Triplet blockade in a Josephson junction with a double quantum dot

Dávid Pataki[1], Gorm Steffensen[2], Daniël Bouman[3], Péter Boross[1], Jens Paaske[2], Attila Geresdi[4], András Pályi[1]
[1] Department of Theoretical Physics and MTA-BME Exotic Quantum Phases Research Group, Budapest University of Technology and Economics, H-1111 Budapest, Hungary
[2] Center for Quantum Devices, Niels Bohr Institute, University of Copenhagen, 2100 Copenhagen, Denmark
[3] QuTech and Kavli Institute of Nanoscience, Delft University of Technology, 2600 GA Delft, The Netherlands
[4] Quantum Device Physics Laboratory, Department of Microtechnology and Nanoscience, Chalmers University of Technology, SE 41296 Gothenburg, Sweden
Email: dpataki@edu.bme.hu

Topological superconductors are promising building blocks for future quantum computers, although their experimental realization remains a challenging task. Here we present theory results [1] on a Josephson junction with a double quantum dot, a minimal model system toward engineered topological superconductivity based on quantum dot chains [2]. In the (1,1) charge sector of the serially coupled double quantum dot, we illustrate a magnetically induced singlet-triplet ground-state transition via triplet blockade: the Josephson current carried by the triplet ground state at high magnetic field is much suppressed compared to the current carried by the singlet ground state at low magnetic field. The theory results we present are based on the zero-bandwidth approximation [3]. Simple arguments for a strong triplet blockade are provided in the large-gap [4], and the strong-Coulomb-repulsion limit, furthermore we also outline a process-counting argument that supports partial triplet blockade in the intermediate regime, using perturbation theory [5]. We also present experimental data showing the triplet blockade predicted by the theory [1]. The triplet blockade mechanism could provide a coupling mechanism between spin qubits, and (topological or non-topological) superconducting qubits.

References

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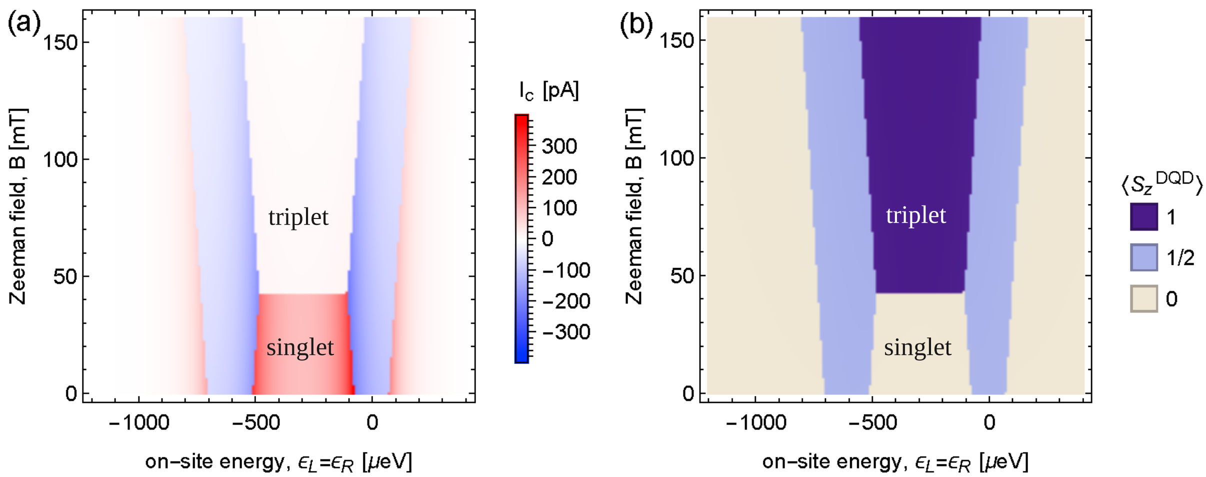

Figure 1. (a) Magnetic stability diagram of the double quantum dot Josephson junction; (b) Ground state expectation value of the z-component of the total double quantum dot spin reveals that the supercurrent is blockaded in the triplet configuration.