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Theory of the pairbreaking superconductor-metal transition in nanowires[1]

SUBIR SACHDEV, Harvard University

We present a detailed description of a zero temperature phase transition between superconducting and diffusive metallic states in very thin wires due to a Cooper pair breaking mechanism. The dissipative critical theory contains current reducing fluctuations in the guise of both quantum and thermally activated phase slips. A full cross-over phase diagram is computed via an expansion in the inverse number of complex components of the superconducting order parameter (one in the physical case). The fluctuation corrections to the electrical (σ) and thermal (κ) conductivities are determined, and we find that σ has a non-monotonic temperature dependence in the metallic phase which may be consistent with recent experimental results on ultra-narrow wires. In the quantum critical regime, the ratio of the thermal to electrical conductivity displays a linear temperature dependence and thus the Wiedemann-Franz law is obeyed, with a new universal experimentally verifiable Lorenz number. We also examined the influence of quenched disorder on the superconductor-metal transition. The self-consistent pairing eigenmodes of a quasi-one dimensional wire were determined numerically. Our results support the proposal by Hoyos *et al.* (Phys. Rev. Lett. **99**, 230601 (2007)) that the transition is described by the same strong disorder fixed point describing the onset of ferromagnetism in the quantum Ising model in a transverse field.