Chez Pierre

Presents ...

Monday, March 8, 2021

12:00pm Noon

Broadcast via Zoom

Chez Pierre Seminar

Oskar Vafek – Director, CMS-Theory National High Magnetic Field Laboratory

"Correlations and topology in the magic angle twisted bilayer graphene "

In the first part of the talk I will present a two-stage renormalization group treatment [1] of the continuum Bistritzer-MacDonald model for magic angle twisted bilayer graphene with Coulomb electron-electron interactions. This approach connects the physics at length scales shorter than the moire superlattice period to the Hamiltonian for the active narrow bands only, which is valid at distances much longer than the moire period. I will show that the progressive elimination of remote bands leads to an increase in the Fermi velocity -- well known for the monolayer graphene -- as well as to a decrease of the AA relative to the AB interlayer tunneling, thus approaching the so-called chiral limit. Once all remote bands are eliminated, the relative strength of the one-particle terms will be shown to be much smaller than the interactions within the active narrow band Hamiltonian. This justifies the strong coupling approach in the final step.
I will also present the results of the exact calculation of the exciton energy spectrum from the residual Coloumb interactions within the renormalized narrow bands. The softening of a branch of collective modes marks the enlarged U(4)×U(4) symmetry as the chiral limit is approached.

In the second part of the talk, I will discuss the energetics and the phenomenology of the many-body states favored by the residual Coulomb interactions at integer fillings of the narrow bands. Such states may be gapped or gapless, and some may even spontaneously double the moire period of the continuum model. Analytical and DMRG results based on 2D localized Wannier states [2,3,5], 1D localized hybrid Wannier states [4] and Bloch states [1,4] will be compared. Topological and symmetry constraints on the spectra of charged excitations for various ground states, as well as non-Abelian braiding of Dirac nodes[4], will also be presented.

[1] Oskar Vafek and Jian Kang Phys. Rev. Lett. 125, 257602 (2020)
[2] Jian Kang and Oskar Vafek, Phys. Rev. X 8, 031088 (2018)
[3] Jian Kang and Oskar Vafek, Phys. Rev. Lett. 122, 246401 (2019)
[4] Jian Kang and Oskar Vafek, Phys. Rev. B 102, 035161 (2020)
[5] Bin-Bin Chen, Yuan Da Liao, Ziyu Chen, Oskar Vafek, Jian Kang, Wei Li, Zi Yang Meng arXiv:2011.07602