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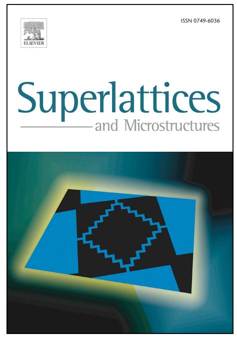

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Gate-dependent spectral functions and many-body effect for a triple dot structure

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Abstract

In this paper, we study the spectral functions and the phase transition for a parallel triple dot structure. When the external gate voltage sweeps, the total charge number N_{tot} changes from 0.0 to 6.0 in a steplike manner. We highlight the related properties beyond the regime $N_{tot} \sim 3.0$. When $N_{tot} \approx 2.0$, two of the dots are singly occupied, while the remaining one is empty. In this case, the possibilities of each dot being singly occupied decrease, leading to the reduction of the Ruderman-Kittel-Kasuya-Yosida interaction, hence a local spin singlet between two singly occupied dots is generated, and the linear conductance is suppressed. The inter-dot transport is responsible for this suppression, since a negative peak with considerable size develops in the out-of-diagonal spectral function. In the regime $N_{tot} \approx 1.0$, a large potential scattering peak is found around the Fermi energy in the transmission coefficient, relates to the process of adding an additional electron on the dots, instead of the Kondo effect. Since the dots are in the strong correlation limit, the many-body effect may be significantly important, thus we try to understand above behaviors by considering the many-body state configurations. To approach theses problems, the numerical renormalization group method is implemented, and the charge number and spectral properties of the bonding and antibonding orbits are shown.

Keywords: Triple Dot Structure, Spectral Functions, Quantum phase transition, Many-body Effect

1. INTRODUCTION

Multi-quantum dot systems are considered as ideal models to reveal various kinds of strongly correlated behaviors in nanoscale structures. After the properties in single and double dot systems were elucidated in the last two decades, the research interests turns to the triple quantum dot (TQD) structures, which offer the possibility of analyzing new fascinating properties, such as the quantum interference phenomena [1], [2], [3], the magnetic frustration [4], [5], the Fermi liquid and non-Fermi liquid behaviors [6], [7], [8], and various kinds of Kondo effect [9], [10],

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