

Quantum Effect in the Mesoscopic RLC Circuits with a Source

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(Received: 2005-3-28; Revised: 2005-5-23)

Abstract: The research work on the quantum effects in mesoscopic circuits has undergone a rapid development recently, however the whole quantum theory of the mesoscopic circuits should consider the discreteness of the electric charge. In this paper, based on the fundamental fact that the electric charge takes discrete values, the finite-difference Schrödinger equation of the mesoscopic RLC circuit with a source is achieved. With a unitary transformation, the Schrödinger equation becomes the standard Mathieu equation, then the energy spectrum and the wave functions of the system are obtained. Using the WKBJ method, the average of currents and square of the current are calculated. The results show the existence of the current fluctuation, which causes noise in the circuits. This paper is an application of the whole quantum mesoscopic circuits theory to the fundamental circuits, and the results will shed light on the design of the miniation circuits, especially on the purpose of reducing quantum noise coherent controlling of the mesoscopic quantum states.

PACS: 73.23.Ra, 03.65.Ca, 73.23.-b

Key words: mesoscopic circuit, Mathieu equation, quantum effect

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