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Synthesis of Single-Cycle Optical Fields

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Achieving full control of microscopic motion of free electrons and other charged particles in free space and in matter has been a major goal in ultrafast physics [1]. Such a control can be realized using single cycle optical fields of attosecond duration that can be Fourier synthesized by manipulating the amplitude and phase of the components of a frequency comb that spans more than one octave. We have generated a frequency comb by molecular modulation whereby two laser pulses are used to drive the Raman coherence of a molecule [2]. When the two laser pulses are the fundamental and the second harmonic they form the first two components of a harmonic comb. Periodic waveforms synthesized from this harmonic comb then have a constant carrier-envelope phase. The electric field waveform is stable over time and space [3].

For many applications an isolated waveform instead of a periodic waveform is desirable. In this case a continuous phase-coherent frequency spectrum (supercontinuum) instead of a comb of frequencies must be available. For many years the method of self-phase-modulation in a gas medium has been used to generate the supercontinuum in the visible or near infrared. Large dispersion and ease of optical damage have hindered acceptance of using a solid medium [4]. We have overcome these limitations and succeeded in using a solid medium to generate a pulsed supercontinuum that extends from the uv to the near ir [5]. The supercontinuum has high pulse energy of tens of microjoules and excellent beam quality. Interferometric measurements show that the pulse maintains high coherence and is compressible to a few femtoseconds to reach a peak power of over ten gigawatts. The pulse will be suitable for isolated pulse high harmonic generation and for applications in attosecond pump-probe measurements.

References:

[1] E. Goulielmakis, V. S. Yakovlev, A. L. Cavalieri, M. Uiberacker, V. Pervak, A. Apolonski, R. Kienberger, U. Kleineberg, F. Krausz, “Attosecond Control and Measurements: Lightwave Electronics”, Science **317**, 769 (2007).

[2] S. E. Harris and A. V. Sokolov, “Subfemtosecond pulse generation by molecular modulation,” Phys. Rev. Lett. **81**, 2894 (1998).

[3] H. Chan, Z. Hsieh, W. Liang, A. H. Kung, C. Lee, C.Lai, R. Pan, and L. Peng, “Synthesis and measurement of ultrafast waveforms from five discrete optical harmonics,” Science **331**, 1165 (2011).

[4] S. L. Chin, Chapter 3, “Femtosecond Laser Filamentation” Springer Series on Atomic, Optical and Plasma Physics 55. (2009).

[5] Chih-Hsuan Lu, Yu-Chen Cheng, Shang-Da Yang, Yuan-Yao Lin, Chia-Chen Hsu, and A. H. Kung, “A new and improved approach to supercontinuum generation in solids”, paper STh1E.6, CLEO, June, 2014.

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