DAMOP13-2013-000412
Abstract for an Invited Paper
for the DAMOP13 Meeting of
the American Physical Society

High harmonic generation with intense infrared few-cycle laser pulses

FRANCOIS LEGARE, INRS-EMT

Further shortening of attosecond pulse duration via high harmonic generation (HHG) can be achieved utilizing few-cycle pulses at wavelengths longer than 800 nm, because the HHG cut-off shifts towards higher photon energies proportional to the square of the laser wavelength [1]. The IR spectral range at 1800 nm is accessed by choosing the narrow band Idler of a white light seeded optical parametric amplifier which enables passive carrier envelope phase (CEP) stabilization. Pulse compression is achieved via the combined action of nonlinear propagation in a hollow-core fiber (HCF) followed by subsequent linear propagation through fused silica (FS) in the anomalous dispersion regime, enabling sub-millijoule sub-two-cycle pulses [2,3]. HHG spectra from Xenon [4] and cyclohexadiene isomers will be presented demonstrating the benefit of using those ultrashort IR pulses for HHG spectroscopy. To amplify those pulses in the millijoule range, we introduce the concept of Fourier-plane Optical Parametric Amplification (FOPA). The key idea for amplification of octave-spanning spectra without loss of spectral width is to amplify the broad spectrum "slice by slice." Opposed to traditional schemes where amplification takes place in time domain, we propose to amplify different spectral parts independently of each other in the spectral domain. The spectral dispersion is carried out according to a 4-f setup which performs an optical Fourier transformation of time domain input pulses into the spectral domain and vice versa. After amplification which takes place in the Fourier plane, the pulses are transformed back into the time domain. As a first demonstration, the FOPA was used to amplify 0.1 mJ sub-two-cycle pulses to 1.4 mJ denoting 14 fold amplification. Driving the process of HHG from Neon and Helium with those pulses have enabled to generate soft X-ray spectra extending beyond the Oxygen K-edge (∼540 eV) denoting a first step towards the generation of isolated attosecond pulses in the water window spectral range.

[1] P. B. Corkum, Phys. Rev. Lett. Vol. 71, 1994 (1993).
[2] B. E. Schmidt et al. Appl. Phys. Lett. Vol. 96, 121109 (2010).
[3] B. E. Schmidt et al. Opt. Express Vol. 19, 6858 (2011).
[4] A. D. Shiner et al. Nat. Phys. Vol. 7, 464 (2011).