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北京大学量子材料科学中心

International Center for Quantum Materials, PKU

Special Seminar

Spin-triplet supercurrent and controllable phase states in ferromagnetic Josephson junctions

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Abstract

When a superconductor (S) and a ferromagnet (F) are put into contact with each other, the combined S/F hybrid system exhibits altogether new properties. There is a proximity effect where electron pair correlations from S penetrate into F, but the pair correlations oscillate rapidly and decay over a very short distance due to the large exchange splitting between the spin-up and spin-down electron bands in F. In the presence of non-collinear magnetization, Bergeret et al. [1] predicted that spin-triplet pair correlations are generated, which are immune to the exchange field and hence persist over much longer distances in F. Several groups have observed convincing evidence for such spin-triplet correlations in a variety of S/F and S/F/S systems. Our approach is based on measuring the supercurrent in Josephson junctions of the form S/F'/F/F''/S, with non-collinear magnetizations in adjacent ferromagnetic layers [2,3]. We have demonstrated control of the supercurrent amplitude [4] and the ground-state phase across the junction [5] by rotating the magnetization direction of the F' layer by 90° or 180°, respectively.

Controlling the ground-state phase of a Josephson junction can also be accomplished using only the short-range pair correlations, in a "spin-valve" junction containing only two ferromagnetic layers, S/F/F'/S [6]. In the second half of the talk I will discuss how phase-controllable Josephson junctions could be used as memory elements in random-access memory for a superconducting computer.

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[1] F.S. Bergeret, A.F. Volkov, and K.B. Efetov, Phys. Rev. Lett., 86, 4096 (2001).

[2] T.S. Khaire, M.A. Khasawneh, W.P. Pratt, Jr., and N.O. Birge, Phys. Rev. Lett. 104, 137002 (2010); C. Klose et al, Phys. Rev. Lett. 108, 127002 (2012).

[3] M. Houzet and A.I. Buzdin, Phys. Rev. B 76, 060504(R) (2007).

[4] W. Martinez, W.P. Pratt, Jr., and N.O. Birge, Phys. Rev. Lett. 116, 077001 (2016).

[5] J.A. Glick et al., Science Advances 4, eaat9457 (2018).

[6] E.C. Gingrich, B.M. Niedzielski, et al., Nature Phys. 12, 564 (2016).

About the speaker

Norman Birge received his Ph.D. in 1986 from the University of Chicago, studying the glass transition in supercooled liquids. He changed his focus to electronic transport during his post-doctoral work at AT&T Bell Laboratories. He came to Michigan State University in 1988 and has been there ever since, aside from two sabbatical years with the Groupe Quantronique at the CEA Saclay in France and a brief sabbatical with Geoffrey Beach's group at MIT. His research has spanned several topics in quantum transport and mesoscopic physics, including 1/f noise and universal conductance fluctuations, dissipative quantum tunneling of defects in metals, electron phase coherence in metals at very low temperatures, the superconducting proximity effect, and nonequilibrium transport phenomena in metallic systems. His current research focuses on the interplay between superconductivity and ferromagnetism in hybrid structures. He is best known for his group's work on spin-triplet supercurrent in ferromagnetic Josephson junctions and controllable phase states in spin-valve Josephson junctions.