Supercurrent diode effect in hybrid Josephson junctions

Matteo Carrega[1], Bianca Turini[2], Sedighe Salimian[2], Andrea Iorio[2], Samuele Fracassi[3], Simone Traverso[3], Niccolo Traverso Ziani[1,3], Elia Strambini[2], Valentina Zannier[2], Francesco Giazotto[2], Lucia Sorba[2], Stefan Heun[2], Maura Sassetti[1,3]

[1] CNR-SPIN, Via Dodecaneso 33, 16146 Genoa, Italy
[2] NEST, Istituto Nanoscienze-CNR and Scuola Normale Superiore, Piazza San Silvestro 12, 56127 Pisa, Italy
[3] Dipartimento di Fisica, Università di Genova, Via Dodecaneso 33, 16146 Genoa, Italy

The simultaneous breaking of time-reversal and inversion symmetry can lead to peculiar effects in Josephson junctions, such as the anomalous Josephson effect or supercurrent rectification, which is a dissipationless analog of the diode effect. Due to their potential impact in new quantum technologies, it is important to find robust platforms and external means to manipulate the above effects in a controlled way.
Here, we demonstrate that hybrid Josephson junctions made of high-quality InSb nanoflags constitute a promising platform for supercurrent rectification due to its strong spin orbit coupling. The high quality of the devices enabled the observation of the diode effect in these Josephson junctions [1]. When subjected to an in-plane magnetic field, these devices enter a non-reciprocal transport regime, manifesting an asymmetry between positive and negative critical currents.
Furthermore, we consider a quantum spin Hall-based Josephson junction subjected to a magnetic field in the direction defined by spin momentum locking, and in presence of a local tip in close proximity to the normal region [2]. We predict that magnetic tips are a useful tool that allow for tunability of both φ_0 response and supercurrent rectification, thus proposing another potential platform for dissipationless transport.

References

[1] B. Turini et al., *Nano Lett.* **22** (2022) 8502.
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