Minimal Kitaev-transmon qubit based on double quantum dots

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Minimal Kitaev chains composed of two semiconducting quantum dots coupled via a superconductor have emerged as a promising platform to realize and study Majorana bound states (MBSs), which appear for fine-tuned configurations [1, 2]. We propose a hybrid qubit based on a Josephson junction between two such double quantum dots (DQDs) embedded in a superconducting qubit geometry (Fig. 1). The qubit makes use of the 4π-Josephson effect in the Kitaev junction to create a subspace based on the even/odd fermionic parities of the two DQD arrays hosting MBSs. Deep in the transmon regime, we demonstrate [3] that by performing circuit QED spectroscopy, one could observe distinct MBS features in perfect agreement with precise analytical predictions in terms of DQD parameters only (Fig. 2). This also allows us to extract the Majorana polarization in the junction.

References

[1] T. Dvir et al., Nature 614, 7948 (2023) 445.

[2] M. Leijnse and K. Flensberg, Phys. Rev. B 86, 13 (2012) 134528.

[3] D. Michel Pino, Rubén Seoane Souto and Ramón Aguado, Phys. Rev. B 109, 7 (2024) 075101.

Figures

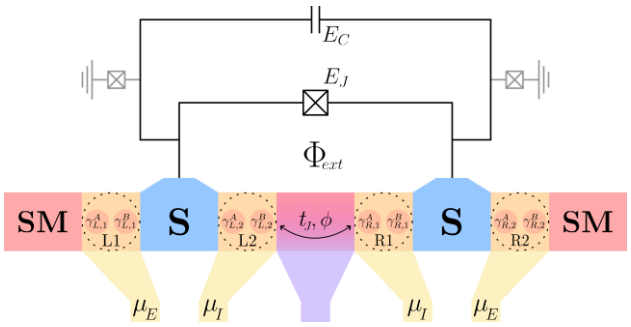

Figure 1: Schematic illustration of the Kitaev-transmon device.

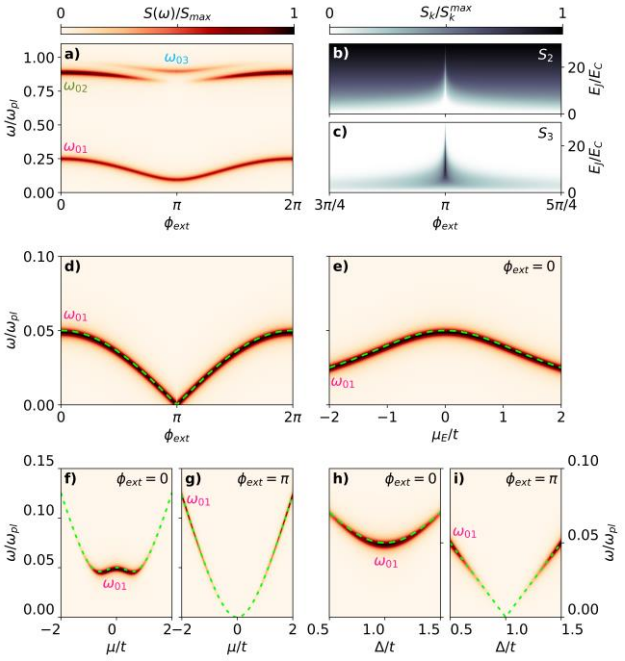

Figure 2: Kitaev-transmon qubit spectroscopy.