Wave-particle duality in complex space

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Abstract

The purpose of this paper was to justify the fact that deterministic corpuscular description of a free particle can be made reconciled with its dual probabilistic wave description in complex space. It is found that the known wave-particle duality can be best manifested in complex space by showing that the wave motion associated with a material particle is just the phenomenon of projection of its complex motion into real space. To verify this new interpretation of matter wave, the equation of motion for a particle moving in complex space is derived first, then it is solved to reveal how the interaction between the real and imaginary motion can produce the particle's wave motion observed in real space. The derived complex equation of motion for a "free" particle indicates that a so-called free particle is only free from classical potential, but not free from the complex quantum potential. Due to the action of this complex quantum potential, a free particle may move either right or left in a classical way retaining its corpuscular property, or may oscillate between the two directions producing a non-local wave motion. A propagation criterion is derived in this paper to determine when a particle follows a classical corpuscular motion and when it follows a quantum wave motion. Based on this new interpretation, the internal mechanism producing polarization of matter wave and the formation of interference fringes can all be understood from the particle's motion in complex space, and the reason why wave function can be served as a probability density function also becomes clear.

Article Outline