Copper pair splitting and Josephson resonances in voltage biased multiterminal superconducting devices.

Thierry Martin

Centre de Physique Théorique, Aix Marseille Université, France

We propose an approach allowing the computation of currents and their correlations in interacting multiterminal mesoscopic systems involving quantum dots coupled to normal and/or superconducting leads. The formalism relies on the expression of branching currents and noise crossed correlations in terms of one- and two-particle Green's functions for the dots electrons, which are then evaluated self-consistently within a conserving approximation. We then apply this to the Cooper-pair beam-splitter setup which we model as a double quantum dot with weak interactions, connected to a superconducting lead and two normal ones. Our method not only enables us to take into account a local repulsive interaction on the dots, but also to study its competition with the direct tunneling between dots. Our results suggest that even a weak Coulomb repulsion tends to favor positive current cross correlations.

An all-superconducting bijunction consists of a central superconductor contacted to two lateral superconductors, such that non-local crossed Andreev reflection is operating. Then new correlated transport channels for the Cooper pairs appear in addition to those of separated conventional Joseph- son junctions. We study this system in a configuration where the superconductors are connected through gate-controllable quantum dots. Multipair phase-coherent resonances and phase-dependent multiple Andreev reflections are both obtained when the voltages of the lateral superconductors are commensurate, and they add to the usual local dissipative transport due to quasiparticles. The two-pair resonance (quartets) as well as some other higher order multipair resonances are {\pi}-shifted at low voltage. Dot control can be used to dramatically enhance the multipair current when the voltages are resonant with the dot levels.