Electronic multi-criticality in bilayer and trilayer graphene

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Electronic properties of bilayer graphene are qualitatively different from properties of two separate graphene single layers. The difference stems partly from the fact that the dispersion is no longer described by two isotropic Dirac cones near K and K' points. Rather, over wide energy range, the dispersion can be accurately described by two parabolically touching bands.

As a result, at the "neutrality point" the many-body effects are expected to lead to broken symmetry ground states. I will review current theoretical approach to electron-electron interaction driven many-body instabilities within the framework of Wilson RG. The role of competing interactions and the dependence of different ordering tendencies on the range of the interaction will be examined. In particular, I will argue that for longer range interaction giving predominantly forward scattering, the leading ordering tendency is towards a gapless electronic nematic state[1][4]. For shorter range interactions, such as in the Hubbard model, additional back scattering becomes comparable to the forward scattering and the leading ordering tendency is towards a gapped Neel antiferromagnet[2][3]. These results will be discussed in the context of recent experiments reporting signatures of broken symmetry states in suspended bilayer graphene.

Similar analysis will also be presented for ABC stacked trilayer graphene. There we find that the leading instability with forward scattering density-density interaction only is a mirror-breaking gapless state[5]. Addition of a small, but finite back scattering favors gapped phases[5], allowing us to make connections to the existing experiments on TLG. A fundamental symmetry difference between TLG and bilayer graphene (BLG) will be discussed. This symmetry difference is responsible for disfavoring nematic states in TLG under the same conditions that favor nematic states in BLG.

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