## Manipulating of resonances in conductance of an electron waveguide with antidots

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There are interesting manifestations of interference between propagating and localized electron waves (Fano-interference) which have been already observed in the transport investigations of nanostructures. Now it is considered that Fano-interference may potentially be used for the design of new types of quantum electronic or spintronic devices such as an interference transistor or a filter for polarized electrons. Many recent publications about Fano resonance in waveguides with quantum dots or antidots have been studied. In order to fit the experimental data, authors used the expression for conductance $G$ of quantum waveguides, rings and quantum islands: $G = G_b |\varepsilon + q|^2 / (\varepsilon^2 + 1)$, where $G_b$ is non-resonant conductance and $\varepsilon = (E - E_R)/\Gamma$ is reduced energy ($E_R$ is the energy of the resonance, $\Gamma$ is the width, and $q$ is coupling parameter). The parameter $q$ measures qualitatively the interference between the bound states and propagating continuum states. Recently, no attempt has been made to detail theoretical investigation of the physical situations when parameter $q$ is complex.

The purpose of this paper is to study the interference of the narrow group states with the continuum. The model we have adopted as the basis of our analysis consists of two (Fig. 1a) or three (Fig. 1b) antidots in the waveguide. We extend our previous method [1, 2] and analyze the evaluation of scattering amplitude with repulsive potentials. We shall study a new scenario when decaying (quasi-bound) states can interfere with the continuum. In a waveguide with two antidots we have observed interesting phenomena: the interference between one subband of the quasi-bound states and background second-subband (Fig. 2), and the interference of resonant group states of different subbands. In this case, zero of Fano resonance is shifted in the complex plane (see Fig. 2b) and the coupling parameter $q$ becomes complex. The degeneration of two quasi-bound states takes place in the waveguide with three antidotes, where interference of the degenerate states may be considered (see Fig. 3). The Fano-interference of two almost degenerate resonances may bring full suppression of pair resonances in the transmission. This can be explained by parities of quasi-bound states. Our results show that the zero of Fano resonance due to interference between the quasi-bound states and the continuum is generally placed in the complex plane. It gives an additional possibility to manipulate conductance resonances in a waveguide by changing the antidots parameters.

This work is supported by the Indiana 21st Century Research and Technology Fund.

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A full journal publication of this work will be published in the Journal of Computational Electronics.

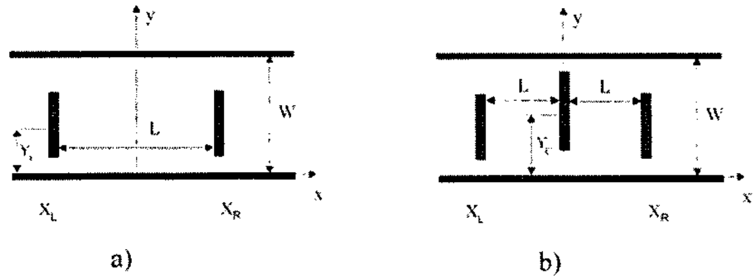


Fig. 1. Electron waveguides with (a) two and (b) three antidots. The width of the waveguide is $W = 23.69nm$, which gives $E_1 = 10meV$ and $E_2 = 40meV$ for gaps of band. The antidot has a width $0.5W$ and it is characterized by scattering parameter $aV_0$=350 eV nm, where $a$ is the length of the antidot and $V_0$ is a potential barrier height.

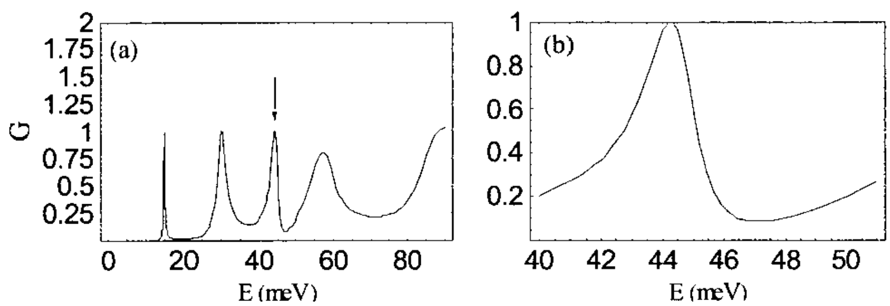


Fig. 2. (a) Conductance of waveguide with two dots. The distance between the dots is $L = 30nm$. Fano resonance is a result of interference between the second subband of the quasi-bound states and the first subband of the continuum (Fano-resonance is marked by an arrow). (b) Fano resonance is depicted in a different scale.

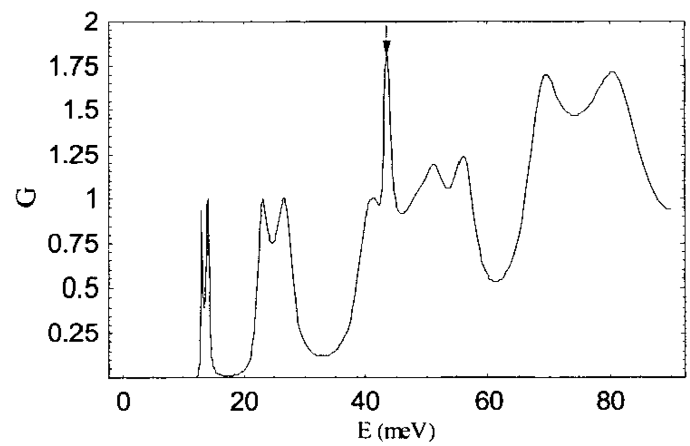


Fig. 3. Conductance of waveguide with three antidots (distance between the dots is $L = 33.3nm$, and amplitude of the intermediate antidot potential is chosen as 1.25 larger than the others). Fano-interference of two almost degenerate resonances brings full suppression in pair resonances as a consequence of different parities of quasi-bound states.

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