Quantum size effects

Mariam Gabadadze

E-mail: mariam.gabadadze102@ens.tsu.edu.ge

Department of Chemistry, Faculty of Exact and Natural Sciences, Iv. Javakhishvili Tbilisi State University, I. Chavchavadze Ave. 3, Tbilisi, Georgia, 0179

Quantum size effects and quantum confinement form the basis of modern nanotechnology and nanoelectronics. When materials have nanoscale dimensions, quantum confinement becomes apparent, which manifests itself in the electronic, optical, and mechanical properties of nanostructures. This phenomenon is divided into quantum wells, quantum tubes, and quantum dots, each of which corresponds to confinement in one, two, and three spatial dimensions. Nanostructures confine charge carriers: electrons and holes within specific geometric boundaries, which leads to quantization of energy levels and unique behavior not observed in macroscopic bodies.

The uncertainty principle, a cornerstone of quantum mechanics, further highlights the limits of measurement precision at the nanoscale. It explains the inherent trade-offs in simultaneously determining the position and momentum of a particle, emphasizing the probabilistic nature of quantum systems.

The paper highlights the synergies between existing theoretical foundations and technological advances in nanoelectronics based on quantum size effects, quantum constraints, and fundamental phenomena. By bridging theory and practice, quantum principles continue to shape the future of science and technology.

References:

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