Q 46: Ultrashort laser pulses II

Time: Thursday 14:00–16:00 Location: DO26 207

Q 46.1 Thu 14:00 DO26 207

Spectral amplitude and phase noise of an optical frequency comb revealed with ultrafast pulse shaping — Roman Schmeissner, Jonathan Roslund, Claude Fabre, and •Nicolas Treps — Laboratoire Kastler Brossel, 4 Place Jussieu, 75005 Paris, France

Amplitude and phase noise of optical frequency combs has been characterized extensively for individual wavelengths or the mean field; however, the relevance of correlations among various frequencies of the comb is largely unknown. We employ ultrafast pulse shaping to measure the noise covariance matrix of a frequency comb, which reveals the spectral distribution of laser noise as well as the correlations among different wavelengths. The noise covariance matrix is obtained with pulse shaping, a passive cavity, and shot noise limited balanced detection. The form of both amplitude and phase correlations is examined for a multitude of time-scales, ranging from 100kHz to several MHz. For low frequencies, the covariance matrix reveals the fundamental noise modes, which describe how noise is partitioned among the individual comb frequencies. All correlations vanish as the standard quantum limit is approached at microsecond timescales. The presented data provide an intuitive understanding of relevant spectral noise structures and how they evolve from the classical to the quantum regime. The latter is the basis for recently demonstrated, ultrafast wavelength-multiplexed quantum networks [1]. [1] J.Roslund et al.,arXiv preprint arXiv:1307.1216, 2013

Q 46.2 Thu 14:15 DO26 207

Line-by-line pulse shaping for pump-probe spectroscopy applications using a 10 GHz femtosecond frequency comb — •Oliver Kliebisch, Dirk Heinecke, and Thomas Dekorsy — Department of Physics, Universität Konstanz, D-78457 Konstanz

Femtosecond lasers with high repetition rates in the GHz range are becoming more and more important for spectroscopy, especially high speed asynchronous optical sampling (ASOPS). The currently used excitation and detection methods limit the usable resonance frequencies of nanomechanical resonators to the MHz or lower GHz range [1]. Due to the high spacing of the comb lines of a 10 GHz Ti:sapphire laser [2] each mode can be spatially resolved and manipulated individually. A so called GRISM (a combination of a grating and a prism) is used as a dispersive element with nearly constant dispersion [3]. This ensures independent line-by-line modulation over a large bandwidth. The amplitude and phase of each mode can be controlled individually using a spatial light modulator. [4]. This allows to synthesize pulse trains for resonant excitation of acoustic phonons in nanomechanical systems [5]. Using a second 10 GHz Ti:sapphire laser with a detuned repetition rate pump-probe experiments can be carried out employing the method of asynchronous optical sampling [6].

[1] Bruchhausen et al., PRL 106, 077401 (2011). [2] Bartels et al., Opt. Lett. 33, 1905 (2008). [3] Kirchner et al., Opt. Lett., 35, 3264-3266 (2010). [4] Cundiff et al., Nature Photonics 4, 760-766 (2010). [5] Heinecke et al., PRB 87, 075307 (2013). [6] Gebs et al., Opt. Express 18, 5974-5983 (2010).

Q 46.3 Thu 14:30 DO26 207

Measurement and optimization of the temporal resolution in a broadband transient spectrometer — •Emanuel Wittmann, Roland Wilcken, Sebastian Wiegner, Maximilian Bradler, and Eberhard Riedle — LS für BioMolekulare Optik, LMU München

With tunable UV or visible excitation and continuum probe pulses molecular dynamics are measured with sub-50 fs resolution [1]. Particularly for UV excitation the optimization of the pump pulse compression is far from trivial. The coherent artifact contained in the measurement signal is heavily intermingled with the molecular response. We recently showed that two-photon-absorption can be used to characterize the UV pulses - unfortunately at the price of additional complexity in the experiment. We now investigate the use of the continuum to characterize the UV pulses *in-situ* and find: a) the proper crystals, glasses or liquids have to be chosen to ensure pure absorptive TPA signals and to avoid dispersive contributions that complicate the interpretation. b) no single material covers the more than octave wide probe spectrum, but suitable combinations can be found. c) with these materials a temporal scan can be largely avoided as the width of the time resolved crosscorrelation spectrum correlates to the temporal width. d) with the newly developed characterization a minimization of the pump pulse length and the temporal resolution can be performed within minutes.

[1] U. Megerle, I. Pugliesi, C. Schriever, C. F. Sailer, E. Riedle, Appl. Phys. B **96**, 215 (2009).

[2] C. Homann, N. Krebs, E. Riedle, Appl. Phys. B **1046**, 783 (2011).

Q 46.4 Thu 14:45 DO26 207

Hochfrequenz-modulierte Diodenlaser für die Quelle polarisierter Elektronen am S-DALINAC — •Andreas Kaiser, Joachim Enders, Martin Espig, Yuliya Fritzsche und Markus Wagner — Institut für Kernphysik, TU Darmstadt

Der Darmstädter supraleitende Elektronen-Linearbeschleuniger S-DALINAC ist im Jahr 2011 um eine Quelle polarisierter Elektronen erweitert worden. Durch photoinduzierte Emission mit Strained-superlattice-GaAs- und bulk-GaAs-Photokathoden können je nach Wellenlänge des Laserlichtes hochpolarisierte Elektronen erzeugt oder hohe Strahlströme für den Beschleuniger bereitgestellt werden. Hierfür kommt ein mit 3 GHz modulierter Diodenlaser zum Einsatz, welcher Pulslängen unter 50 ps erreicht, um die Lebensdauer der Photokathoden zu maximieren.

Gefördert durch die DFG im Rahmen des SFB 634 und durch das Land Hessen im LOEWE-Zentrum HIC for FAIR.

Q 46.5 Thu 15:00 DO26 207

Weiterentwicklung Hochfrequenz-modulierter Diodenlaser für die Quelle polarisierter Elektronen am S-DALINAC — •Martin Espig, Joachim Enders, Yuliya Fritzsche, Andreas Kaiser und Markus Wagner — Institut für Kernphysik, TU Darmstadt

Die Quelle polarisierter Elektronen am Darmstädter supraleitenden Elektronen-Linearbeschleuniger S-DALINAC nutzt photoinduzierte Emission mit Strained-superlattice-GaAs- und bulk-GaAs-Photokathoden. Hochpolarisierte Elektronen können so mit Laserlicht der Wellenlänge 780 nm erzeugt werden, während blaues Laserlicht für Hochstromexperimente zum Einsatz kommt.

Es wird die Weiterentwicklung des Hochfrequenz-modulierten Diodenlasersystems vorgestellt, darunter die Impedanzanpassung zur Diode, Modulation mit kurzen elektrischen Pulsen und die Pulsung mit einem Mach-Zehnder-Modulator. Der gepulste Betrieb soll die Erzeugung kurzer Elektronenbunche ($<$ 50 ps) am S-DALINAC gewährleisten mit variablen Repetitionsraten von einigen MHz bis 3 GHz.

Gefördert durch die DFG im Rahmen des SFB 634 und durch das Land Hessen im LOEWE-Zentrum HIC for FAIR.

Q 46.6 Thu 15:15 DO26 207

Bestimmung eines Langzeitdrifts der Ankunftszeit ultrakurzer Laserpulse mittels Kreuzkorrelation — •Daniel Espeloer[1,2], Alaa Al-Shemmary[1], Vivek Asgekar[1], Torsten Golz[1], Marc Temme[1], Nikola Stojanovic[1] und Ulrich Teubner[2,3] — [1]Deutsches Elektronen-Synchrotron DESY, Notkestraße 85, D-22607 Hamburg — [2]Institut für Lasertechnik, HS Emden/Leer - University of Applied Sciences, Constantiaplatz 4, D-26723 Emden, Germany — [3]Institut für Physik, Carl von Ossietzky Universität, Ammerländer Heerstraße 114-118, D-26129 Oldenburg, Germany

Ziel dieser Arbeit ist es, den Drift in der Ankunftszeit ultrakurzer Pulse eines Oszillators und eines mit diesem synchronisierten Verstärker zu bestimmen.

Um einen NOPA mit dem Verstärkerstrahl als Pumpstrahl und dem THz Strahl, welcher im THz Undulator des FLASH generiert wird, als Signal Strahl betreiben zu können, muss der zeitliche Überlapp der Pulse gewährleistet sein. Beide Quellen sind getrennt voneinander mit dem Oszillator synchronisiert. Damit ein Langzeitdrift zwischen Verstärker- und Oszillatorpuls kompensiert werden kann, muss dieser zunächst bestimmt werden. Hierfür wurde ein Intensitäts SHG Kreuzkorrelator für die besagten Strahlen aufgebaut. Anhand der Verschiebung des Peaks der einzelnen Traces mit der Betriebszeit konnte der gesuchte Drift bestimmt werden.

Q 46.7 Thu 15:30 DO26 207

Time-domain pulse compression by interfering time-delay op-

erations — •Yonghao Mi, Andreas Kaldun, Kristina Meyer, and Thomas Pfeifer — Max-Planck-Institut für Kernphysik, Saupfercheckweg 1, 69117 Heidelberg, Germany

We introduce a time-domain pulse compression method for arbitrary pulses [1]. Coherent superposition of a number of pulse replicas with time delays can lead to constructive interference at only one specific time, while partly destructive interference reduces the intensity of the pulse anywhere else in time. We show that chirped and statistical pulse shapes can be compressed effectively. By optimizing the number of employed replicas, pulse durations close to their corresponding Fourier transform limits can be obtained after compression while already very few replicas (˜3-4) are enough to lead to substantial pulse duration reduction. We also investigate the influence of the method on the spectrum of the pulses, where the spectral phase is close to flat in the regions of large spectral amplitude, as expected for pulse compression.

[1] Yonghao Mi, Andreas Kaldun, Kristina Meyer and Thomas Pfeifer, Phys. Rev. A 88, 053824 (2013)

Q 46.8 Thu 15:45 DO26 207

Realization of near-bandwidth-limited 7-fs Ti:Sapphire pulses at the foci of high-NA microscope objectives — •H. Wan[1], S. Gomes da Costa[1], H. B. de Aguiar[1], G. Tempea[2], and A. Volkmer[1] — [1]3. Institute of Physics, Stuttgart ,Germany — [2]FEMTOLASERS GmbH, Wien, Austria

We demonstrate that near-bandwidth-limited pulses with 7 fs durations and very clean temporal profile can be systematically achieved at the focus of commonly used, high-numerical-aperture microscope objectives. Controlling not only the group delay dispersion (GDD) but also the third-order dispersion (TOD) of the setup was of paramount importance for achieving these results. We coupled 6.4-fs laser pulses from a Ti:Sapphire oscillator into an inverted microscope, via an ultrabroadband dispersive mirror compressor that compensates both the GDD and TOD of the system. A pair of fused silica wedges was used for fine dispersion adjustment. The shortest pulse duration of 6.9 fs was achieved at the focus of an 20x NA 0.5 W objective. For a high-NA microscope objective (60x NA 1.2W), only slightly longer in-focus pulses of 7.1 fs are routinely attained. The efficiency of second harmonic and two-photon fluorescence excitation in nonlinear optical microscopies is predicted to increase linearly with decreasing pulse duration. This behavior has been previously demonstrated experimentally for pulse durations down to 20 fs only. Equipped with the setup described above, we first verified the validity of this prediction for pulses with durations down to 7 fs. These results pave the way for fundamental studies of ultrafast phenomena with sub-micron spatial resolution.