Andreev and Majorana bound states in nanoscale devices

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Over the past decade we have studied Majorana bound states in hybrid devices of superconducting and semiconducting materials. Due to finite-size effects, unavoidable residual disorder and inhomogeneities in our devices, Majorana bound states with topological protection have not been observed. Instead of these studies in long hybrid nanowires, we have adopted a new bottom-up approach by building a Kitaev chain starting from a minimal cell. The minimal cell consists of two spin-polarized quantum dots coupled via a short, grounded superconductor. This coupling provides both single-electron tunneling between the quantum dots as well as a Cooperpair coupling via crossed Andreev reflection. We discuss how sweet spots can be found where Majorana states arise on the dots. This minimal cell is too short to develop a topological gap such that these Majorana states are only partially protection, hence these states have been dubbed 'poor man's Majorana's'. Ongoing work is on longer chains that are predicted to have more and more protection against local noise..

References

[1] Relevant reference: Dvir, Wang..., Kouwenhoven, Realization of a minimal Kitaev chain in coupled quantum dots. Nature 614(7948), 445–450 (2023)