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Gapless topological superconductivity identified by the spectral localiser

Ever since the first discovery of a topological insulator in the integer quantum Hall effect in 1980, topological band theory has played a pivotal role in the discovery and classification of topological insulators, semimetals, and superconductors. Furthermore, recent advances in real-space topological theory has enabled one to calculate local topological markers and identify topological phases in disordered or aperiodic systems such as quasicrystals. However, in metals or other gapless systems, any topological energy eigenstate would be a member of highly degenerate zero-energy eigenstates and thus be mixed strongly with bulk states, making it impossible to identify topological edge states. In this work, we demonstrate the occurrence of gapless topological superconductivity in Ammann-Beenker quasicrystals. Utilising a recently developed, general theory of gapless topological materials, we show that topological states can be characterised by a local Chern number derived from the system's spectral localiser. We explore topological phase diagrams in terms of the local Chern number and possible interplay of topological edge states and confined states in the bulk.