ID: 2.2a

Title: Numerical studies of the fractional quantum Hall effect in two-dimensional chiral electron systems

Name: Papic, Zlatko

Affiliation: Princeton University

We discuss the prospects for various strongly correlated phases in materials with non-trivial Berry phases, such as graphene, bilayer graphene and topological insulators, in high magnetic fields. Using exact diagonalization calculations with spherical and periodic boundary conditions, we demonstrate several unusual features of the fractional quantum Hall (FQH) effect in these materials compared to the canonical material, Gallium Arsenide (GaAs). The presence of multicomponent degrees of freedom (spin, valley degeneracy) leads to novel phases, e.g. at $\nu=1/3$ filling in graphene which is distinct from the Laughlin state in GaAs. Furthermore, we argue that the exposed surface of chiral materials allows the effective Coulomb interaction to be tuned via dielectric screening and thereby enhance the excitation gap of prominent, Abelian and non-Abelian FQH states, or reduce the gap causing the transition to the compressible states. A combination of the specific form of the band structure and the applied field enables one to engineer quantum phase transitions between incompressible FQH states, and stripes or bubble phases by tuning the mass parameter. We predict such transitions to be realized in bilayer and trilayer graphene under the bias of the electric field.