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Application of the Numerical Phase Method to Find the Electronic Energy Spectrum in a Spherical Quantum Dot with Arbitrary Confining Potential

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Abstract

The paper discusses the phase method for solving a second-order differential equation, particularly the equation for eigenfunctions and eigenvalues of the Hamiltonian operator, i.e., the Schrödinger equation. The classical phase method is adapted to a problem containing two different regions with corresponding parameters. This method is implemented using computer algebra systems (Wolfram Mathematica). The modified method is applied to compute the electronic energy spectrum of an electron in a spherical quantum dot for cases of rectangular confining potential and smooth potential. For the rectangular potential, exact solutions of the corresponding Schrödinger equation exist, so they are compared with the results obtained from the proposed method, showing high accuracy in convergence. The advantage and value of the method lie in its applicability to spherical

quantum dots, both single-layer and multi-layer, with arbitrary confining potentials. © The Author(s), under exclusive license to Springer Nature Switzerland AG 2024.

Author keywords

Computer Algebra System; Phase Method; Quantum Dot; Schrödinger Equation

Indexed keywords

Engineering controlled terms

Eigenvalues and eigenfunctions; Hamiltonians; Integral equations; Linear equations; Mathematical operators; Numerical methods; Partial differential equations; Quantum computers; Stability criteria

Engineering uncontrolled terms

Computer algebra systems; Eigen-value; Electronic energy spectrum; Hamiltonian operators; Mathematica; Phase methods; Quantum dot; Schrödinger equation; Second orders; Spherical quantum dot

Engineering main heading

Schrodinger equation

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Abstract

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