Exploring Quantum Electronic Transport in Flatland

Pablo Jarillo-Herrero, MIT

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Over the past decade, the physics of low dimensional electronic systems has been revolutionized by the discovery of materials with very unusual electronic properties where the behavior of the electrons is governed by the Dirac equation. Among these, graphene has taken center stage due to its ultrarelativistic-like electron dynamics and its potential applications in nanotechnology. Moreover, recent advances in the design and nanofabrication of heterostructures based on van der Waals materials have enabled a new generation of quantum electronic transport experiments in graphene. In this talk I will describe our recent experiments exploring electron-electron interaction driven quantum phenomena in ultra-high quality graphene-based van der Waals heterostructures. In particular I will show two novel realizations of a symmetry-protected topological insulator state, specifically a quantum spin Hall state, characterized by an insulating bulk and conducting counterpropagating spin-polarized states at the system edges. Our experiments establish graphene-based heterostructures as highly tunable systems to study topological properties of condensed matter systems in the regime of strong e-e interactions and I will end my talk with an outlook of some of the exciting directions in the field.