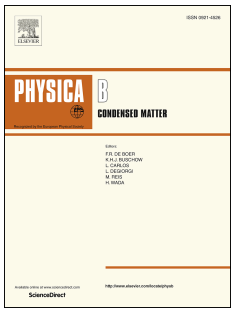
Accepted Manuscript



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PII: S0921-4526(18)30301-6

DOI: 10.1016/j.physb.2018.04.035

Reference: PHYSB 310851

To appear in: *Physica B: Physics of Condensed Matter*

Received Date: 15 March 2018

Accepted Date: 23 April 2018

Please cite this article as: S. Sarkar, S. Sarkar, C. Bose, Influence of polarization and self-polarization charges on impurity binding energy in spherical quantum dot with parabolic confinement, *Physica B: Physics of Condensed Matter* (2018), doi: 10.1016/j.physb.2018.04.035.

Influence of polarization and self-polarization charges on impurity binding energy in spherical quantum dot with parabolic confinement

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Abstract

We present a general formulation of the ground state binding energy of a shallow hydrogenic impurity in spherical quantum dot with parabolic confinement, considering the effects of polarization and self energy. The variational approach within the effective mass approximation is employed here. The binding energy of an on-center impurity is computed for a GaAs/ $Al_xGa_{1-x}As$ quantum dot as a function of the dot size with the dot barrier as parameter. The influence of polarization and self energy are also treated separately. Results indicate that the binding energy increases due to the presence of polarization charge, while decreases due to the self energy of the carrier. An overall enhancement in impurity binding energy, especially for small dots is noted.

Keywords: Quantum dot, parabolic potential, impurity state, polarization charge, variational technique

1. Introduction

As impurities in semiconductor nanostructures play a crucial role in determining the electronic and optical properties of quantum devices, study of impurity states in nano-scale attracted attention in the field of low-dimensional semiconductor research. With the pioneering work of Bastard [1, 2] in the early 80's, a lot of work on impurity states in quantum wells (QWs) [3, 4], quantum well wires (QWWs) [5, 6] and quantum dots (QDs) [7, 8] has been reported in the last three decades. As the spatial confinement of carriers is stronger in QDs than in QWs and QWWs with the same confining dimensions, the bound states are most pronounced for impurities within a QD. Thus, the study of impurity binding energy in QDs becomes of prime interest. Theoretical studies involve QD models of a finite or infinite (square or parabolic) confining potential with

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