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News

Jul 11, 2008

An unprecedented near-uniform supercontinuum spanning 270 to 1000 nm will help researchers gain an insight into electron motion.



Near-uniform supercontinuum

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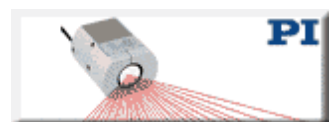
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By sending laser pulses with a duration of just 5 femtoseconds through a helium cell held at high pressure, researchers have created a coherent supercontinuum with near-uniform spectral intensity spanning the range 270 to 1000 nm. The result relies on a process known as self-channeling and gives the team a new tool with which to explore electron motion inside atoms (*Optics Letters* 33 1407).

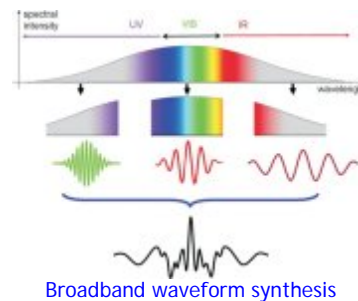
"Our ultimate goal is to generate coherent continuum light that spans several optical octaves," researcher Eleftherios Goulielmakis from the Max-Planck Institute for Quantum Optics in Garching, Germany, told *optics.org*. "In attosecond physics, we aim to steer the electron motion on atomic scales of space and time. To do this, we require fields that can be precisely controlled and shaped with sub-cycle (attosecond) accuracy and that are intense enough to enable nonlinear interactions with matter."



High and near-uniform efficiency are the prerequisites for generating light fields on a sub-cycle scale. While supercontinuum generation has been at the forefront of ultrafast research for several years, with groups using nonlinear propagation in photonic crystal fibres and solids, this prerequisite combination has remained elusive.

"Using few-cycle pulses

dramatically improves the situation," explained Goulielmakis. "Once the duration of the pulse approaches the oscillating period (around 2.5 fs) of the light wave, phenomena like ionization-induced blue shift and shockwave effects result in a dramatic enhancement of the generation of light in the blue wing of the spectrum. We have been able to generate light that extends into the UV part of the spectrum at nearly uniform intensity."



The team focused 5 fs pulses with a central wavelength of 750 nm into a gas cell filled with helium. Self-channeling sets in at a pressure of around 25 bar, which results in a 5 cm long channel and a substantial reduction of the beam divergence in the far field. A intensity-calibrated fibre spectrometer monitored the emerging supercontinuum.

"Helium was found to be remarkably stable against multifilamentation, an effect that splits the laser beam into many smaller filaments and compromises its applicability," commented Goulielmakis.



Supercontinuum setup

With this impressive result under its belt, the team now has several new experiments in the pipeline. "We plan to extend the supercontinuum source into the VUV by means of quasi-monocycle (~ 1.5 cycles of the field) laser pulses recently realized in our laboratories," said Goulielmakis.

A second follow-on experiment will see Goulielmakis and colleagues split the supercontinuum into narrower bands. The plan is to control properties such as the duration, phase and amplitude of these narrower bands separately before recombining them to synthesize intense light waveforms with a desired shape. "We plan to use these waveforms to control the generation of intense attosecond soft x-ray pulses from atoms," said Goulielmakis.




Other partners in the team come from the Technical University of Vienna, Austria; the Lomonosov Moscow State University, Russia; and the Ludwig-Maximilians University, also in Garching, Germany.

Author

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