Energy scaling for multi-exciton complexes in semiconductor quantum dots

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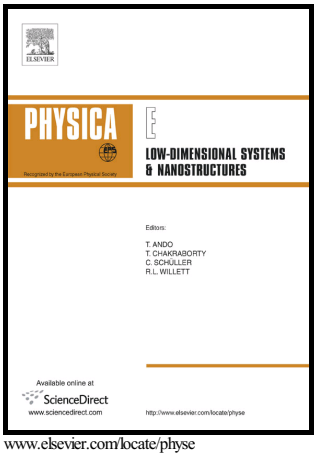

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Energy scaling for multi-exciton complexes in semiconductor quantum dots

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Abstract

The ground state properties of an multi-exciton (ME) complex localized in a nanoscale semiconductor quantum dot (QD) have been studied. The calculations have been performed using the envelope function approximation for electron and hole motion in the QD. The many-body quantum mechanical treatment of the electron-hole dynamics was done within the Density Functional Theory approach. The ground state energy dependencies upon QD radius, number of electron-hole pairs, QD dielectric function and effective masses of electron and holes have been analyzed. It is demonstrated that when multi-exciton complex is strongly localized within the QD, the physical properties of the system are determined by a single parameter, the ratio of QD and free exciton radii, and its binding energy is given by the function of this parameter multiplied by the binding energy of an isolated exciton in bulk semiconductor.

Keywords: quantum dot; multi-exciton complex; ground state; binding energy; Wigner-Seitz radius.