Highlights

Activity F - Electronic and thermal transport from the nanoscale to the macroscale - 2021

Formation and detection of Majorana modes in quantum spin Hall trenches

C. Fleckenstein[1], N. Traverso Ziani[2,3], A. Calzona[1], M. Sassetti[2,3], B. Trauzettel[1]

[1]Institute of Theoretical Physics and Astrophysics, University of Wurzburg, 97074 Wuerzburg, Germany
[2]Dipartimento di Fisica, Università di Genova, 16146 Genova, Italy
[2]CNR-SPIN, Sede Genova c/o Università di Genova, Via Dodecaneso 33, 16146 Genova, Italy

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We propose a novel realization for a topologically superconducting phase hosting Majorana zeromodes on the basis of quantum spin Hall systems. Remarkably, our proposal is completely free of ferromagnets. Instead, we confine helical edge states around a narrow defect line of finite length in a two-dimensional topological insulator. We demonstrate the formation of a new topological regime, hosting protected Majorana modes in the presence of s-wave superconductivity and Zeeman coupling. Interestingly, when the system is weakly tunnel-coupled to helical edge state reservoirs, a particular transport signature is associated with the presence of a non-Abelian Majorana zero-mode.

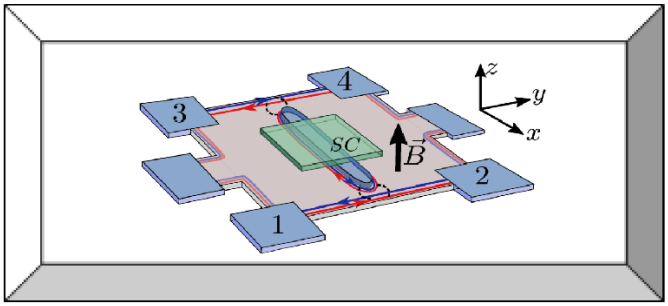

Fig. 1: The setup we analyze. It consists of a long constriction between the helical edges of a two-dimensional topological insulator. The constriction implements a novel type of mass at the helical edge. The system is proximitized with an s-wave superconductor and a magnetic field is applied. The ingredients just mentioned are enough to the implementation of Majorana fermions

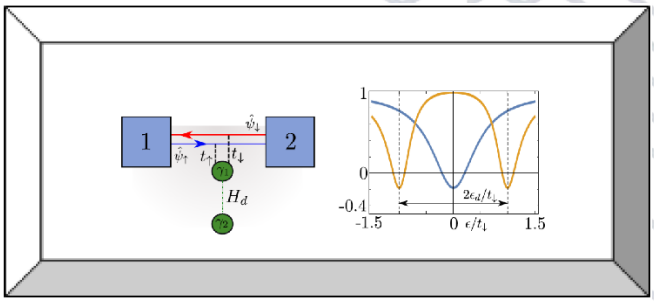

Fig. 2: The topological phase extends for a wide range of parameters. Moreover, it is detected almost unambiguously through transport experiments. Such a special property is enabled by the fact that the system is naturally embedded in a two-dimensional structure with helical contacts. Moreover, the structure we envisioned seems easy to scale in terms of number of Majorana fermions.