TUNABLE PURE SPIN SUPERCURRENTS and the demonstration of a super-conducting spin-wave device

seminar

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Abstract

Superconducting spin currents are key to the development of superconducting spintronics [1-2] and involve the transfer of spin angular momentum via proximity-induced equal-spin triplet states in a singlet superconductor (SC) [3-5]. Our recent ferromagnetic resonance experiments [3,4] and theory [5] of Pt/Nb/Ni8Fe2 proximity-coupled structures strongly suggest that spin-orbit coupling (SOC) in Pt in conjunction with a magnetic exchange field in Ni8Fe2 are the essential ingredients to generate a pure spin supercurrent channel (without accompanying net charge supercurrent) in Nb. In this tutorial, I would like to describe our recent progress of tunable pure spin currents and the demonstration of a superconducting spin-wave (SW) device [6]:

1) By substituting Pt for a perpendicularly magnetized Pt/Co/Pt spin-sink, we were able to demonstrate the role of SOC, and show that pure spin supercurrent pumping efficiency across Nb (singlet SC) is tunable by controlling the magnetization direction of Co.

2) By inserting a Cu spacer with weak SOC between Nb and Pt/(Co/Pt) spin-sink, we also proved that Rashba-type SOC is key for forming and transmitting pure spin supercurrents across Nb.

3) Finally, by engineering these properties within a single multilayer structure, we demonstrated a prototype superconducting SW device in which lateral SW propagation is gateable via the opening or closing of a vertical pure spin supercurrent channel in Nb.

Reference:

[1] Nat. Phys. 11, 307 (2015). [2] Rep. Prog. Phys. 78, 104501 (2015). [3] Nat. Mater. 17, 499 (2018). [4] Phys. Rev. B 99, 024507 (2019). [5] Phys. Rev. B 98, 104513 (2018). [6] arXiv:1908.00873 (2019).

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