Embedded Majorana Islands

Mesoscopic superconducting islands hosting Majorana zero modes (MZMs), or Majorana islands in short, offer a prototype of topological qubits. In this work we investigate theoretically the model of a generic Majorana island tunneling-coupled to a single-piece metallic substrate, hence an embedded Majorana island. We show the crucial consequences of an interplay between the topological ground states nonlocally addressed by the MZMs and the metallic bath with coherent electron propagation: on the one hand, the topological degeneracy on the Majorana island can be preserved, by virtue of the particle-hole symmetry, despite the apparent bath-induced coupling between MZMs; on the other hand, the electronic interference in the metallic bath may lead to profound alterations to the renormalization group behavior of the hybrid system towards low energy/temperature compared with conventional Kondo physics. This work serves to establish the model of embedded Majorana islands as an experimentally relevant and theoretically intriguing problem particularly in the direction of topological quantum computation.