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(G*) Ultrafast Coherence: A Combination of Quantum and Classical

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The two definitions of coherence: quantum and classical, are equivalent under the condition of stationarity and both remain useful for different experimental scenarios. However, as in many scenarios, the boundaries and connections between quantum and classical become unclear without common assumptions. One such scenario is an ultrashort laser pulse. Classical coherence is almost always defined for stationary and ergodic processes, which leads to a confusion between the time and ensemble averages for non-stationary processes, such those that are ultrashort. Quantum mechanical coherence does not require stationarity but it is an ensemble average over field modes rather than instances of the field. This means it cannot be applied to classical pulse shapes, such as those generally used to describe an ultrashort pulse, unless those fields are written as spatial-temporal modes. These modes are linear combinations of the usual monochromatic plane wave modes of the electromagnetic field. We derive a method to generate a set of spatial-temporal modes that describe a generic pulse shape. Further, by considering the coherent and single photon states of spatial-temporal modes, we can discuss the photon composition of laser pulses. This presents interesting implications for models that consider light as photons without being in a photon number state and helps to clarify experimental interpretations.

Keyword-3

Keyword-1

Coherence

Keyword-2

Ultrafast

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