Q 34: Ultrashort Laser Pulses: Applications II

Time: Wednesday 14:00–16:00 Location: F 342

Q 34.1 We 14:00 F 342

Ultimate fast optical switching of a photonic microcavity — •Georgios Ctistis[1,3], Alex Hartsuiker[1], Julien Claudon[2], Jean-Michel Gérard[2], and Willem L. Vos[1,3] — [1]Center for Nanophotonics, FOM Institute for Atomic and Molecular Physics (AMOLF), Amsterdam, Netherlands — [2]CEA-CNRS Nanophysics and Semiconductors joint laboratory, Grenoble, France — [3]Complex Photonic Systems (COPS), MESA+ Institute for Nanotechnology, University of Twente, Netherlands

Exciting prospects arise when photonic nanostructures are switched on ultrafast timescales. Of particular interest is the ultrafast switching of the resonance of a cavity wherein photons are stored for a long time in a tiny volume. Such switching permits the quantum electrodynamical manipulation of the stored photons, or the optical properties of a source embedded in the cavity. Here we have switched the resonance in the telecom range of an ultrafast ($\tau_{cav} = 0.9$ ps) cavity by the instantaneous electronic Kerr effect. Essential steps in our experiments are fabricating a dedicated cavity with a resonance in the telecom range and employing low-energy pump photons. This switching mechanism potentially allows beyond-THz modulation rates that could be of use for extremely fast datamodulation.

Q 34.2 We 14:15 F 342

Faserlasergepumpter Femtosekunden LBO optisch parametrischer Oszillator — •Jörn Epping, Carsten Cleff, Petra Gross und Carsten Fallnich — Institut für Angewandte Physik, Westfälische Wilhelms-Universität, Corrensstr. 2, 48149 Münster

Es wird ein synchron gepumpter einfachresonanter Femtosekunden LBO-OPO vorgestellt. Als Pumpquelle dient ein diodengepumpter Ytterbium-Faser-Oszillator, bei dem nach einem zweistufigen Yb-Verstärker die Impulse komprimiert und in einem LBO-Kristall frequenzverdoppelt werden. Die erzeugten Pumpimpulse haben eine Dauer von 300 fs bei einer Wellenlänge von 525 nm und eine mittlere Leistung von 6 W bei einer Repetitionsrate von 61 MHz. Begrenzt durch die verwendeten Spiegel kann die Signalwellenlänge des OPOs von $780 - 950$ nm und die Idlerwellenlänge von $1200 - 1600$ nm durch die Veränderung der Kristalltemperatur variiert werden. Die Bandbreite der erzeugten Signalimpulse ist gegenüber den Pumpimpulsen vergrößert und ermöglicht eine Kompression unterhalb der Pumpimpulsdauer. Die weite Durchstimmbarkeit des OPOs und die intrinsische Synchronität zwischen Signal- und Idlerimpulsen sowie zu den Impulsen des Yb-Faserlasers ermöglichen den Einsatz für Mikroskopie mit kohärenter anti-Stokes Raman Streuung (CARS), welche sowohl eine hohe räumliche Auflösung, als auch eine chemische Selektivität ermöglicht.

Q 34.3 We 14:30 F 342

Ultrashort-pulsed, ultra-broadband nondiffracting tubular beam generated with a phase only spatial light modulator — •Martin Bock and Ruediger Grunwald — Max Born Institute, Max-Born-Straße 2a, 12489 Berlin, Germany

Tubular beams propagating diffractionless were generated with a high-resolution liquid crystal on silicon spatial light modulator (LCoS-SLM). Contrary to higher-order Laguerre-Gauss or Bessel-Gauss modes [1,2], such beams exhibit no significant extrinsic orbital angular momentum. The new approach is based on generating adapted angular distributions by shaping the beam with a bi-prism bent to an annulus (torus-axicon) which was programmed into the SLM. The active area was completely involved by including a convex conical center thus leading to high energy efficiency. A diverging wave from the center is superimposed with a converging wave from the outer parts. In the experiments we used a Ti:sapphire oscillator emitting 10 fs pulses to illuminate the SLM. The ring-shaped wavepacket resulting from the interference of the parts constituting the wave was found to propagate in the fashion of a nondiffracting beam. With 20 fs, the pulse duration was only slightly changed. We suppose that this was mainly caused by the cover glass of the SLM.

[1] D. McGloin, et al., Opt. Comm. 225, 215-222 (2003).
[2] I. G. Mariyenko, Opt. Express 13, 7599-7608 (2005).

Q 34.4 We 14:45 F 342

Photonic fiber for flexible sub-20 fs pulse delivery — •Jens Bethge[1], Tuan Le[2], Julia Skibina[3], Andreas Stingl[2], and Günter Steinmeyer[1] — [1]Max Born Institute, Berlin, Germany — [2]Femtolasers Produktions GmbH, Vienna, Austria — [3]Saratov State University, Saratov, Russia

A flexible femtosecond pulse delivery is desirable for many applications, e.g,. microscopy, endoscopy, and photodynamic therapy. We report on the experimental demonstration of sub-20 fs pulse delivery with a spectrally flat phase through 80 cm of chirped photonic crystal fiber (CPCF)[1]. The delivery is utilizing chirped mirrors for dispersion precompensation of the coupling optics as well as the remaining waveguide dispersion of the CPCF. Even tough the use of precompensation has been recently shown for large mode area fibers with a solid core [2], our improved concept of a hollow-core fiber sets a new world record on short pulse delivery and is scalable towards higher energies. Since the dispersion contribution of the fiber is flat and virtually vanishing for all wavelengths involved, we are able to precompensate the dispersion of the optics and of the fiber with only 8 bounces off chirped mirrors. This is an easy-to-implement technique for delivering bandwidth-limited pulses of sub-20 fs duration over meter distances, promising interesting future applications.

[1] J. S. Skibina, et al., Nature Photonics 2, 679 - 683 (2008).
[2] T. Le, et al., Opt. Express 17, 1240-1247 (2009).

Q 34.5 We 15:00 F 342

Multimodales Koppeln in ultrakurzpuls geschriebenen Faser-Bragg-Gittern — •Ria Becker[1], Jens Thomas[1], Stefan Nolte[1] und Andreas Tünnermann[1,2] — [1]Friedrich-Schiller-Universität Jena, Institut für Angewandte Physik, Max-Wien-Platz 1, 07743 Jena — [2]Fraunhofer-Institut für Angewandte Optik und Feinmechanik IOF, Albert-Einstein-Str. 7, 07745 Jena

Faser-Bragg-Gitter (FBG) haben sich als faserintegrierte Reflektoren in einmodigen Fasern zu Schlüsselelementen für optische Kommunikationssysteme und Sensoren etabliert. Bei mehrmodigen Fasern jedoch erzeugen FBG's multimodale Reflektionen, für die es keine effizienten Filtermöglichkeiten gibt. Herkömmlichen Einschreibeverfahren beruhen auf photosensitiven Prozessen. Daher betrifft die Brechzahlmodifikation den ganzen Faserkern. Verwendet man jedoch femtosekunden Laserpulse für die Erzeugung der FBG's, kann man partiell im Kern die Brechzahl modifizieren. Die Erzeugung des Brechzahlhubs beruht auf nichtlinearer Absorption, so dass das die Modifikation nur im Fokus des Laserstrahls auftritt. Mit Hilfe der gekoppelten Modentheorie kann gezeigt werden, dass durch Variation der Position der Brechzahlmodifikation im Kern die Kopplung in Moden höherer Ordnung gesteuert werden kann. Bei Hochleistungsfaserlasern werden Fasern mit großen Kerndurchmessern benötigt, die oft leicht mehrmodig sind. Die dadurch entstehenden multimodalen Reflektionen verursachen Instabilitäten. Durch partielle Modifikation des Faserkerns konnten diese unterdrückt, und ein stabiler Laserbetrieb gewährleistet werden.

Q 34.6 We 15:15 F 342

Non-adiabatically changing the frequency of light in a transient microcavity — •Georgios Ctistis[1], Philip J. Harding[1,2], Huib Bakker[2], Alex Hartsuiker[2], Julien Claudon[3], Allard Mosk[1], Jean-Michel Gérard[3], and Willem L. Vos[1,2] — [1]Complex Photonic Systems (COPS), MESA+ Institute for Nanotechnology, University of Twente, The Netherlands — [2]Center for Nanophotonics, FOM Institute for Atomic and Molecular Physics (AMOLF), Amsterdam, The Netherlands — [3]CEA-CNRS Nanophysics and Semiconductors joint laboratory, Grenoble, France

We study frequency-resolved femtosecond pump-probe reflectivity of a planar GaAs/AlAs microcavity. About 8 ps after a pump pulse, we observe an excess signal due to a non-adiabatic frequency change of the stored light by more than 4 linewidths away from the cavity resonance. Strikingly, the frequency change of light occurs at a time when the pump pulse is long gone. The frequency change is caused by the accumulated phase change of the light stored in the transient cavity. In agreement with an analytical model, the excess reflectivity is high when the cavity resonance frequency strongly shifts compared to the cavity linewidth within one cavity storage time.

Q 34.7 We 15:30 F 342

Fiber Based Ultrashort Pulse System with Kilowatt Level Average Power — Tino Eidam[1], •Stefan Hanf[1], Thomas Andersen[2], Enrico Seise[1], Chrisitan Wirth[3], Thomas Schreiber[3], Thomas Gabler[4], Jens Limpert[1], and Andreas Tünnermann[1,3] — [1]Friedrich-Schiller-University Jena, Institute of Applied Physics, Albert-Einstein-Str. 15, 07745 Jena, Germany — [2]NKT Photonics, Blokken 84, DK-3460 Birkeroed, Denmark — [3]Fraunhofer Institute for Applied Optics and Precision Engineering, Albert-Einstein-Str. 7, 07745 Jena, Germany — [4]JT Optical Engine, Prüssingstr. 41, 07745 Jena, Germany

Ultrashort pulse laser systems combining simultaneously high peak and average power are desirable in many applications. Especially the high pulse repetition rate results in a reduced measurement time in fundamental science and in an increased processing speed for industrial applications. Extreme parameters, i.e. mJ-level pulses at average powers beyond one kilowatt and diffraction limited beam quality, is still a huge challenge for every existing laser architecture. The application of the chirped pulse amplification (CPA) technology in combination with photonic crystal fibers (PCFs) led to ultrashort pulses with mJ-level pulse energies. Herein we present a three-stage fiber CPA system generating 830 W of compressed average power at 78 MHz pulse repetition frequency and 640 fs pulse duration. Beside these record parameters we discuss possibilities to overcome limitations of current large mode area fiber amplifiers imposed by transversal spatial hole burning enabling fiber CPA systems with kW average power and GW peak power.

Q 34.8 We 15:45 F 342

Ultrafast solid-state lasers for frequency comb stabilization — •T. Südmeyer[1], M. C. Stumpf[1], S. Pekarek[1], A. E. H. Oehler[1], C. Fiebig[2], K. Paschke[2], G. Erbert[2], J. M. Dudley[3], and U. Keller[1] — [1]Department of Physics, ETH Zurich, Switzerland — [2]Ferdinand-Braun-Institut für Höchstfrequenztechnik, Berlin, Germany — [3]Institut FEMTO-ST, CNRS-Université de Franche-Comté, Besançon, France

Very recently, we demonstrated the first self-referencable ultrafast solid-state laser oscillator operating in the 1500 nm spectral region. Here we present for the first time the full CEO frequency stabilization and repetition rate stabilization of this laser. Our system is based on a 170-fs Er:Yb:glass laser generating 110 mW output power at less than 1.5 W electrical power consumption. It generates a coherent octave spanning frequency comb in a polarization maintaining highly nonlinear fiber (PM-HNLF) without any amplification. Our free-running CEO-beat is 49 dB above the noise floor and its linewidth of 3.6 kHz is more than an order of magnitude lower than typically obtained by free-running ultrafast fiber laser systems. The CEO frequency was stabilized by feedback on the diode current from a phase-locked loop (PLL). A stable CEO-beat was observed even with pulse durations above 260 fs.

Furthermore, we present the first femtosecond SESAM-modelocked Yb:KGW laser operating at 1 GHz repetition rate. We generated 120 mW output power in 317-fs pulses at 1030 nm for 1.7-W pump power from a high-brightness single-frequency DBR tapered diode laser.