PHD GRANT

Topological Josephson junctions – Joule poisoning of Majorana modes

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The new excitations called Majorana zero modes that can emerge in topological superconducting systems are attracting considerable attention for the prospect of topological quantum computing. In this work we have investigated topological Josephson junctions made by grafting the surface of the 3-dimensional topological insulator Bi_2Se_3 with superconducting electrodes: the surface states are predicted to host Majorana Bound States with an unusual 4π-periodicity in the superconducting phase difference across the junction, and the subsequent suppression of the odd Shapiro steps in the current-voltage characteristics.

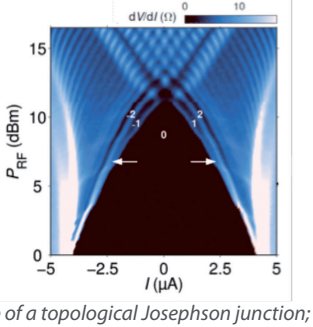

Fig. 1: Shapiro map of a topological Josephson junction; white numbers indicate Shapiro steps index. The white arrows mark the appearance of the Shapiro steps ±1 upon increasing the microwave power P_{rf}.

We have studied the response of the characteristics of our junctions to a microwave excitation. Our main experimental finding is the absence of the first Shapiro step at low microwave power (Fig. 1). By including electron overheating due to Joule dissipation in our theoretical analysis, we predict a poisoning of the 4π-periodic Majorana Bound States [1]. The numerical simulations compare very well with the experimental data and lend support to the Majorana origin of the partial suppression of the first Shapiro step [2].

OUTCOMES

[1] Interplay between electron overheating and ac Josephson effect, Phy. Rev. B 93, 180505(R) (2016).

[2] Joule overheating poisons the fractional ac Josephson effect in topological Josephson junctions, arxiv:1803.07674 (2018).

Oral presentations: Shybrids, Les Arcs (2018); Optima18, MPI Dresden (2018).

Leverage: Development of a fruitful collaboration between theory (INAC) and experiments (NEEL) on topological superconductivity.