Feature-energy duality of topological boundary states in multilayer quantum spin Hall insulator

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Abstract
Gapless topological boundary states characterize nontrivial topological phases arising from the bulk-boundary correspondence in symmetry-protected topological materials, such as the emergence of helical edge states in a Z_2 topological insulator. However, the incorporation of symmetry-breaking perturbation terms in the Hamiltonian leads to the gapping of these edge bands, resulting in missing these crucial topological boundary states. In this talk, I will introduce our recent results on the critical issue of bulk-boundary correspondence in the quantum spin Hall insulator (QSHI) via novel-approaching feature spectrum topology [1]. Our findings present a comprehensive understanding of feature-energy duality, illustrating that the aggregate number of gapless edge states in the energy-momentum map and the non-trivial edge states in the feature spectrum equals the spin Chern number of multilayer QSHI. We identify a van der Waals material Bi_4Br_4 as a promising candidate through first-principles calculations. Our work not only unravels the intricacies of bulk-boundary correspondence but also charts a course for exploring quantum spin Hall insulators with high spin-Chern number.

[1] Yueh-Ting Yao et al., *arXiv:2312.11794* (2023).