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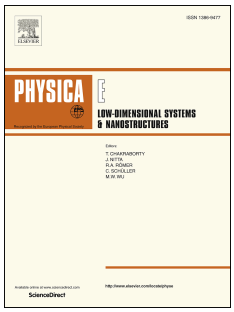

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Magnetoelectric effect in concentric quantum rings induced by shallow donor

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Highlights

The influence of the external electric and magnetic fields on the lower energies, charge distribution, dipole momentum and polarization induced by the excessive electron released from the off-center donor in a double concentric InAs/GaAs quantum ring are studied by using the Kane model and the double Fourier-Bessel series expansion method

The effect of the donor position on the electron tunneling between rings, stimulated by the external magnetic field, is analyzed.

A possibility of the formation of a giant dipole momentum and spike-like dependence of the polarizability prompted by the external electric field and associated with an off-axis donor is revealed.

An alteration of the electric dipole momentum and polarization in the presence of the external magnetic field, found in our calculations, we consider as a manifestation of the magnetoelectricity effect inherent to the analyzed system.

Abstract

We study the alteration of the magnetic and electric properties induced by the off-axis donor in a double *InAs/GaAs* concentric quantum ring. To this end we consider a model of an axially symmetrical ring-like nanostructure with double rim, in which the thickness of the *InAs* thin layer is varied smoothly in the radial direction. The energies and of contour plots of the density of charge for low-lying levels we find by using the adiabatic approximation and the double Fourier-Bessel series expansion method and the Kane model. Our results reveal a possibility of the formation of a giant dipole momentum induced by the in-plane electric field, which in addition can be altered by of the external magnetic field applied along the symmetry axis.

Keywords

Concentric quantum rings
Shallow donor
Polarizability
Magnetoelectric effect

1. Introduction

Progress achieved in last decades in nanofabrication has permitted self-assembled growing of double concentric quantum rings (DCQRs) with high uniformity [1.2] stimulated a considerable interest in theoretical analysis of spectral properties of such structures, related to optical transitions between energy levels of the electron and the exciton confined within such structures [3-6]. It has been demonstrated that unlike structures with a single ring, the topology of a CDQR offers an additional way for modifying the effect of the external magnetic field on energies and dipole momenta of few-particle system, owing to a possibility of the tunneling of carriers between two rings. Earlier, the method of the local-spin-density-functional theory has been used also to