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Horizon Physics: Bridging The Classical and Quantum Worlds

A. Keshavardhan Goud, Research Scholar, Department of Physics, Glocal School of Science, Glocal University, U.P.

Abstract

Modern physics presents a fascinating transition from the deterministic framework of classical mechanics to the probabilistic and counterintuitive principles of quantum mechanics. This paper, titled “Horizon Physics: Bridging the Classical and Quantum Worlds,” explores the conceptual and theoretical connections between these two foundational domains. Classical physics provides an effective description of macroscopic systems through concepts such as position, momentum, energy, and continuous motion, whereas quantum physics describes matter and radiation at microscopic scales using wave functions, probability amplitudes, quantization, and uncertainty. The transition between these frameworks raises fundamental questions concerning measurement, determinism, locality, and the emergence of classical behaviour from quantum systems. This paper examines important concepts such as the correspondence principle, wave-particle duality, quantum superposition, decoherence, and the classical limit to understand how quantum phenomena evolve into familiar classical behaviour at larger scales. It also discusses the role of quantum theory in explaining phenomena that cannot be adequately described by classical models and highlights the continuing search for a unified understanding of nature. Particular attention is given to contemporary perspectives in quantum information, quantum technologies, and foundational physics, where the boundary between classical and quantum descriptions is increasingly significant. By examining the conceptual bridge between the two regimes, the study aims to provide a broader understanding of the continuity and distinction between classical and quantum descriptions of physical reality.

Keywords: Classical Physics, Quantum Physics, Quantum Mechanics, Correspondence Principle, Quantum Superposition, Wave-Particle Duality, Decoherence, Classical Limit, Quantum Information, Foundations of Physics.