Spin-Triplet Supercurrent in Ferromagnetic Josephson Junctions

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The proximity effect between a conventional superconductor (S) and a ferromagnet (F) decays and oscillates over an extremely short length scale in F due to the large exchange splitting between the spin-up and spin-down electron bands. If spin-triplet pair correlations were present, they would persist over much longer distances in F. Such spin-triplet correlations have been predicted to occur in S/F systems in the presence of certain forms of magnetic inhomogeneity near the S/F interface.[1] We have observed strong evidence for spin-triplet pair correlations in S/F/S Josephson junctions containing strongly-ferromagnetic cobalt.[2] The experimental signature of the triplet correlations is a Josephson critical current that decays very slowly for Co thicknesses up to several tens of nm. This long-range supercurrent appears only in samples with additional ferromagnetic F' layers inserted between the central Co and outer superconducting electrodes, and is caused by non-collinear magnetizations of the F' and Co layers. After application of a large in-plane magnetic field, the magnitude of the long-range supercurrent is further enhanced, contrary to expectation. I will discuss possible reasons for this additional critical current enhancement, and provide an update on our current experiments.

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[2]T.S. Khaire, M.A. Khasawneh, W.P. Pratt, Jr., and N.O. Birge, Phys. Rev. Lett. 104, 137002 (2010).

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