usually not accounted for and may have important fallouts in few-cycle pulse applications such as attosecond science and highly nonlinear optics.

As a significant example of the effects here described, we have simulated a typical single attosecond pulse generation experiment, based on high harmonic generation in He jets by 4.5 and 1.8 fs focused laser pulses centered at 800 nm carrier wavelength. We have compared the outcome when using the few-cycle pulse obtained by considering the true complete propagation, for which spatial and time evolution of the pulse are interconnected, with the result obtained within the typical approximation of a few-cycle field, for which the spatial propagation is taken to be decoupled from the pulse temporal evolution. The comparison is extremely interesting, showing the essential role played by the "true" structure of the wave in space and time when the shorter fundamental pulse is used. Our investigation shows that, for the sake of a correct understanding of high-harmonic and attosecond pulse generation, an appropriate treatment of focusing and propagation of near-single-cycle and sub-cycle pulses cannot be done without taking into account the real wavefronts, which are being formed and propagate in the diffraction process. In particular, for modeling high-harmonics generation, considering the real wavefront brings a better description of the physical process, basically because the shape of the field in space will influence the phase-matching process in both axial and radial direction. In time domain, the initial wavefront curvature has an influence on the formation of attosecond pulses, either in trains or single pulses. Indeed, the ionization strongly varies in radial direction and induces additional wavefront deformations during propagation so that the bursts have a continuous shift in emission time [23] along the radial direction. The structure of the initial wavefront of the fundamental field is found to be essential since it can help or deteriorate the formation of short attosecond pulses. The simulations also show that the spectra of the generated XUV radiation are different in the two cases, indicating that both the spectral extension and the efficiency of the conversion into XUV radiation can differ significantly.

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