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Plasma wakefield acceleration of light

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Bright, coherent extreme ultraviolet (XUV) light has many important applications across the sciences. Frequency upshifting of an optical laser pulse in the co-moving refractive index gradient of a relativistic phase-velocity plasma wave is one method for producing short wavelengths at high intensity. In particular, beam-driven plasma wakefields can generate arbitrarily high frequency-upshifts of 'relativistically intense' light pulses and preserve their spatio-polarization structure. We present some recent theoretical advancements in understanding photon kinetics in plasma wakes. Ab-initio quasi-3D, boosted-frame electromagnetic particle-in-cell simulations show the formation of attosecond duration XUV light with 30-nm wavelengths, nearly flat phase fronts and high pulse-energy. Using only weak focusing with a plasma lens, it may be possible to achieve 10^{23} Wcm^{-2} intensities. The use of such XUV laser light in laser-beam collisions at 50 GeV energies would enable studies of the most extreme regimes of strong field QED at the onset of the fully non-perturbative regime. Beam-driven wakefield acceleration of light may provide new applications for intermediate level (~100 GeV) plasma accelerators.

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