Theory of Superconducting Diode effect in Multiterminal Josephson junctions

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We theoretically study the superconducting diode effect (SDE) in a three-terminal Josephson junction (Figure 1). The diode effect in superconducting systems is typically related to the presence of a difference in the critical currents for currents flowing in the opposite direction. We show that in multi-terminal systems this effect occurs naturally without the need of the presence of any spin interactions and is a result of the presence of a relative shift between the Andreev bound states (ABSs) carrying the supercurrent (Figure 2). The origin of this phenomenon is related to the local breaking of time reversal and inversion symmetries, resulting from the coupling of the third terminal with a phase different from 0, mod(π).

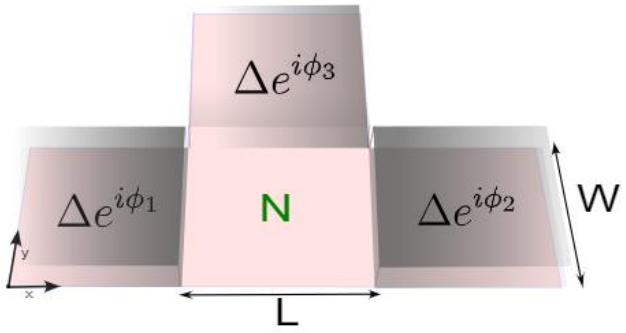

Figure 1: Planar Josephson junction. The pink region corresponds to the normal part and the gray superconducting segments are the superconducting leads.

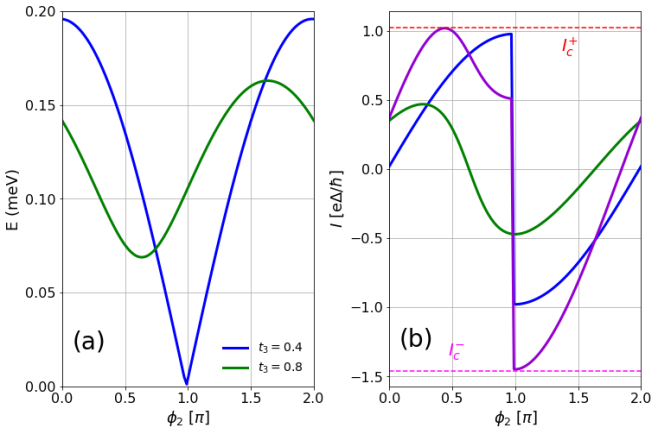

Figure 2: Energy spectrum (a) and supercurrent (b) in three-terminal Josephson junction hosting two ABSs characterized by different coupling strength to the superconducting terminals. The violet curve in (b) shows the non-reciprocal current carried by the two ABSs. The phase on the third superconducting terminal is $\varphi_3 = 1.5\pi$.

References

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