Gate tunable supercurrent diode and anomalous Josephson effect

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Résumé

The discovery of the supercurrent diode effect by Ando et al. (1) and its observation in a rich variety of systems caused an increasing interest in the physics of non-reciprocal superconductivity.
Here, we study Josephson junctions in hybrid Al/InGaAs/InAs structures, which harbor strong Rashba spin-orbit interaction. In combination with a Zeeman field, this gives rise to an anomalous phase shift ϕ in the current-phase relation (CPR). The presence of high harmonics in the CPR gives rise, in addition, to the supercurrent diode effect (2,3,4). Using a superconducting quantum interferometer we simultaneously measure the ϕ-shift and supercurrent diode effect on a single junction (5). By electrostatic gating of the junction, we reveal the link between the ϕ-shift and supercurrent diode effect.

(1) F. Ando et al., Nature **584**, 373–376 (2020)
(2) C. Baumgartner et al., Nature Nanotechnol. **17**, 39 (2022)
(3) A. Costa et al., Nat. Nanotechnol. **18**, 1266–1272 (2023)
(4) C. Baumgartner et al., J. Phys. Condens. Matter **34**, 154005 (2022)
(5) S. Reinhardt et al., Nat Commun **15**, 4413 (2024)

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