Fragility of spectral flow for topological phases in non-Wigner-Dyson classes

Luka Trifunovic*[1]

[1]LPT – CNRS : UMR5152 – France

Résumé

Topological insulators and superconductors support extended surface states protected against the otherwise localizing effects of static disorder. Specifically, in the Wigner-Dyson insulators belonging to the symmetry classes A, AI, and AII, a band of extended surface states is continuously connected to a likewise extended set of bulk states forming a “bridge” between different surfaces via the mechanism of spectral flow. In this work we show that this principle becomes {fragile} in the majority of non-Wigner-Dyson topological superconductors and chiral topological insulators. In these systems, there is precisely one point with granted extended states, the center of the band, E=0. Away from it, states are spatially localized, or can be made so by the addition of spatially local potentials. Considering the three-dimensional insulator in class AIII and winding number =1 as a paradigmatic case study, we discuss the physical principles behind this phenomenon, and its methodological and applied consequences. In particular, we show that low-energy Dirac approximations in the description of surface states can be treacherous in that they tend to conceal the localizability phenomenon. We also identify markers defined in terms of Berry curvature as measures for the degree of state localization in lattice models, and back our analytical predictions by extensive numerical simulations. A main conclusion of this work is that the surface phenomenology of non-Wigner-Dyson topological insulators is a lot richer than that of their Wigner-Dyson siblings, extreme limits being spectrum wide quantum critical delocalization of all states vs. full localization except at the E=0 critical point. As part of our study we identify possible experimental signatures distinguishing between these different alternatives in transport or tunnel spectroscopy.

*Intervenant