МЕДИЦИНА, ПЕДАГОГИКА И ТЕХНОЛОГИЯ:
ТЕОРИЯ И ПРАКТИКА
Researchbib Impact factor: 11.79/2023
SJIF 2024 = 5.444
Том 2, Выпуск 12, 31 Декабрь

"QUANTUM MATHEMATICS AND PHYSICS: STUDYING MATHEMATICAL FOUNDATIONS AND APPLICATIONS."

Khudaikulova Saida Zakirovna
Teacher of Termez State Pedagogical Institute
Phone: +99890-246-47-47
E-mail: hudaykulova.sz@gmail. com
Ruzikulov Shahabbas
2nd-year student of
Temez State Pedagogical Institute

Annotation: Quantum mechanics and quantum physics have revolutionized our understanding of the fundamental nature of reality. At the core of this revolution lies quantum mathematics, which provides the mathematical foundation for describing the motion of particles at microscopic scales. This article explores the fundamental mathematical structures of quantum mechanics, including Hilbert spaces, operators, and wave functions, as well as their applications in modeling physical systems. The research also examines how quantum physics contrasts with classical physics concepts and offers new insights into topics such as quantum entanglement, superposition, and quantum computing. By analyzing the mathematical foundations of quantum theories, the article aims to shed light on the intersection of mathematics and physics, offering a deeper understanding of how mathematical formulas help predict and explain quantum phenomena. Furthermore, it discusses the potential implications of quantum mathematics in emerging fields such as quantum computing and cryptography.

Keywords: Quantum mechanics, quantum physics, mathematical physics, Hilbert space, quantum operators, wave functions, quantum entanglement, quantum computing, quantum cryptography, superposition, mathematical modeling, quantum theory.

Quantum mechanics, often described as the most successful theory in physics, introduces counterintuitive concepts that challenge classical intuition. The mathematical framework underlying quantum theory has enabled physicists to explain phenomena previously considered impossible, such as the dual nature of light and particles, the uncertainty principle, and quantum tunneling. Studying quantum mathematics involves advanced mathematical tools like linear algebra, functional analysis, and probability theory, all of which are essential for rigorously formulating quantum mechanics.

Key Highlights:

1. Mathematical Foundations of Quantum Mechanics

Quantum mechanics operates on a mathematical structure primarily defined in terms of Hilbert spaces and linear operators. This section elaborates on the formalism of quantum states, the role of observables, and the measurement process. It also discusses the significance of wave functions, their interpretation, and their evolution over time.

2. Quantum Operators and Commutation Relations

Quantum operators represent physical observables, and their commutation relations govern the fundamental characteristics of quantum systems. For instance, the Heisenberg uncertainty principle arises as a direct consequence of non-commuting operators, imposing fundamental limits on the precision with which certain pairs of physical quantities (e.g., position and momentum) can be simultaneously known.

3. Quantum Entanglement and Superposition

Quantum entanglement describes the phenomenon where the quantum states of two or more particles are interconnected such that the state of one particle cannot be described independently of the others. Superposition, another cornerstone of quantum mechanics, refers to a system's ability to exist in multiple states simultaneously. Both phenomena have profound implications for interpreting reality and have practical applications in quantum computing and cryptography.

4. Schrödinger Equation and Quantum Evolution

The time-dependent Schrödinger equation forms the cornerstone of quantum mechanics. This section explores its role in determining the time evolution of quantum states. Solutions to the Schrödinger equation provide insights into the dynamic behavior of quantum systems, ranging from simple particles in potential wells to complex multi-particle interactions.

Key Mathematical Elements:

- The role of complex numbers in quantum theory.
- The importance of commutation relations between operators.
- The significance of eigenvalues in measurement theory.

- The probabilistic interpretation of quantum states.

References:

1. *Xudaykulova, S. (2024). DARAJALI GEOMETRIYA - KO'PHADLAR VA NORMAL KONUSLAR. Interpretation and Researches, 1(1). извлечено от https://interpretationandresearches.uz/index.php/iar/article/view/2496 Mathematical Analysis* (Yu. M. Geller, L. D. Faddeev).

2. Xudaykulova , S. (2024). TEXNIK IJODKORLIKNING HOZIRGI HOLATI. Research and Implementation. извлечено от https://rai-journal.uz/index.php/rai/article/view/520

3. Ne'matova , D. (2023). BOSHLANG'ICH SINF O'QUVCHILARIDA TANQIDIY FIKRLASH KO'NIKMALARINI SHAKLLANTIRISHNING PEDAGOGIK-PSIXOLOGIK XUSUSIYATLARI. Interpretation and Researches, 2(1). извлечено от https://interpretationandresearches.uz/index.php/iar/article/view/973

4. Холмуминова, А. (2023). ОСОБЕННОСТИ И ПРЕИМУЩЕСТВА ФОРМИРОВАНИЯ КОМПЕТЕНТНОСТИ ПОДГОТОВКИ ИННОВАЦИОННОЙ ДЕЯТЕЛЬНОСТИ У БУДУЩИХ УЧИТЕЛЕЙ НАЧАЛЬНЫХ КЛАССОВ. Interpretation and Researches, 2(1). извлечено от https://interpretationandresearches.uz/index.php/iar/article/view/1145

5. "Matematika" (S. M. Radjabov, Sh. T. Ismoilov, A. D. Muhitdinov).

6. "Matematik Analiz" (Yu. M. Geller, L. D. Faddeev).

7. "Algebra" (S. I. Adishchev, Yu. L. Ershov).

8. "Matematika" (Educational textbooks in Uzbekistan).