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Isolated attosecond pulses in the water window[1]

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Millijoule level, few-cycle, carrier-envelope phase (CEP) stable Ti:Sapphire lasers have been the workhorse for the first generation attosecond light sources in the last decade. The spectral range of isolated attosecond pulses with sufficient photon flux for time-resolved pump-probe experiments has been limited to extreme ultraviolet (10 to 150 eV). The shortest pulses achieved are 67 as. The center wavelength of Ti:Sapphire lasers is 800 nm. It was demonstrated in 2001 that the cutoff photon energy of the high harmonic spectrum can be extended by increasing the center wavelength of the driving lasers. In recent years, mJ level, two-cycle, carrier-envelope phase stabilized lasers at 1.6 to 2.1 micron have been developed by compressing pulses from Optical Parametric Amplifiers with gas-filled hollow-core fibers or by implementing Optical Parametric Chirped Pulse Amplification (OPCPA) techniques. Recently, when long wavelength driving was combined with polarization gating, isolated soft x-rays in the water window (280-530 eV) were generated in our laboratory. The number of x-ray photons in the 120–400 eV range is comparable to that generated with Ti:Sapphire lasers in the 50 to 150 eV range. The yield of harmonic generation depends strongly on the ellipticity of the driving fields, which is the foundation of polarization gating. When the width of the gate was set to less than one half of the laser cycle, a soft x-ray supercontinuum was generated. The intensity of the gated x-ray spectrum is sensitive to the carrier-envelope phase of the driving laser, which indicates that single isolated attosecond pulses were generated. The ultrabroadband isolated x-ray pulses with 53 as duration were characterized by attosecond streaking measurements.

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