Spin-orbit coupling assisted transport phenomena in superconducting magnetic nanojunctions

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Superconducting magnetic junctions exhibit fascinating physical phenomena, making them essential building blocks for modern technologies like quantum computing. Particularly attractive are multicomponent junctions in which the inherently broken space-inversion symmetry additionally rises strong spin-orbit coupling (SOC). Pairing the interplay of the two most important spin interactions---magnetic exchange and SOC---with superconducting coherence has already been demonstrated to lead to unique signatures in spectroscopy and transport, and is furthermore expected to induce topological superconductivity hosting Majorana states.

In this talk, I will introduce the most intriguing transport ramifications of SOC in superconducting magnetic junctions covering, in particular, giant transport magnetoanisotropies in the junctions' conductance and Josephson-current flow [1], the possibility to generate sizable transverse anomalous (Josephson) Hall effects [2, 3], as well as nonreciprocal transport and supercurrent-diode characteristics in proximitized 2DEG Josephson junctions [4, 5, 6] that were recently experimentally classified through robust Josephson-inductance measurements and have been attracting considerable attention in the superconducting-transport community.

[1] Phys. Rev. B **95**, 024514 (2017).
[2] Phys. Rev. B **100**, 060507(R) (2019).
[3] Phys. Rev. B **101**, 104508 (2020).
[4] Nat. Nanotechnol. **17**, 39 (2022).
[5] arXiv:2212.13460 (accepted for Nat. Nanotechnol.).
[6] arXiv:2303.14823.

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