Majorana modes and gauge invariance of NSN junctions of magnetic topological insulators

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Magnetic topological insulators (MTIs) are outstanding candidates for the realization of topological 1D and 2D superconducting phases [1,2] with end-localized or propagating Majorana modes. However, the experimental detection of these elusive quasiparticles is still a matter of concern.
We propose to detect such topologically-protected Majorana boundary states in NSN junctions between normal and proximitized MTIs by applying asymmetric bias drops on the two leads of the device. Without Majorana modes in the superconductor, the conductance is independent of the way the total bias is split across the junction. We refer to this physical property as "gauge invariance" of the electric conductance, and we argue that such invariance is lost in presence of zero-energy Majorana modes. Indeed, an unbalanced bias leads to asymmetric currents on the two terminals of the junction and the charge conservation requires a current of Cooper pairs going to ground from the superconductor. Such electric current constitutes a characteristic signal of Majorana quasiparticles, and can be directly detected through conductance measurements in realistic devices.

Figures

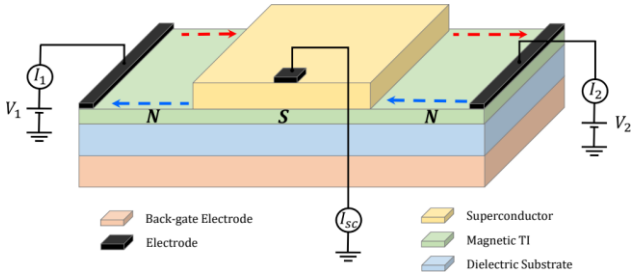

Figure 1: Proposed setup for the detection of Majorana edge modes in magnetic topological insulators.

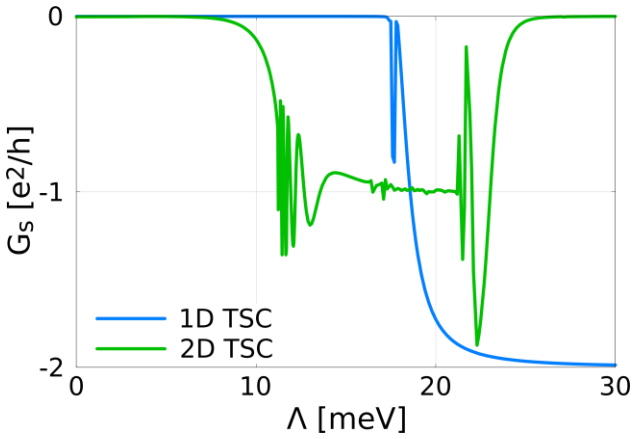

Figure 2: Conductance G_s in the superconducting lead as a function of magnetization Λ in the MTI. Conductance Plateaus $G_s = \neq 0$ are observed in presence of nontrivial Majorana modes.

References

[1] J. Wang, Q. Zhou, B. Lian and S.C. Zhang, Phys. Rev. B **92**, 064520 (2015).
[2] Y. Zeng, C. Lei, G. Chaudhary and A.H. MacDonald, Phys. Rev. B **97**, 081102(R) (2018).