

## Q 19: Erzeugung ultrakurzer Lichtimpulse

Zeit: Dienstag 10:30–12:15

Raum: 5K

Q 19.1 Di 10:30 5K

**Fourier limited tunable pulses in the visible and NIR by cw seeding of fs and ps NOPAs** — ●MARKUS BREUER<sup>1</sup>, CHRISTIAN HOMANN<sup>1</sup>, EBERHARD RIEDLE<sup>1</sup>, and FRANK SETZPFANDT<sup>2</sup> — <sup>1</sup>LS für BioMolekulare Optik, LMU München — <sup>2</sup>Institut für Angewandte Physik, Friedrich-Schiller-Universität Jena

Optical parametric amplifiers (OPAs) seeded by a continuum or a parametric generator are the prime source of tunable ultrafast radiation. They do, however, not render pulses with a clean Gaussian spectrum and a pulse length given by the Fourier limit. In the nanosecond regime superior pulses are generated by amplification of monomode cw seed light in dye amplifiers and optical parametric oscillators. For the ultrafast regime the principle has so far not been exploited, due to the small number of seed photons contained within the temporal amplification interval. Yet, the ever increasing availability of low cost diode sources would make it an attractive method. We have succeeded to operate cw seeded 2-stage noncollinear OPAs (NOPAs) with a 150 fs Ti:sapphire pump source and a 10 ps Nd:VAN system. A few hundred  $\mu$ J of pump energy at 1 or 5 kHz led to a few  $\mu$ J of output with single mWs of seed power. The fs NOPA rendered 88 fs pulses at 532 nm with a bandwidth of 6 nm (time bandwidth product of 0.55) from about 500 seed photons. For ps operation the lower damage threshold of the BBO amplifier crystals for ps pulses had to be overcome by long crystal lengths. The resulting ps NOPA was tunable over a wide range in the NIR by tuning the fiber coupled seed and had a spectral bandwidth of only 0.86 nm (at 1.53  $\mu$ m) with a clean Gaussian distribution.

Q 19.2 Di 10:45 5K

**Circular phase mask for control and enhancement of femtosecond optical filamentation** — ●THOMAS PFEIFER<sup>1,2</sup>, LUKAS GALLMANN<sup>1,2</sup>, MARK J. ABEL<sup>1,2</sup>, PHILLIP M. NAGEL<sup>1,2</sup>, DANIEL M. NEUMARK<sup>1,2</sup>, and STEPHEN R. LEONE<sup>1,2</sup> — <sup>1</sup>Departments of Chemistry and Physics, University of California, Berkeley, CA 94720, USA — <sup>2</sup>Chemical Sciences Division, Lawrence Berkeley National Laboratory, Berkeley, CA 94720, USA

Optical filamentation is an interesting alternative to gas-filled hollow-core fibers for applications in supercontinuum generation and pulse compression to the few-cycle limit. The output characteristics of the optical filamentation process are critically dependent on the stability of the laser system and spatial quality of the laser beam. Imprinting circular phase masks onto the beam prior to filamentation can be used to improve crucial characteristics of the optical filaments: spectral bandwidth and beam pointing stability [1]. A simulation was developed which indicates that the imprinted phase mask could result in a better pointing stability after the filament than the pointing of the laser beam that produced it.

Ref.: [1] T. Pfeifer et al., Opt. Lett. **31**, 2326 (2006).

Q 19.3 Di 11:00 5K

**Amplification of Shaped Supercontinuum from a Photonic Crystal Fiber** — ●JENS MÖHRING, TIAGO BUCKUP, BERNHARD VON VACANO, and MARCUS MOTZKUS — Physikalische Chemie, Philipps Universität Marburg, D-35032 Marburg, Germany

Ultrafast spectroscopy applications require the generation of intense and broadband ultrashort pulses. To achieve the respective optical bandwidth, supercontinuum (SC) can be generated in photonic crystal fibers (PCF) with great flexibility. When pumped by an amplified femtosecond laser system, a PCF generated supercontinuum can be used for seeding in parametric amplification. In this work, we present the amplification of a phase modulated supercontinuum from a PCF in a single stage noncollinear parametric amplifier (nc-OPA). A pulse shaper is used for complete phase management of the SC pulse before the amplifier stage. This approach allows the generation of intense Fourier-limited pulses after the amplification stage, without the need of any additional compressor behind the parametric amplifier. Besides that, complex phase modulation of the amplified pulse can also be easily obtained by phase control of the SC seed pulse. We show compression, complex phase modulation and amplification of a 14 fs supercontinuum pulse at 700 nm.

Q 19.4 Di 11:15 5K

**Flexible Dispersion Control for Ultrashort Laserpulses** — ●GEORG GADEMANN, KONSTANTIN SIMEONIDIS und JOACHIM ULLRICH — Max-Planck-Institut für Kernphysik, 69117 Heidelberg

The compression of ultrashort laser pulses by filamentation in a noble gas is an easy and efficient method to approach the one cycle limit for laser pulses. These afterwards can be used to produce single attosecond light pulses through high harmonic generation. Used in pump probe experiments these attosecond light pulses yield a higher time resolution. The presented setup for filamentation is based on previous works [1].

On such short time scales it is of particular importance to have good means of compensating dispersion which is introduced by air and optical material. In our case the remaining dispersion is compensated for by a multi level setup. This setup consists of a chirped mirror pair, prism compressor and deformable mirror. Using the combination of those different parts we are able to flexibly react on changing configurations and variation of experimental parameters while ensuring optimal compression. Furthermore active pulse shaping is also possible.

Particularly innovative is the use of the deformable mirror, wherein the spectral phase information measured by ZAP-SPIDER method can be directly used for compensation. Especially residual higher order chirp can efficiently be adjusted.

[1] C.P.Hauri and J.Biegert and U.Keller Generation of intense view-cycle laser pulses through filamentation - parameter dependence Optics Express **19** 7541-7547 (2005)

Q 19.5 Di 11:30 5K

**Tunable ultrashort laser pulses generated through filamentation in gases** — ●A. BECKER<sup>1</sup>, F. THEBERGE<sup>2</sup>, N. AKOZBEK<sup>3</sup>, W. LIU<sup>2</sup>, and S.L. CHIN<sup>2</sup> — <sup>1</sup>Max-Planck-Institut für Physik komplexer Systeme, Nöthnitzer Str. 38, 01187 Dresden — <sup>2</sup>COPL, Université Laval, Québec G1K 7P4, Canada — <sup>3</sup>Time Domain Corporation, Huntsville, Alabama 35806, USA

Tunable and stable ultrashort laser pulses in the visible spectrum are generated with high efficiency by four-wave-mixing process during filamentation of near-infrared and infrared laser pulses in gases. It is shown [1] that these tunable ultrashort pulses have a very low energy fluctuation and an excellent mode quality due to the processes of intensity clamping and self-filtering in the filament.

[1] F.Théberge et al., Phys. Rev. Lett. **97**, 023904 (2006).

Q 19.6 Di 11:45 5K

**Short-pulse optical parametric chirped-pulse amplification (OPCPA) for the generation of high-power few-cycle pulses** — ●ANDREAS HENIG<sup>1,2</sup>, JÓZSEF FÜLÖP<sup>1,2</sup>, SZUSZANNA MAJOR<sup>1</sup>, SEBASTIAN KRUBER<sup>1</sup>, JENS OSTERHOFF<sup>1</sup>, RAINER HÖRLEIN<sup>1,2</sup>, FERENC KRAUSZ<sup>1,2</sup>, and STEFAN KARSCH<sup>1</sup> — <sup>1</sup>Max-Planck-Institut für Quantenoptik, Hans-Kopfermann-Str. 1, D-85748 Garching, Germany — <sup>2</sup>Department für Physik, Ludwig-Maximilians-Universität München, Am Coulombwall 1, D-85748 Garching, Germany

In order to combine ultrashort pulse durations in the few-cycle regime with high pulse energies, we propose to pump an OPCPA chain with TW-scale short pulses (100 fs – 1 ps) delivered by a conventional CPA laser system. This approach inherently improves the conditions for generating high-power ultrashort pulses using OPCPA in the following ways. The short pump-pulse duration firstly reduces the necessary stretching factor for the seed pulse, thereby increasing stretching and compression fidelity. Secondly, it allows for a much higher contrast. In addition, the significantly increased pump power makes the use of thinner OPCPA crystals possible, which implies an even broader amplification bandwidth, thereby allowing for even shorter pulses.

We present experimental results of the first stage of a multi-stage OPCPA setup pumped by the frequency doubled output of our ATLAS TW-scale Ti:Sapphire laser located at MPQ. The final system is expected to deliver high-energy ( $\sim 100$  mJ) few-cycle ( $\sim 5$  fs) pulses, which together with the inherently optically synchronized pump laser will be ideally suited for future pump-probe experiments.

Q 19.7 Di 12:00 5K

**Tunable pulses from below 300 to 950 nm with durations down to 12 fs from a 2 MHz Yb-doped fiber system** — CHRISTIAN SCHRIEVER, PATRIZIA KROK, ●STEFAN LOCHBRUNNER, and EBER-

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For many applications in spectroscopy, imaging, and machining, ultrafast low energy pulses at a high repetition rate are required. Fiber based femtosecond lasers are promising sources, however, they are not tunable which limits their application areas. We developed a noncollinearly phase matched optical parametric amplifier (NOPA) [1] for high repetition rates that not only provides the necessary tunability but also shortens the pulses by more than a factor of 10. A commercial 2 MHz Yb-doped fiber oscillator / fiber-amplifier system (IMPULSE; Clark-MXR, Inc.) delivering 10  $\mu\text{J}$  pulses at 1035 nm is used as pump. Its output is first frequency doubled, then the green is split off for pumping

the NOPA stage while the remainder is used for continuum generation. The NOPA provides a tuning range of 600 - 950 nm with pulse energies up to 850 nJ. Due to the noncollinearity, the bandwidth can reach as much as 175 nm with a Fourier limit of 11 fs. With a fused silica prism sequence pulses at 865 nm were compressed to 11.9 fs and at 720 nm to 17.7 fs. Frequency doubling the NOPA output allows to access the spectral region of 300 - 475 nm and subsequent sum frequency mixing with NIR pump light reaches 233 - 326 nm. Applying these schemes, pulses at 427 nm were generated with an internal efficiency of 15% and pulses at 303 nm with 18% for the second step.

[1] T. Wilhelm, J. Piel, and E. Riedle, *Opt. Lett.* **22** 1494, (1997).