REALISTIC CONFINEMENT POTENTIAL FOR A SQUARE PATTERNED TWO-DIMENSIONAL SEMICONDUCTOR QUANTUM DOT AND ITS APPROXIMATED CIRCULAR COUNTERPART

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Two-dimensional semiconductor quantum dot systems are typical nanoscale structures in which a few number of electrons is confined in a small region of space by applying external electric gate potentials. While the detailed form of the confining potential depends on the specific experimental setup, the parabolic confinement model has commonly been used because of its simplicity. Clearly, on those instances in which the experimental setup involves placement of gate potentials with sharp geometric features, the area depleted of electrons, thus the quantum dot region cannot be considered circular. If, for simplicity, we consider the confinement region of the electrons as square in shape, then an accurate calculation of the properties of such square patterned quantum dot should be made by using a realistic confinement potential originating from that particular configuration. We calculated exactly such a confinement potential for a square quantum dot. The particular analytic form of this realistic potential is complicated given the dependence on the two-dimensional position coordinates, rather than simply the distance from the center of the quantum dot. In this work we choose to substitute the realistic confinement potential for a square patterned quantum dot with an approximated circular symmetric potential. We assess the quality of this approximation and discuss instances in which one can reliably use the approximated simplified potential instead of the computationally unyielding exact one.