Coherent tunneling and canyon of current suppression in quantum dots

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Recently, a canyon of conductance suppression in a semiconductor nanowire quantum dot was reported [1]. Here a distinct line of vanishing conductance crosses both the lines of direct tunneling as well as the Coulomb blockade region in the conventional conductance spectrum. This effect is attributed to the crossing of levels with equal spin and can be well reproduced within the second order von Neumann formalism [2] for transport developed by some of us earlier. The general scenario contains the previously predicted vanishing conduction at the electron-hole symmetry and the associated correlation-induced resonance [3] as limiting cases.

Here we demonstrate in detail how this current suppression arises in a general two-level system with equal spin, which is attached to two leads [4]. It turns out that the existence of this canyon occurs over a wide parameter range and is clearly visible both for small and finite bias. Using different approaches such as Breit-Wigner transmission for noninteracting states and a Schrieffer-Wolff transformation for the strongly interacting case close to the electron-hole symmetry point, we elucidate the origin of conductance suppression. For larger bias, on the other hand, the current suppression can be related to blockade effects in the spirit of [5].

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