Influence of disorder on vortex Majorana states in 3D topological insulators

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Abstract

Majorana states hosted in vortex cores of topological insulator/superconductor heterostructures present a promising alternative to nanowire-based approaches. Vortices can be pinned to anti-dots prefabricated in the superconductor; large anti-dots are relatively simple to fabricate and ensure that weak magnetic fields are sufficient to induce a required quantum of flux. However, it has thus far been unclear whether current topological insulator materials are clean enough to sustain Majorana vortex modes with a sizable gap to excitations. Also, if the anti-dot is too large, the level spacing of subgap vortex states may become too small even in a clean case. In this talk, I will present our numerical studies of the vortex subgap spectrum as a function of disorder, chemical potential, and the anti-dot size. We employ a two-dimensional low-energy description of the topological insulator surface, which allows us to simulate large system sizes with vortices up to 1 µm in diameter. We connect our results to existing mobility measurement data to translate the level of disorder in existing materials to our simulated disorder model.

References


Figures

**Figure 1:** Majorana bound state wave function in disordered vortex of radius 900 nm.

**Figure 2:** Energy spectrum of Andreev bound states inside of anti-dot (with trapped vortex) as a function of disorder strength on TI surface. For an antidot with micron radius critical disorder RMS is about 40 meV.