

## Topological protection of perturbed edge states.

Guillaume Bal, University of Chicago

Topological insulators are materials characterized by a non-trivial topological invariant. In two-dimensions, a practically important feature of such materials is the presence of edge states that can propagate in only one direction and hence are back-scatter free. Moreover, since such a feature is protected by the topological invariant, it is immune to a large class of random fluctuations that do not break the invariant. In this talk, we model such two-dimensional materials by (differential) Dirac equations that describe the propagation of low frequency states. We show that an appropriate number of edge states is indeed a topological invariant for such Hamiltonians. We then develop a scattering theory to assess the quantitative influence of random fluctuations on transport along the edge. We show that conductance is indeed strongly affected by topology as expected, with Anderson localization prevented in non-trivial topologies. However, we also show that back-scattering is absent only for very specific fluctuation-dependent incoming modes. The main mathematical tools are the index theory of Fredholm operators and the diffusion approximation for wave propagation in one-dimensional random environments. The results also generalize to the setting of fermionic time reversal symmetry, where the standard index is replaced by a  $\mathbb{Z}_2$  index.