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Manifestations of Unconventional Pairing Symmetry in Superconducting Hybrids

Alexander Golubov[1,2]
[1]*Faculty of Science and Technology, University of Twente, The Netherlands*
[2]*Moscow Institute of Physics and Technology, Russia*

Superconducting states with broken time-reversal symmetry may arise in structures with nontrivial topological properties and are currently of high interest from fundamental and applied points of view. We will discuss theoretical basis for the description of interfaces between unconventional superconductors (S) and normal metals (N). We will present the results for electronic and spin transport in multiterminal S/N hybrid structures [1-3]. Technically, the derivation of boundary condition for the Nambu-Keldysh quasiclassical Green's functions at the S-N interfaces will be outlined. Of particular interest is application to superconductors with mixed s + p-wave superconducting pairing symmetry, including the cases of chiral and helical p-wave state in two dimensions, as well as the so-called Balian-Werthamer state in three dimensions. The local density of states, charge and spin conductance will be discussed. The cases will be identified when the proximity induced pairing in N has odd-frequency spin-triplet s-wave symmetry. This state is characterized by the existence of a robust zero energy Andreev bound state.

Within the developed approach, three- and four-terminal S/N structures are investigated where the superconducting potential is a mixture between s-wave and p-wave potentials. The ways are proposed to determine whether S has a mixed pair potential and to distinguish between chiral and helical p-wave superconductivity. In this case a difference in conductance for electrons with opposite spins arises if both an s-wave and a p-wave components are present, even in the absence of a magnetic field. It is shown that a setup containing two SN junctions provides a clear difference in spin conductance between the s + chiral p-wave and s + helical p-wave symmetries. Further, we propose new approach to distinguish p-wave from s-wave symmetry by measuring conductance a four terminal junction consisting of S and N terminals. The N-terminals are used to manipulate the energy distribution functions of electrons in the junction in order to control the charge transport. It is shown that the differential conductance of junctions containing p-wave and s-wave superconductors is distinctly different, thus providing experimental test to detect potential p-wave superconductivity.

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References

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