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Electronic Transport Resonances in Coupled Quantum Dot Systems

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Introduction

We examine how local pairings affect quantum interference in nanosomic systems. We select the double quantum dot connected to a metallic and a superconducting electrode in a T-shaped configuration as our model system. The analysis is especially useful for systems that involve connected items with a wide range of varying energy levels. In such systems, the Fanon-type interference results from the scattering of wandering electrons on a discrete or limited energy level. Along with well-known Fanon resonances, systems with induced superconducting order display additional characteristics on the other side of the Fermi level [1]. These resonances' line shapes are very different from their reflection on the other side of the Fermi level, and their origin has not been fully elucidated. Here, we explain a microscopic mechanism for the production of these resonances and talk about the nature of their unusual line forms while taking the spin-polarized tunnelling model into consideration.

Description

We demonstrate that the coupling of no scattered electrons with scattered electrons is the only source of the abnormal Fanon profiles. We also look into how each sort of resonance interacts with Kondo physics and talk about the resonance characteristics of differential conductivity. Through proximity effects, impurities or nanoscale objects like quantum dots hybridised with superconductors acquire certain capabilities. As a result, either a single particle state or a superposition of an empty and doubly populated state can be used to represent the ground [2]. In the Andreev spectroscopy, two quasiparticle peaks serve as the fingerprints of this local pairing [3]. The ability to build based systems made of multiple quantum rings, monoatomic chains, gate-controlled carbon nanotubes with multiple walls, modified Haroon Bohm rings with an embedded within one of the ring's arms, interferometers with gate-controlled quantum dots, or quantum dots connected to chains is currently made possible by the dynamic development in the fabrication of complex devices on top of substrates.

These systems result in quantum phenomena due to the different electron propagation routes. The size of these systems is principally responsible for their intriguing properties, such as quantum interference effects that appear in electron transport and are connected to the discretization of the energy structures. Numerous systems have been regarded like synthetic molecules in a lot of recent research, and this is a fair description because the states that constitute the can be easily understood as a mixture of atomic orbitals and handled like bonding and anti-bonding states [4]. The electron coherence is maintained during transmission, which is one of the primary characteristics of transport through systems. The coherence of the transport makes it possible to describe the transport characteristics more effectively. This enables the coupling to the leads and the coupling parameter connecting them to control the transmission only. In our research, we examine the system as a whole, including the parallel and serial connected components as well as the transition between them. One lead may only interact with one other in a serial coupled, where the leads couple to each other asymmetrically [5]. While both leads couple equally to both in the parallel coupled system, we discover. As a result, we may easily change the coupling parameters to get a good image of the quantum transport events under various coupling situations.

Conclusion

When considering electron interaction effects, such as the Coulomb blockade and Kondo effect at low temperatures, in addition to quantum transport features, they are crucial to take into account. These effects, albeit intriguing, are outside the purview of the present study, despite the fact that they are frequently mentioned in related studies in the literature. We focus on the transmission characteristics in the current work to find interference effects in the electronic spectrum. We restrict ourselves to the investigation of non-equilibrium transport across the system. Our system's balance is permitted to be disturbed at the junction that originates at the leads. This can be accomplished in a number of ways, including by varying the junction's temperature or the chemical potential of the leads or even just by running a biased current through it. Instead of allowing temperature changes in our system, we will bias the voltage over the junction and misalign the leads' chemical potentials in order to produce non-equilibrium over the junction.

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