Title:
Green's function based symmetry constraints and topological semimetals without quasiparticles

Abstract:
Whether and how correlated topological states without free-electron counterparts occur in metallic systems is an open and pressing question. In heavy fermion systems, it has recently become possible to utilize symmetry to design correlated topological semimetals [1]. In this work, we introduce a general framework where lattice symmetries constrain single-particle excitations through Green's function eigenvectors even when the Fermi-liquid description breaks down, and substantiate it in a two-channel periodic Anderson model [2]. We demonstrate that correlation-induced emergent excitations are constrained by lattice symmetries to produce non-Fermi liquid topological phases. The topological nature of these phases is characterized by surface states and valley and spin Hall conductivities. We then identify candidate materials to realize the proposed phases. To further demonstrate the power of the Green's function based symmetry constraints on electronic excitations, we study an exactly solvable model of a Mott insulator with long-range interactions. By relating the symmetry-enforced spectral crossings to degeneracies of the original non-interacting eigenstates, we show that both Mott poles and zeros are subject to lattice symmetry constraints [3]. Our work opens a door to a variety of non-Fermi liquid topological phases in abroad range of strongly correlated materials.

Work at Rice was supported by the AFOSR Grant # FA9550-21-1-0356, the NSF Grant #DMR-2220603 and by the Robert A. Welch Foundation Grant No. C-1411.

[1] L. Chen et al., Nat. Phys. (2022). https://doi.org/10.1038/s41567-022-01743-4
[2] H. Hu, et al., arXiv:2110.06182
[3] C. Setty et al., arXiv:2301.13870