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Explaining duality, the "only mystery" of quantum mechanics, without complementarity or "which way" (welcher-weg)

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Wave-particle duality has been extensively debated from the earliest days of quantum mechanics, for example the historic discussions between Albert Einstein and Niels Bohr, to the present. Richard Feynman called it the "only mystery" in quantum mechanics, long after Neils Bohr had offered his widely accepted explanation based on complementarity involving the observation also. Following John A. Wheeler's ingenious delayed choice thought experiment to test observer involvement in interference, it was implemented with and without entanglement by experimenters and who confirmed observation involvement as predicted by Niels Bohr, but they also revealed the phenomenon of *retro-causality* which begs proper explanation. The criterion of "which way" (welcher-weg) that captures the observation involvement is currently widely used in all single photon interference systems. In this paper a break-through Axiom is presented and justified which (a) Explains duality in interference, *with particle always remaining particle and wave always remaining wave throughout, without wave-particle complementarity or "which way" (welcher-weg) observation* that is the currently accepted mystifying view (b) Shows the equivalence: Coherence and alignment ≡ Interference ≡ No "which way" observation; No coherence or alignment ≡ No interference ≡ "which way" observation (c) Explains Wheeler's delayed choice thought experiment (d) Explains results of experimental implementations of Wheeler's thought experiment which show *retro-causality* with and without entanglement (e) Explains non-local action at a distance, and (f) Rephrases Albert Einstein's unanswered question "Is quantum mechanics complete?" at a more fundamental level than just duality and non-locality. The explanation given does not require that the particle (photon) somehow "know" about the test setup or "which way" observation or change its behavior from particle to wave and vice versa as required by currently accepted explanation based on Niels Bohr's complementarity principle and observation involvement. No new assumptions are made, only *a new complete interpretation* of probability which is already a fundamental assumption of quantum mechanics. The proposed Axiom not only explains duality without complementarity or "which way", it does so with substantial objective clarity that removes unwarranted mysticism that goes beyond physical objectivity. It avoids metaphysical subjectivity that seems to surround certain current perceptions of quantum mechanics.

Biography

Sarma N. Gullapalli achieved distinction from Indian Institute of Technology Madras, Chennai, India, he pursued graduate studies at Polytechnic Institute of Brooklyn (now New York Polytechnic) completing PhD in electrical engineering. In the graduate school, he also studied quantum physics, aspects of which intrigued him. After initially working on various computer systems, he subsequently spent several decades working on highly advanced electro-optomechanical systems, starting with the photon-counting interferometric Fine Guidance Sensor of Hubble Space Telescope at Perkin Elmer Corporation, later Hughes Aircraft Corporation, Raytheon, Veridian and General Dynamics, finally retiring from Scitor Corporation (now part of SAIC) as Senior Research Scientist. The wide range of research projects included mirrors for Chandra X-ray telescope, prototype cryogenic secondary mirror of Space Infrared Telescope Facility, star trackers, adaptive optics, actuators, deformable mirrors, focal plane arrays and quantum dot devices. Focal plane instruments naturally involve quantum mechanics, certain aspects of which intrigued him, but their investigation was out of the scope of the projects which had specific goals. After retirement, on his own, he pursued the study of some of the intriguing aspects such as duality and came up with the results which are presented in this paper, which removes much mystery and offers a new and useful perspective on quantum mechanics.

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