On the existence of complex spacetime in relativistic quantum mechanics

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Abstract

The infinite dimensional $E^{(\infty)}$ space, when viewed at large scales, mimics the appearance of a 4-dimensional complex spacetime. The aim of this paper is to prove the existence of such a complex spacetime in our physical world and to show that what the current relativistic quantum mechanics describes is just the quantum phenomena appeared in this 4-dimensional complex spacetime. We point out that the complex spacetime is a natural consequence of including quantum effects in the relativistic mechanics, and is a bridge connecting the causality in special relativity and the non-locality in quantum mechanics. In other words, extending special relativity to the complex spacetime automatically leads us to the relativistic quantum mechanics. We will see in this paper that the Klein–Gordon equation is a special form of the Hamilton–Jacobi equation when both relativistic and quantum effects are taken into account. The solutions of the relativistic quantum Hamilton equations of motion provide us with a detailed description of the superluminal propagation in entangled states predicted by the Bell's theorem, and give a new mass–energy relation $E = mc^2\sqrt{1-2Q/(m_0c^2)}$ that is reduced to the conventional one $E = mc^2$, when the quantum potential Q is neglected.