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# Spin–Orbit and Zeeman Effects on the Electronic Properties of Single Quantum Rings: Applied Magnetic Field and Topological Defects

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**Abstract:** Within the framework of effective mass theory, we investigate the effects of spin–orbit interaction (SOI) and Zeeman splitting on the electronic properties of an electron confined in GaAs single quantum rings. Energies and envelope wavefunctions in the system are determined by solving the Schrödinger equation via the finite element method. First, we consider an inversely quadratic model potential to describe electron confining profiles in a single quantum ring. The study also analyzes the influence of applied electric and magnetic fields. Solutions for eigenstates are then used to evaluate the linear inter-state light absorption coefficient through the corresponding resonant transition energies and electric dipole matrix moment elements, assuming circular polarization for the incident radiation. Results show that both SOI effects and Zeeman splitting reduce the absorption intensity for the considered transitions compared to the case when these interactions are absent. In addition, the magnitude and position of the resonant peaks have non-monotonic behavior with external magnetic fields. Secondly, we investigate the electronic and optical properties of the electron confined in the quantum ring with a topological defect in the structure; the results show that the crossings in the energy curves as a function of the magnetic field are eliminated, and, therefore, an improvement in transition energies occurs. In addition, the dipole matrix moments present a non-oscillatory behavior compared to the case when a topological defect is not considered.

**Keywords:** spin–orbit interaction; Zeeman splitting; circularly polarized light; topological defect; optical absorption coefficient

## 1. Introduction

The study of low-dimensional semiconductor heterostructures has attracted much attention from the scientific community due to their novel and prospective applications. Varying