Optical Spectra of Wide Parabolic Quantum Wells

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We show how to compute the optical spectra of Wide Parabolic Quantum Wells (WPQWs) of thicknesses in the growth direction of the order of a few excitonic Bohr radii of the well material. The semiconductor nanostructures with parabolic confinement have attracted more attention in the recent decades (see, for example, [1] and references therein). In typical (narrow) Quantum Wells (QW) with the dimension of, say, one excitonic Bohr radius in the growth direction we observe only a few excited states. In WPQWs, due to the greater extension, significantly larger number of states is observed. The Coulomb potential and different confinement potentials for electrons and holes couples electron and hole confinement states of different quantum numbers. Such phenomena have been observed experimentally. We propose a computational method which leads to an analytical expression for the electric susceptibility of a WPQW taking into account the screened electron-hole interaction and parabolic confinement potential. The method is based on the so-called real density matrix approach (for example, [2]). With the purpose of exemplification, we consider a WPQW with GaAs as the optically active layer and $Ga_{1-x}Al_xAs$ as the barriers, where the active layer is of the extension of a few excitonic Bohr radii. The absorption spectra of such a structure show a large number of resonances ($n = 8$ observed in [3]). The agreement between our calculated spectrum and experimental data is very good with regard to the number and position of the maxima of susceptibility.

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