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Correlated and Topological Phases in flat bands of two-dimensional crystals

Abstract: Due to their vanishing density of states and gapless semi-metallic behavior at charge neutrality, honeycomb lattice two-dimensional (2D) crystals are ideal candidates to host topological states. Even more interesting are twisted or strained 2D crystals, as the electron dispersion in these systems can be weakly dispersing, (i.e. exhibit a small bandwidth) or completely flat. In these situations, the interplay of topology and correlation driven phases in flat bands of 2D crystals can result in emergent topological order. Similarly, at high magnetic fields, multi-layer graphene and twisted bilayer graphene exhibit topological bands and various correlated states. In this talk, I will discuss possibility of superconductivity in strained graphene and correlated ferromagnetic states in twisted bilayer graphene at high magnetic fields. I will also discuss a new class of interacting and non-interacting symmetry protected topological phases stabilized by mirror symmetry in 2D Dirac semi-metals. This state coined the quantum parity Hall state, exhibits two one-dimensional counter-propagating metallic edge states, distinguished by even or odd parity under the system's mirror reflection symmetry.

Bio: Yafis Barlas received his doctorate from the University of Texas at Austin in 2008. He joined the faculty of University of Nevada Reno in 2019, after postdoc stints at NHMFL in Tallahassee, FL and UC Riverside and working as research scientist at UC Riverside and Yeshiva University. Yafis Ballas's research interests span topological states in condensed matter systems, the physics of 2-dimensional crystals, superconductivity, quantum Hall effects and magnetism.