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Form-preserving transformations of wave and Wigner functions

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Solutions of the time-dependent Schrödinger equation are mapped to other solutions for a (possibly) different potential by so-called form-preserving transformations. These time-dependent transformations of the space and time coordinates can produce remarkable solutions with surprising properties. A classic example is the force-free accelerating Airy beam found by Berry and Balazs. We review the 1-dimensional form-preserving transformations and show that they also yield Senitzky coherent excited states and the free dispersion of any waveform. Form preservation of the D- and 3-dimensional Schrödinger equation with both a scalar and a vector potential is then considered. It is shown that time-dependent rotations may be included when a vector potential is present. Moving to phase space, we consider the rigid translations that characterize the Airy beam and the coherent excited states. Then we study form-preserving transformations of the quantum Moyal equation obeyed by Wigner functions. The explicit transformation formula is the natural analog of the simple transformation of classical phase-space densities. It explains and generalizes the above-mentioned rigid translation in phase space.

Keyword-1

Schrodinger equation

Keyword-2

form-preserving transformation

Keyword-3

Wigner functions

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