High frequency emission of a carbon nanotube in the Kondo regime: quantum noise and AC Josephson effect

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Abstract

The Kondo effect is a many body phenomenon that results from the interaction between a localized impurity and the conduction electrons in a metal. Quantum dots are famous realization of Kondo effect, in which it is possible to probe the Kondo resonance out of equilibrium and its competition with superconductivity if the quantum dot is contacted with superconducting leads.
While dc properties of the Kondo effect have been widely studied, its ac behavior is less understood. In this work, we investigate high frequency transport in a carbon nanotube quantum dot, by coupling it to an on-chip quantum detector through a micro-wave resonator with a resonance frequency of the order of the Kondo temperature [1].
We have investigated the emission noise at frequencies where the Kondo effect may be affected, either due to its dynamics or by out of equilibrium effects, in two different situations. In the first one, we have investigated the influence of the asymmetry on quantum noise measured in a nanotube contacted by normal electrodes. The measurements show the existence of a high frequency cutoff of the electronic emission noise related to the Kondo resonance. This cutoff frequency is of the order of a few time the Kondo temperature when the electronic system is close to equilibrium, which is the case when bias is strongly asymmetrical. On the other hand this cuttoff is strongly depressed to lower frequency by out-of-equilibrium decoherence effects, occuring in a symmetrical bias situations where the Kondo resonance is strongly split [2].

In the second situation, the nanotube is contacted to superconducting reservoirs, allowing to investigate the AC Josephson emission in the Kondo regime thanks to its interplay with the superconducting proximity effect. We show that, while the dc supercurrent is enhanced thanks to the interplay between the Kondo and superconducting correlations, the ac Josephson emission is strongly suppressed.

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