Complementarity Principle Encyclopedia Article

Complementarity Principle

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Complementarity Principle

The complementarity principle states that physical phenomena on the atomic scale exhibit a wave particle-duality. The principle was first advanced by Danish physicist **Niels Bohr** (1885-1962), one of the founders of **quantum theory**, in 1928.

The complementarity principle was intended to be a general framework through which the new and unfamiliar features of quantum **mechanics** could be understood. Unlike in classical physics, in **quantum mechanics** there are limits on the types of properties that can be simultaneously determined. For example, a particle such as an **electron** cannot have both its **momentum** and position determined exactly at the same time. This effect is one of the unique aspects of **quantum physics**, and is described by the Heisenberg uncertainty principle. Bohr's view of such physical systems was that they could exhibit features that seemed contradictory or mutually exclusive, and that this should be viewed as a guiding principle in the understanding of nature, replacing the classical concept of nature which taught that all of the physical variables in a system could theoretically be exactly determined.

The counterintuitive and paradoxical wave-particle duality of quantum particles is the central example of the complementarity principle, and it demonstrates the apparent impossibility of completely describing a particle such as an electron as being either strictly a wave or a particle. Further, the complimentarity principle, asserts that it is impossible to observe both the wave and particle characteristics at the same time. The wave-particle duality of phenomena means that elements of both particle and wave descriptions of phenomena must be synthesized to give a more accurate description of phenomena (e.g., an electron). Moreover, the principle also implies that description of natural phenomena often depends upon the type of experiment performed.

Rather than attempt, as German-born American physicist **Albert Einstein** to eliminate these paradoxical features of quantum mechanics, Bohr chose to embrace them as the basis for a new world-view.