Heavy and light-hole magneto-exciton complexs in type II gallium antimonide quantum ring

S. Zambrano-Rojas[1,2], G. E. Escorcia-Salas[1], and J. Sierra-Ortega[1*]
[1]Grupo de investigación en Teoría de la Materia Condensada, Universidad del Magdalena, Santa Marta, Colombia
[2]Universidad de la Guajira, Riohacha, Colombia

jsierraortega@gmail.com
* Corresponding Author

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Abstract

Recently, it has been shown that GaSb/GaAs quantum rings display a photoluminescence intensity enhanced to ~20 times that of the quantum dot samples. It may be related to an essential alteration of the morphology and the exciton oscillator strength during transformation of the quantum dot to the quantum ring structure. In order to analyze such possibility we propose a simple model of the confinement that allows us to study Aharonov-Bohm oscillations of the energy levels and the density of states of excitons confined in circular narrow type II GaSb/GaAs rings in the presence of the magnetic field applied along the symmetry axis and to compare them with experimental results obtained previously. Taking into account a significant difference between effective mass of the heavy- and light-holes confined inside GaSb ring, we in our numerical work analyze the effect the variation of the electron-to-hole masses ratio on the exciton spectral properties. Our results reveal that energy spectra of the excitonic complexes in quantum rings with large radii consist of overlapping subbands corresponding to different relative rotational states and with closely spaced sublevels within them, corresponding to different center-of-mass angular momenta. We find that for the heavy-hole excitonic complexes the sublevels distribution inside the subbands has a clearly pronounced border, which exhibits Aharonov-Bohm oscillation in the presence of the external magnetic field. Conversely, for the light-hole complexes the sublevels distribution is almost homogeneous and the overlap of subbands is so strong that their borders become blurred. In the last case the Aharonov-Bohm oscillation can be detected only in a weak oscillation of positions of peaks in curves of the density of states.