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EDITORIAL

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EDITORIAL

10th anniversary of attosecond pulses

Guest Editors

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Attosecond science is an emerging field prompted by the development of attosecond light sources during the last decade. Since shorter light sources can diagnose faster phenomena, the generation of very short light pulses is critical in ultrafast measurements. In 2001 two groups at Commissariat à l'Energie Atomique (CEA), Saclay, and Technische Universität Wien (TUW), Vienna, succeeded in proving the production of attosecond pulse trains and isolated attosecond pulses using high harmonic generation processes, respectively. For the temporal characterization, cross correlation techniques such as RABITT and FROG CRAB that make use of the photoionization of atoms by harmonic and infrared pulses have been demonstrated, in addition to autocorrelation techniques. Femtosecond laser technology has progressed so well that carrier envelope phase (CEP)-stabilized few cycle lasers are now widely used in the production of attosecond pulses. For the generation of isolated attosecond pulses the high-harmonic generation processes have been controlled: the amplitude gating method has been powerful with CEP-stabilized sub-two-cycle laser pulses and the temporal gating methods, including polarization gating and double optical gating, have been effective in accommodating multi-cycle laser pulses. In achieving near transform-limited attosecond pulses the compensation of the inherent attosecond chirp by material dispersion has been useful. The attosecond pulse duration has reached sub-100 attoseconds both for attosecond pulse trains and isolated attosecond pulses, and it is expected that attosecond pulses shorter than one atomic unit (24 as) will be obtained soon.

With attosecond light sources, attosecond science has become an active research field. Ultrafast phenomena in atoms and molecules have been looked at in detail, especially in the time domain. The photoionization processes of atoms and molecules occurring in sub-optical cycles have been analyzed, and ultrafast characteristic times in atoms and molecules, such as Auger decay time and autoionization lifetime, have been measured directly as compared to indirect spectroscopic measurements normally done using synchrotron light sources. The reconstruction of molecular orbital wave functions has been demonstrated by developing the molecular tomography method. Ultrafast phenomena in condensed matter and in nanostructures have been tackled also. The successful development of attosecond light sources has thus opened up a variety of new research activities in ultrafast optical science; it will be continued and accelerated further in coming years with intensive research investments by more groups joining the field of attosecond science.

In this special issue celebrating the 10th year of attosecond pulse generation 6 review articles and 16 regular articles are included. Although it does not cover all active research areas, we sincerely hope it gives a glimpse of active research activities in attosecond science throughout the world.