QUANTUM ELECTRODYNAMICS OF 2D AND 3D DIRAC SEMIMETALS

We review the different phases that may arise in 2D and 3D Dirac semimetals under the effect of the long-range Coulomb interaction, considering the many-body theory of these electron systems as a variant of the conventional quantum electrodynamics. In the case of 2D semimetals like graphene, we will discern between a weak-coupling regime with soft renormalization of electron quasiparticles and a strong-coupling phase characterized by the dynamical breakdown of either chiral symmetry or time-reversal invariance. On the other hand, we will see that 3D Dirac semimetals have a richer phase diagram depending on the number N of Dirac fermions, with a strong-coupling instability leading to dynamical mass generation up to N = 4 and a line of critical points for larger values of N characterized by the vanishing of the electron quasiparticle weight in the low-energy limit. Such a critical behavior signals the transition to a strongly correlated liquid, characterized by noninteger scaling dimensions that are the signature of non-Fermi liquid behavior.