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Uncovering fermionic zero-energy modes through a boundary-matrix approach ABHIJEET ALASE, Graduate Student, EMILIO COBANERA, Postdoctoral researcher, GERARDO ORTIZ, LORENZA VIOLA, Professor — Given a non-interacting fermionic lattice system with arbitrary boundary conditions, we show how the problem of diagonalizing the single-particle Hamiltonian can be split into suitably defined bulk and boundary problems. Following this exact separation, a boundary matrix may be constructed, which contains complete information about the emergence and nature of zero-energy modes, even in the thermodynamic limit. Our approach is applicable to model Hamiltonians in arbitrary space dimensions of relevance to topological quantum matter. As a concrete illustration, we show how to correctly describe the zero-energy Majorana modes of a time-reversal-invariant two-band s-wave topological superconductor in a Josephson ring configuration, and also provide physical insight into the predicted unconventional Josephson effect.

Abhijeet Alase
Graduate Student

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