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# Electronic and optical properties of the exponential and hyperbolic Rosen–Morse types quantum wells under applied magnetic field

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**Abstract** In this study, we considered the electronic and optical properties of quantum wells with the exponential and hyperbolic Rosen–Morse potentials under an applied magnetic field. Calculations are made within the framework of effective mass and parabolic band approximations. We have used the diagonalization method by choosing a wave function based on the trigonometric orthonormal function to find eigenvalues and eigenfunctions of the confined electron. Our results show that the magnetic field, asymmetry, and confinement parameters cause a significant increase in electron energies and energy differences between the electron states and the blue shift in the absorption peaks. These results can be used to probe materials' electronic and structural properties and develop new materials with tailored optical properties.

## 1 Introduction

Semiconductor quantum wells (QWs) have attracted much interest due to their promising potential applications in electronic and optoelectronic devices. In these nanostructures, the quantum confinement effects on the charge carriers have quite different electronic and optical properties than their bulk materials [1]. External perturbations, such as electric, magnetic, or intense laser fields, are powerful tools in controlling the optical response of low-dimensional semiconductor systems.

Thanks to recent advancements in material growth techniques, due to their unusual electronic and optical properties, single or multiple QWs consisting of inhomogeneous pieces with various confinement potentials have attracted remarkable attention. These structures' electronic and optical properties can be adjusted according to the desired outcome by selecting appropriate geometries, material parameters, and applied external fields, leading to new potential applications in optoelectronics. Therefore, these structures have been extensively studied and are still being investigated under external fields such as electric, magnetic, and intense laser fields [2–18].

The main objective of selecting the appropriate confinement potential profile for any of the mentioned structures is to manipulate their electronic properties to best reflect the material's atomic structure and enable the design of new optoelectronic devices. It should be noted that the physics of QWs with different confinement potentials offers opportunities to explore new applications in lower dimensions. In addition to the different shaped QWs mentioned above, molecular potentials such as Konwent [19], Manning [20], hyperbolic type Rosen–Morse [21–23], and Razavy [24] are used extensively in the investigation of electronic and optical properties of low-dimensional systems.

The exponential Rosen–Morse potential has independent fitting parameters more than the hyperbolic type Rosen–Morse potential for the experimental results. The exponential Rosen–Morse quantum well (eRMQW) is a more reliable and advantageous model as it provides a more flexible framework than the hyperbolic type Rosen–Morse potential, which includes more parameters to represent experimental data accurately. Although there are a limited number of studies on the optical properties of QWs and quantum dots with hyperbolic type Rosen–Morse potential under external fields [21–23], as far as we know, one has not reported any investigation on the electronic and optical properties of the eRMQW except for the calculation of rotational vibration energies of some diatomic molecules. Therefore, in this study, we investigated, for the first time, the electronic and optical properties of the eRMQW under an applied magnetic field. In addition, in order to make a detailed comparison with the hyperbolic RMQW (hRMQW) potential, the hRMQW potential function modified by us was defined, and both QWs were investigated in detail, and the results were compared.

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