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"Magic Angle" Semimetals

We will discuss the effects of quasiperiodicity on semimetals with Dirac points in two and three dimensions. Semimetals have garnered a significant amount of attention in recent years following the discovery of graphene and topological Dirac and Weyl materials. We will show that a quasiperiodic potential gives rise to a sharp quantum phase transition from a Weyl semimetal into a diffusive metal phase, with a clear non-analyticity in the density of states. We demonstrate that this transition can be described by a delocalization transition in *momentum space*: the quasiperiodic potential destabilizes the ballistic plane wave eigenstates. Due to the weakness of quasiperiodicity, we are able to generalize this transition to two and even one dimension. Interestingly, this transition does not exist in the presence of randomness. We track the velocity of the Dirac cone and show that at the semimetal to metal phase transition, the velocity goes to zero and the effective bands become flat. We will discuss how this is the same phenomena that happens at the band structure level in twisted bi-layer graphene at the "magic angle". Lastly, we will discuss the effects of interactions by constructing effective Hubbard models with large interactions due to this novel semimetal-to-metal phase transition.