FAKULTÄT für PHYSIK
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MÜNCHEN/GARCHING

PHYSIK-DEPARTMENT
TECHNISCHE UNIVERSITÄT MÜNCHEN
MÜNCHEN/GARCHING

MLL-KOLLOQUIUM

Donnerstag, 15.10.2015, 16^{15} Uhr

Seminarraum 127, TUM, Physik II, Erdgeschoss/Nord
Treffen zum gemeinsamen Kaffee 16 Uhr

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(MPI f. Quantenoptik und MAP-Cluster)

Time-Domain Spectroscopy in the Molecular Fingerprint Region

Biomolecular assemblies exhibit fundamental rotational and vibrational modes in the mid- infrared (MIR) spectral range between 2 and 25 μm. MIR vibrational spectroscopy thus grants access to information on the molecular composition, structure and conformation, affording tremendous potential for breakthroughs in fields ranging from fundamental research over security and environmental applications to the life sciences. Most prominently, MIR spectroscopy affords the promise of early detection and diagnosis of diseases like Alzheimer or cancer via statistically-proven disease-specific spectral fingerprints, since any change in the structure of molecular constituents of a human cell invariably causes changes in the MIR absorption spectrum of the cell itself or of its metabolic products. Tapping this potential has so far been precluded by the lack of MIR sources combining the properties essential for high-sensitivity detection: high power, broad bandwidth, coherence and high repetition rate. Here, we present the first MIR source unifying all of these properties. Difference-frequency generation among the spectral components of the nonlinearly compressed 19-fs pulses of a high- power Kerr-lens-mode-locked Yb:YAG thin-disk oscillator, spectrally centered at 1030 nm, was driven in a LiGaS2 crystal. The resulting sub-2-cycle-duration MIR pulses emerged at the original repetition rate of the oscillator of 100 MHz with an average power of 0.1 W and a continuous spectral coverage from 6.7 to 18 μm. This compact source is up to 1000 times more powerful than state-of-the-art frequency combs emitting in the same range and around its central wavelength it exhibits a spectral brightness superior to that of 3^{rd}-generation synchrotrons. Furthermore, in this intrapulse DFG scheme, the MIR pulses are inherently phase-stable. The electric field of the phase-coherent MIR pulses is detected with electro-optical sampling, performed with a low-power copy of the 19-fs NIR driving pulses. This allows for broadband detection using near-infrared photodiodes with noise figures dramatically superior to detectors customarily employed in MIR absorption spectroscopy. Furthermore, it grants access to the full information on the electric field after passing a probe (rather than to the spectrally resolved intensity absorption only), enabling the use of powerful pattern recognition algorithms for determining the molecular composition of complex probes.

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