Beams and Applications Seminar Series

This ANL seminar series is a CARA activity and focuses on the physics, technology and applications of particle and photon beams. It is sponsored jointly by the ASD Division, the AWA group of the HEP Division, and the ATLAS group of the PHY Division.

Bldg. 401, Room B2100
Friday, December 6, 1:30 PM

Jun Ye (JILA, NIST, Univ. of Colorado)

Ultra-precise Phase Control of Ultra-Short Pulses

Host: Yuelin Li

Precise phase control of ultra-wide-bandwidth optical frequency combs has produced remarkable and unexpected progress in precision metrology and ultrafast science. The combination of the ability to do completely arbitrary, optical, waveform synthesis with recently developed optical pulse measurement techniques is analogous to the development of oscilloscopes and waveform generators in the early 20th century. The development of ultra-stable optical frequency standards into optical atomic clocks and optical frequency synthesizers again complement and rival the similar technologies developed in the radio frequency domain.

We have generated a precise optical frequency comb spanning an entire octave (> 300 THz) bandwidth. We have used the comb for absolute optical frequency measurements and for establishing a simple optical clock based on an optical transition. The clock provides an rf clock signal with a frequency stability comparable to that of an optical standard and superior to almost all conventional rf sources. A CW optical frequency synthesizer has also been demonstrated, with the capability of setting a CW laser frequency at a precisely pre-determined value and continuously tuning the laser frequency with rf precision.

For the ultrafast science, carrier-envelope phase stabilization of few cycle optical pulses has recently been realized. We can now control the absolute carrier-envelope phase to tens of milli-radians, paving the groundwork for synthesizing electric fields with known amplitude and phase at optical frequencies. Using the frequency domain control technology, we have also synchronized the pulse timing between two independent femtosecond lasers, with a residual jitter noise below 1 fs observed at a bandwidth of 200 Hz over several minutes. This result has allowed us to phase lock the carrier frequencies of two femtosecond lasers for the first time and we can now coherently stitch together optical bandwidths from different spectral windows emitted by independent laser sources, leading to synthesized optical pulses. The simultaneous control of timing jitter (repetition rate) and carrier-envelope phase has already been applied to diverse fields such as optical amplifier and nonlinear-optics based spectroscopy and imaging. In short, we now appear to have all the experimental tools required for complete control over coherent light, including the ability to generate pulses with arbitrary shape, and precisely controlled frequency and phase, and to synthesize coherent light from multiple sources.

For more information visit

http://www.aps.anl.gov/asd/physics/seminar.html

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