Intense Infrared Lasers for Driving Attosecond X-Ray Sources

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Attosecond extreme ultraviolet sources based on high harmonic generation (HHG) in gases driven by Ti:Sapphire lasers centered at 800 nm have been the workhorse for studying electron dynamics since 2001. However, the photon energy range with sufficient flux for time-resolved experiments has been limited $<$ 130 eV. It was predicted that the cutoff photon energy of the phase-matched HHG can be extended by increasing the driving laser wavelengths. Significant progress has been made in developing few-cycle, carrier-envelope phase stabilized, high peak-power lasers in the 1.6 to 2 micron that has laid the foundation for tabletop attosecond X-ray sources in the water window (282 – 533 eV), which covers the atomic K-shell excitation of carbon and oxygen. Breakthroughs in ultrafast mid-wave infrared light sources have been made in recent years. Chirped pulse amplifiers centered at 2.5 and 4.1 micron based on Cr:ZnSe and Fe:ZnSe have been developed. In addition, chirped pulse optical parametric amplifiers using ZnGeP2 pumped by 2-micron lasers with high conversion efficiency has been demonstrated. They are emerging as powerful tools for studying wavelength scaling laws in strong-field atomic, molecular, and plasma physics.