Effect of Magnetic Field on Energy Spectrum of Electron in Spherical Multi-Shell Quantum Dots

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The semiconductor low-dimensional quantum heterostructures (i.e. quantum wells, wires and dots) are conspicuous in many technological applications such as infrared photo detectors, lasers, light-emitting diodes, single electron transistor, etc. The modern advances in semiconductor technology allow the produce of more complex structures than the simple quantum wells, wires or dots. These structures, such as multiple quantum rings, complex quantum wires and the multi-layered quantum dots (QDs) [1], with various potential profiles of the quasiparticles are extensively studied.

In the paper the theoretical investigation of the energy spectrum and probability densities of the electron in the semiconductor multi-layered quantum dots under the influence of the external magnetic field is hold. We study the different types of the spherical nanosystems with two quantum-bound potential wells: QD with the core-quantum well (three-layered nano-structure) and the QD with the core-quantum barrier (four-layered nano-structure). In the nanosystems of the second type the radii of the curvature of both spherical shells-wells can be increased without any change of the thickness. This property allows to enhance the influence of magnetic field on the spectrum and wave functions of the electron [1].

The calculation of the electron energy spectrum in the QD driven by magnetic field is performed implementing the method of the quasiparticle wave function expansion using a complete set of the electron wave functions in the corresponding nano-structure without the magnetic field:

$$\Psi_{jm}(\vec{r}) = \sum_{n}\sum_{\ell} c^{j}_{n\ell m}\Phi_{n\ell m}(\vec{r}). \qquad (1)$$

The dependencies of the energy spectra of electron in double-well spherical nanosystems on magnetic field induction are obtained. It is shown that the influence of the field on the energy spectrum is bigger for the system with the core-quantum barrier due to larger radii of the curvature of the nanolayers. It is established that the quasiparticle localization in the QD can be controlled by the change of magnetic field induction value. That can be used to create new semiconductor devices.

1. Holovatsky V. Effect of magnetic and electric fields on optical properties of semiconductor spherical layer / V. Holovatsky, I. Bernik // *Semiconductor Physics, Quantum Electronics and Optoelectronics.* – 2014. – V. 17, № 1. – P. 7-13.