Highlights

RESEARCH AREA 3 - Quantum Science and technologies- 2024

Anomalous supercurrent and diode effect in locally perturbed topological Josephson junctions

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Applied Physics Letters

The interplay between superconductivity and topological materials has led to intriguing phenomena in the realm of condensed matter physics. Of particular interest is the quantum transport driven by edge states. These emerge because of the topological nature of the material's bulk. If a superconductor is brought into proximity, the edge states become superconducting. In this work we theoretically explored the possibility of achieving nonreciprocal superconducting transport across a Josephson junction based on the topological edge states of the so-called Quantum Spin Hall Effect. The nonreciprocity of the supercurrent is called Superconducting Diode Effect and can emerge if time-reversal and inversion symmetry are broken. We broke these symmetries considering the joint effect of an overall magnetic field and the effect of a tip that locally perturb one of the two edges. We were able to obtain a high efficiency diode when the tip itself is magnetized. Moreover, this work contributes to the exploration of the role of symmetries in superconducting systems.