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Nonlocal supercurrent in mesocopic multiterminal SNS Josephson junction

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A nonlocal supercurrent was observed in mesoscopic planar SNS Josephson junctions (Al-Cu-Al) with additional normal metal electrodes (Cu). Nonequilibrium quasiparticles were injected from a normal-metal electrode into the left superconducting bank of the Josephson junction in the absence of a net transport current through the junction. The value of nonlocal supercurrent slightly exceeds the local value I_c and depends on the distance between Josephson junction and the injector. The detected voltage in the resistive state in nonlocal configuration has opposite sign. We claim that the observed effect is due to a supercurrent counterflow, appearing to compensate for the quasiparticle flow in the SNS weak link. We have measured the responses of SNS junctions for different distances between the quasiparticle injector and the SNS junction at temperatures far below the superconducting transition temperature. Such a choice of the distance scale between injectors and Josephson junction allows us to exclude coherent CAR and EC effects. The charge-imbalance relaxation length was estimated by using a modified Kadin, Smith, and Skocpol scheme in the case of a planar geometry. The model developed allows us to describe the interplay of charge imbalance and Josephson effects in the nanoscale proximity system in detail at low temperatures (far below the superconducting transition temperature T_c).

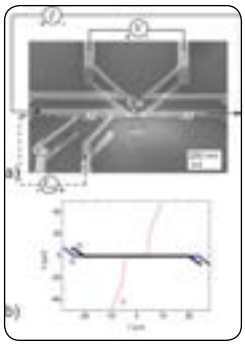

Figure 1. a) SEM image of an Al-Cu-Al multiterminal Josephson junction with two Cu injectors together with the measurement scheme (solid line - local, dashed line - nonlocal).**b)** Current-voltage characteristics of an Al-Cu-Al Josephson junction at 0.4 K . **1)** – local measurement; **2)** and **3)** – nonlocal measurements from the nearest and farest injectors correspondingly.

Recent Publications:

1. D Beckmann, H B Weber, and H V Löneysen (2004) Evidence for crossed Andreev reflection in superconductor ferromagnet hybrid structures. Phys. Rev. Lett. 93:197003
2. P Cadden Zimansky and V Chandrasekhar (2006) Non local correlations in normal metal superconducting systems. Phys. Rev. Lett. 97:237003.
3. A M Kadin, L N Smith, and W J Skocpol (1980) Charge imbalance waves and non equilibrium dynamics near a superconducting phase slip center. J. Low Temp. Phys. 38(3-4):497-534.
4. V K Kaplunenko, V V Ryazanov and V V Shmidt (1985) Effect of non equilibrium quasiparticle flow of SNS Josephson junctions. Journal of Experimental and Theoretical Physics. 89:1389-1403.

Biography

Golikova T E obtained her PhD Degree in Physics in 2014 and she is working on experimental investigation of the interplay of superconductivity and magnetism at low temperatures involving structure fabrication with the nanotechnology tools. Her research interest include: superconductivity and magnetism, spintronics, Josephson junctions.

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