulator states, and propose to distinguish them in experiments using nonlinear optical response [1]. In twisted multilayer graphene, we discovered a universal mechanism of valley-spin competition at half filling of the flat bands, and predicts topological phase transition driven by weak vertical magnetic fields [2]. We further consider a situation that graphene is placed on top of a band-aligned insulating substrate. By virtue of the band alignment, charge carriers can be transferred from graphene to the insulating substrate under the control of gate voltages. This may yield some long-wavelength charge order at the surface of the substrate through the Wigner-crystallization like mechanism. The long-wavelength charge order in turn exerts a superlattice Coulomb potential to the Dirac electrons in graphene, which reduces the non-interacting Fermi velocity, such that e-e Coulomb interactions would give rise rise to gapped Dirac states concomitant with interaction-enhanced Fermi velocities [3].

References:

[1] Phys. Rev. Lett. 128, 247402 (2022)

[2] Phys. Rev. Lett., 128, 026403 (2022)

[3] arXiv:2206.05659 (2022)

Biography:

Jianpeng Liu obtained Ph.D. degree in physics from Rutgers University in 2015. From 2015-2020, he has worked in UCSB and HKUST as postdoctoral scholar and research assistant professor. In 2020, he joined ShanghaiTech University as a tenure-track assistant professor. He has been working on various directions in theoretical and computational condensed matter physics, including but not limited to topological materials, moire 2D systems, magnetism, and periodically driven quantum systems etc. Recently he has been mostly working on the interaction effects and topological properties of moire 2D systems, and has done a number of works including the pseudo-Landau-level representation of magic-angle twisted bilayer graphene, topologically nontrivial flat bands and moire orbital magnetism in twisted multilayer graphene, the theory for correlated insulating states of twisted graphene systems etc., and the theory of interacting Dirac fermions in graphene-insulator heterostructures etc.

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Meeting ID: 963 5673 8745

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https://hku.zoom.us/j/96356738745?pwd=N1VtT1ZwMnhlYStPVmFoNFFRTCtKZz09

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