Chez Pierre

Presents ...

Friday, December 16, 2022

11:00 am

Duboc Room 4-331

Special Chez Pierre Seminar

Eslam Khalaf, University of Austin, Texas

"Ideal flat bands, Topological phases, and charged excitations in graphene based moire systems".

Moire systems have emerged in recent years as a rich system to study correlations in narrow topological bands. In addition to bandwidth and topology, recent works have identified quantum geometry as a crucial ingredient to understand interaction physics in such bands. In particular, bands that satisfy the so-called ideal band condition share several similarities to Landau level physics making them promising to realize exotic topological phases and charge excitations. I will discuss several aspects of quantum geometry in moire systems and their implications in twisted graphene heterostructures. (i) First, I will show how the flat Chern bands of moire systems allow for non-trivial charge excitations consisting of an electron bound to spin flip excitations.These bound states can be interpreted as momentum-space representations of charged skyrmions. I will derive an exact analytical form for these bound states for Chern 1 bands with ideal quantum geometry and show that these analytical wavefunctions serve as a very good variational ansatz for non-trivial charge excitations for more realistic parameters. (ii) Second, I will discuss an idealized class of models describing multilayer graphene systems which host ideal higher Chern bands and show that these can host more exotic charge excitations and fractional topological phases compared to their Chern 1 counterparts (ii) Finally, I will discuss a simple platform based on periodically strained graphene which reproduces several aspects of twisted moire heterostructures without introducing a twist. I will show that this system hosts a tunable topological flat band which satisfies the ideal band condition to exponential accuracy and will provide numerical evidence for the existence of quantum anomalous Hall and fractional Chern insulator phases at partial filling of this band. I will show that this system has favorable parameters for the realization of such phases compared to twisted graphene systems.