

Superconductor-Luttinger Liquid Junction: Reentrant Behavior of Resistance

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The temperature dependence of a resistance often provides useful information on internal dynamics of a system. In a junction made of a superconductor and a diffusive normal conductor, the temperature dependence of its resistance shows a reentrant behavior, which is a manifestation of diffusive nature of transport in the normal conductor. In a recent experiment [A. F. Morpurgo *et al.*, *Science* 286, 263 (1999)] with superconducting Nb in contact with single walled carbon nanotubes (SWNTs), the resistance of the system is found to show similar reentrant behavior. A closer examination of the experiment however shows that conventional theory of reentrant behavior is not applicable in this system because the SWNTs have long mean free paths, of the order of micrometer, and the transport within the SWNTs is ballistic, instead of diffusive. In this work, we study electron-electron interaction effects by using the bosonization technique and the Luttinger liquid model of one dimensional interacting electrons, and show that the competition between the electron interaction and proximity effect can give rise to reentrant behavior of the resistance even if the transport in conductors is ballistic.

keywords : proximity effect, Luttinger liquid, bosonization