Coulomb Impurity Effects on Optical Properties of the System Trapped in Ellipsoidal Confinement Potential

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It has been investigated the influence of the presence of ionized impurity on optical spectra of semiconductor ellipsoidal quantum dots (EQD). For this purpose we calculated eigenfunctions and eigenvalues of electron confined in EQD containing Coulomb impurity. For this purpose first we consider an ellipsoidal quantum dot with rotational symmetry around a given axis (the *z* axis) and call *c* and *a* its axes along the *z* and *x*-*y* directions, respectively. As a model of confining potential we consider the potential that is zero inside the ellipsoid and it is infinity outside. Such model is acceptable either for a quantum dot of a large volume or when the bandgap at the interface is sufficiently large. Using the standard variable change technique one can transform the ellipsoid into a sphere of radius r_0 with the same volume. Thus the problem of motion of the charge carriers in ellipsoidal well reduces to the study of their motion in spherical quantum dot with mew effective potential. The effective potential is proportional to $\alpha = r_0^2\left(c^2 - a^2\right)/\left(ac\right)^2$ which is called as shape anisotropy parameter that reflects the anisotropy of potential well. When $\alpha << 1$ (i.e. ellipsoid is almost a sphere of radius r_0) the problem of finding the charge carrier (electron or hole) energy spectrum in an ellipsoidal quantum dot can be studied with in the perturbation theory as a deformation with respect to the spherical dot.

The optical matrix elements have been calculated for both linearly polarized radiation along the *z* axis and circularly polarized radiation in the *x*-*y* plane relative to transitions from or to the ground state $\langle 100|$. Dipole transition-matrix elements as well as the momentum matrix elements $p_z, p_{\pm} = \left(p_x \pm ip_y\right)/\sqrt{2}$ are calculated as function of $\chi = c/a$ dot aspect ratio by use of perturbation theory. As a further application the derived wavefunctions can be used for calculation of excitonic states of an electron-hole system and their optical properties trapped in the ellipsoidal well.

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References

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