Strong-Field Kramers-Heisenberg Formula for High-Harmonic Generation in Quantized Radiation Modes

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We discuss the question of how can one treat the laser-induced (or laser-assisted) high-order processes of electrons (bound or free) non perturbatively, in such a way that both the electron-atom interaction and the quantized nature of radiation be simultaneously taken into account? An analytic method is proposed to answer this question in the general framework of nonrelativistic quantum electrodynamics. As an application, a quantum optical generalization of the strong-field Kramers-Heisenberg formula has been derived for describing high-harmonic generation (HHG). A semiclassical version of a similar Kramers-Heisenberg formula has already been published long ago [1], which inherently contain the appearance of the plateau in the HHG spectrum and the optional appearance of a Cooper minimum [2,3]. Beyond these, the new quantum formula is suitable to analyse (among various quantal effects, like depletion) the possible role of arbitrary photon statistics of the incoming field, and the amplification of the high-order harmonics, due to stimulated emission.

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