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Kondo effect in a quantum dot embedded between topological superconductors

J. P. Ramos-Andrade[1], G. Lara[1], D. Zambrano[2] and P. A. Orellana[2]
[1]*Departamento de Física, Univerisdad de Antofagasta, Av. Angamos 601, Antofagasta, Chile*
[2]*Departamento de Física, Universidad Técnica Federico Santa María, España 1680, Valparaíso, Chile*
juan.ramos@uantof.cl

Abstract

Majorana fermions are 1/2-spin particles that be their own antiparticles [1]. In condensed matter physics, some zero-energy excitations can mimic this property. Among other systems, these quasiparticles appear localized at the ends of a one-dimensional topological superconductor [2] and are called Majorana zero modes. They have attracted a great deal of attention since they satisfy non-Abelian statistics and therefore are considered for quantum computation implementations. To evidence the presence of Majorana zero modes in physical realizations, transport quantities measurements in quantum dots connected with Majorana zero modes have been proposed [3] and achieved [4], focusing on zero-energy anomalies, for instance in the electronic conductance. In this scenario, it is worth wondering how other zero-energy phenomena, such as the Kondo effect [5], will interplay with the features associated with the presence of Majorana zero modes. In this work, we study the quantum transport through a single-level quantum-dot in Kondo regime, coupled to current leads and embedded between two one-dimensional topological superconductors, each hosting Majorana zero modes at their ends. The Kondo effect in the quantum dot is treated by mean-field finite-*U* auxiliary bosons approximation and solved by using the non-equilibrium Green's function approach. We calculate the density of states of the quantum dot, and then both the current and the differential conductance through the quantum dot to characterize the interplay between the Kondo resonance and Majorana zero modes. The results reveal that the presence of Majorana zero modes modifies the Kondo resonance exhibiting an anti-resonance structure in the density of states, leading to obtain spin-resolved behavior of the measurable current and differential conductance. We believe our findings could be helpful to understand the behavior of the Kondo effect in connection with Majorana zero modes [6].

References

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Figures

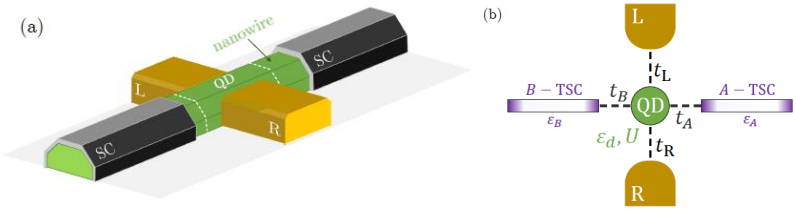

Figure 1:
(a) Setup under study.
(b) Schematic view of the model.