Quantum interference and strong electron correlations in a large quantum dot

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Recently a new kind of quantum interference phenomena has been observed in electron transport through semiconductor quantum dots. It can not be understood and described within standard Fano model [1] with sharp single particle resonant level and delocalized background. Namely, strong electron correlations within the dot have to be taken into account to fully capture the specific nature of the observed phenomena. Moreover, the background channel, one of the basic ingredients of the Fano model, has also an unusual nature. We discuss the influence of quantum interference and strong electron correlations on the electron transport through the dots with different size. We show that the effect of quantum interference inside the dot on the conductance curve is dependent on the nature of the direct background channel, which is activated when the dot is very strongly coupled to the leads. In case of small quantum dots, this channel has delocalized nature and quantum interference leads to full destruction of the conductance when the discrete dot level comes into resonance with chemical potential. Contrary, in large quantum dots, the background channel can be a broad localized dot level strongly coupled to the leads. In this case the Fano dips in the conductance do not reach zero value, which has been also observed experimentally in large dots [2] and single-walled metallic carbon nanotubes [3]. Such a behavior is quite unusual. Moreover, we predict a considerable modification of the quantum interference phenomena inside the dot by the strong electron correlations which try to damp the fluctuation of the particle number [4]. The phase shift acquired by electron wave propagating through such a large dot exhibits an unusual behavior having dependence on the position of the direct channel with respect of Fermi energy apart of the usual dependence on the position on the resonant dot level.

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