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Position-dependent-mass and laser field impact on the optical characteristics of Manning-like double quantum well

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ABSTRACT

A theoretical investigation of the optical and electronic properties produced by a Manning-type double quantum well under the impact of varied electron effective mass and intense laser field has been implemented within the effective mass approximation (EMA). By selecting an appropriate wavefunction, we have computed the eigenvalues and their eigenfunctions using a diagonalization method. After that, the optical absorption coefficients (OACs) were calculated using a two-level approximation. The obtained findings reveal that the optical and electronic properties of the structure under consideration can be regulated to achieve appropriate response to specific needed studies or aims by modifying the structural parameters and sizes such as the width and depth of each well, the coupling distance between them, and the intensity of the applied intense laser field. The obtained results show the flexibility of the Manning potential which can be altered by adjusting its structural parameters and varying an applied intense laser field such flexibility can be applied to arrange the energy spectrum and optical absorption shifts in novel optoelectronic devices.

1. Introduction

The principal goal of choosing the most appropriate confining potential needed in investigating the optical properties of quantum wells and dots is to best contemplate the atomic structure of the material of benefit and to furnish the design and fabrication of new generations of optoelectronic structures by means of the handling of the electronic properties. For studying the electronic and optical properties of quantum systems based on wells or dots, it is beneficial to utilize confining potential describing the inter-atomic interactions. Such interactions are frequently employed in molecular physics, and this alternative leads to quantum structures with more advantageous and typical properties.

The best choice to select the suitable quantum structures is the shape of confining potential which is an interesting factor in the conception of new electronic and photonic systems. In the last years, conventional semiconductor quantum wells or dots are modeled with well-known rectangular or parabolic potentials. Nevertheless, these kinds of potentials did not really describe the atomic interaction, especially in molecules constituting some materials. By dint of the rapid progression in growth techniques of semiconductor materials, it becomes feasible to fabricate quantum wells and dots having confining potential presenting different geometrical shapes to explain and elucidate the different interaction between atoms and also to interpret the effects of external factors such as the application of external fields as well as hydrostatic pressure [1–11].

Given that the electronic and optical properties of quantum wells and dots can be tuned to reach our objectives by adding external fields, impurities, or hydrostatic pressure, researchers in theory and experiment areas focus their attention to study these factors during the last years [12–21]. One important study is nonlinear optics (NLO) which is considered the most interesting topic regarding its huge application in the telecommunication domain and also in memory storage as well as the quantum computing area. In addition, (NLO) shows improvement in the optical characteristics of devices since it was used as the main strategy to amplify the optical signals of various optoelectronic devices. For the time being, quantum computing and optics, plasma physics, optical amplifiers, and ultra-cold atoms constitute direct applications of (NLO) [22,23].

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