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A Quantum Concept of Attosecond Radiation

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It has been shown that symmetric entangled coherent states of a many-mode optical radiation always result in completely locked Fourier superpositions for the expectation value of the electric field operator. Accordingly, in case of such entangled states, even an occasionally random distribution of the phases of the complex amplitudes cannot spoil the locking of the temporal Fourier components. This is in contrast to the case of simple product multimode coherent states, where the possible randomness of the mutual phases should result in a random temporal evolution of the radiation field. When our present formal result on the symmetric entangled states is applied for a sequence of high harmonics, the appearance of attosecond pulse trains can immediately be derived in the frame of the quantum optical description of the radiation field, in accord with various experiments. However, the question still remains whether truly these entangled states are generated in the high-harmonic production processes.

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