IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
Impact Factor: 7.53
Volume 4, Issue 2, August 2024

Operator Algebras and Their Role in Quantum Mechanics: A Functional Approach

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Abstract: *Operator algebras, specifically C-algebras and von Neumann algebras, play a fundamental role in the mathematical formulation of quantum mechanics, offering a functional framework to describe quantum systems. This approach leverages the powerful tools of functional analysis to address key aspects of quantum theory, such as observables, quantum states, and dynamics. In quantum mechanics, physical observables are represented by self-adjoint operators on a Hilbert space, and the spectral theorem provides a mechanism to interpret these operators as measurable quantities. The algebraic structures of C-algebras and von Neumann algebras enable a non-commutative geometric framework, essential for modeling quantum systems where observables do not commute. This functional approach is particularly valuable in quantum measurement theory, quantum field theory, and the study of unbounded operators, providing deep insights into the structure of quantum mechanics and advancing both theoretical understanding and practical applications in physics*

Keywords: Operator algebras, Quantum mechanics, C-algebras

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DOI: 10.48175/568