Topological Superconductivity from Unconventional Band Degeneracy with Conventional Pairing

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Abstract

We present a new scheme for Majorana modes in systems with nonsymmporhic-symmetry-protected band degeneracy. We reveal that when the gapless fermionic excitations are encoded with conventional superconductivity and magnetism, which can be intrinsic or induced by proximity effect, topological superconductivity and Majorana modes can be obtained. We illustrate this outcome in a system which respects the space group P4/nmm and features a fourfold-degenerate fermionic mode at (π , π) in the Brillouin zone. We show that in the presence of conventional superconductivity, different types of topological superconductivity, i.e. first-order and second-order topological superconductivity, with coexisting fragile Wannier obstruction in the latter case, can be generated in accordance with the different types of magnetic orders; Majorana modes are shown to exist on the boundary, at the corner and in the vortices. To further demonstrate the effectiveness of our approach, another example related to the space group P4/ncc based on this scheme is also provided. Our study offers insights into constructing topological superconductors based on bulk energy bands and conventional superconductivity, and helps to find new material candidates and design new platforms for realizing Majorana modes.

Bibliography

[1] arXiv:2208.10225