Dissipative effects in ultrathin superconducting wires coupled to a diffusive metals

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Abstract

Ultrathin superconducting wires (UTSCW) fabricated recently by the means of novel experimental techniques have been the subject of intense experimental and theoretical research. When the diameter is smaller than the coherence length of the bulk superconductor, these systems are effectively one-dimensional (1D), since the order parameter can only vary along the parallel direction. Interestingly, the theory predicts the vanishing of long-range order (LRO) due to strong quantum critical fluctuations, a fact that allows the use of UTSCW to address fundamental questions in Quantum Critical Phenomena. In this work, we focus on UTSCW under the effect of environment-induced dissipation. Presumably, this is a realistic situation in many experimental setups. Remarkably, we show that a weak coupling to a diffusive metallic film can reinforce superconductivity in the wire through the quench of order-parameter fluctuations. We obtain the critical points and phases of the system at T=0, and in particular, we predict a quantum phase transition towards a superconducting phase with LRO as a function of the wire's superconducting stiffness and coupling parameter to the metal. We also discuss implications for experiments.