Q 30: Poster Nichtlineare optische Effekte und Lichtquellen

Zeit: Dienstag 16:30–18:30 Raum: Poster C

Q 30.1 Di 16:30 Poster C

Diodengepumpter cw-OPO aus MgO:PPLN für Anwendungen in der Frequenzkonversion von Einzelphotonen — •Sebastian Zaske[1,2], Peter Haag[1], Johannes L'huillier[1] und Christoph Becher[2] — [1]Technische Universität Kaiserslautern, Fachbereich Physik, Erwin-Schrödinger-Strasse 46, 67663 Kaiserslautern — [2]Universität des Saarlandes, Fachrichtung 7.3, Postfach 151150, 66041 Saarbrücken

Ein elementarer Bestandteil quantenkryptographischer Verfahren ist eine Lichtquelle, die deterministisch einzelne Photonen emittiert. Eine neuartige Realisierungsmöglichkeit für diese Lichtquellen sind Si-basierte Defektzentren in Diamant [1] mit Emissionen im nahinfraroten Spektralbereich bei 737 nm. Für die Entwicklung langreichweitiger Quantennetzwerke ist die Konversion der Einzelphotonen in den Wellenlängenbereich der Telekommunikationsfenster (1550 nm) unabdingbar. Eine interessante Möglichkeit für diesen Konversionsprozess ist die Differenzfrequenzerzeugung (DFG) mit der Pumpquelle bei 1405 nm. Bei dieser Wellenlänge existieren bisher keine geeigneten Halbleiter- oder Festkörperlaser genügend hoher Leistung. Im Rahmen unserer Untersuchungen wurde daher ein Diodenlaser gepumpter cw-OPO auf Basis eines periodisch gepolten MgO dotierten $LiNbO_3$ (MgO:$LiNbO_3$) realisiert, der Strahlung bei 1405 nm erzeugt. Die experimentellen Ergebnisse zu dem OPO sowie den aktuellen Stand der Experimente zur Frequenzkonversion der einzelnen Photonen im DFG Prozess werden vorgestellt.

[1] C. Wang et al., J. Phys. B: At. Mol. Opt. Phys. **39**, 37 (2006).

Q 30.2 Di 16:30 Poster C

High-order harmonic generation as a possible seed source for the BESSY-FEL — •Torsten Leitner, Atoosa Meseck, and Eberhard Jaeschke — Berliner Elektronenspeicherring-Gesellschaft für Synchrotronstrahlung m.b.H., Germany

The "Berliner Elektronenspeicherring-Gesellschaft für Synchrotronstrahlung"(BESSY) is planning to build a free electron laser (FEL), which is based on the concept of high-gain harmonic generation. In this concept, the FEL process is initiated by an external light field, the so-called seed. It is planned to use tunable lasers as seeding sources with wavelengths ranging from 230 nm to 460 nm. After this, a cascade of undulator–magnetic delay–undulator units has to be passed, where in each unit the light field is converted to a higher harmonic order until the desired output of 1 nm to 51 nm is achieved. A new approach is seeding directly at shorter wavelengths close to or in the final output range. To produce these short wavelengths high-order harmonic generation (HHG) in gases can be used. If a gas is irradiated by a high intensity laser, some of the atoms are ionized. Upon recombination, the atoms coherently radiate at integer multiples of the fundamental laser frequency. For this purpose a numerical simulation based on the "strong-field approximation"after M.Lewenstein et al. was developed, which calculates the single atom spectra and the propagation of the produced light through the gas. Using this radiation as the seed, the FEL process is analyzed via a Genesis 1.3 simulation, with special attention on the tranversal behavior of the seed and the produced FEL-light, as well as the frequency filtering effects in the FEL radiator.

Q 30.3 Di 16:30 Poster C

Development of the mid-IR CW narrowband 5 - 15 μm tunable laser source for molecular spectroscopy — •Sergey Vasilyev, Alexander Nevsky, and Stephan Schiller — Institut fuer Experimentalphysik, Heinrich-Heine-Universitaet Duesseldorf

Specific features of molecular gases spectra in mid-IR (MIR) range attract a growing interest for a number of applications. Yet, many promising results have remained confined to laboratories for lack of suitable MIR laser sources. The objective of our research project is the development of a widely tunable narrowband MIR laser source, emitting from 5 to 15 μm. This source will be based on an optical parametric oscillator (OPO) using as nonlinear frequency converting medium a semiconductor crystal: Orientation-Patterned Gallium Arsenide (OP-GaAs). A tunable Thulium-doped fiber laser MOPA at 1.8-2 μm will be used as the OPO pump.

First-order quasi-phase-matched difference frequency generation (DFG) and second harmonic generation (SHG) in OP-GaAs crystal have been investigated on the preliminary stage of the research project. The OP-GaAs sample with 14 mm length and 27.6 μm grating period has been used in both experiments. Narrowband tunable lasers at 1.56 μm (1 W EDFA) and 3.6 μm (30 mW PPLN OPO) were mixed to obtain sub-μW DFG output at 2.76 μm. The same PPLN OPO source, but tuned to the 3.14 μm, was used for SHG experiment. Measured power levels and QPM bandwidths were found to be in agreement with theoretical estimates, indicating good uniformity of tested OP-GaAs crystal sample.

Q 30.4 Di 16:30 Poster C

Effiziente Frequenzverdopplung von Laserlicht der Wellenlänge 738 nm — •T. Collath[1], L. Bohatý[2], P. Becker[2] und Chr. Wunderlich[1] — [1]Universität Siegen, Institut für Physik, Walter-Flex-Straße 3, 57072 Siegen — [2]Universität Köln, Institut für Kristallographie, Zülpicher Straße 49b, 50674 Köln

Zur Laserkühlung und zum zustandsselektiven Nachweis von Ytterbium-Ionen, gespeichert in einer Paul-Falle, auf der optischen Resonanz $^2S_{1/2}, F = 1 \leftrightarrow {}^2P_{1/2}, F = 0$ wird Laserlicht der Wellenlänge 369 nm benötigt [1], das wir mittels eines Ti:Saphir Lasers (738 nm) und Frequenzverdopplung erzeugen. Für diese Wellenlängen können die nichtlinearen optischen Kristalle Lithiumtriborat (LiB_3O_5), β-Bariumborat β-BaB_2O_4), Lithiumiodat ($LiIO_3$) und Bismuttriborat (BiB_3O_6) zum Einsatz kommen [2]. Ein Ringresonator in symmetrischer Doppel-Z Konfiguration dient zur Leistungsüberhöhung. Um die Frequenzkonversionseffizienz zu optimieren werden die Parameter des Resonators (Fokusdurchmesser, Länge, Brennweite und Abstand der Hohl- und Planspiegel, Einfallswinkel) auf das verwendete nichtlineare Medium abgestimmt. Zur Verbesserung der Langzeitstabilität soll eine kurze Resonatorlänge verwirklicht und das Gehäuse des Resonators aus einem Block gefertigt werden. Ein für den genannten Zweck optimiertes System wird vorgestellt.

[1] Chr. Wunderlich, Chr. Balzer, Adv. At. Mol. Opt. Phys. **49**, Academic Press, 295 (2003).

[2] D.N. Nikogosyan, *Nonlinear Optical Crystals: A Complete Survey.* Springer, New York, 2005.

Q 30.5 Di 16:30 Poster C

Spektrale Formung von Weißlicht-Filamenten — •Alexander Sävert[1], Marcus Beutler[1], Sebastian Höfer[1] und Roland Sauerbrey[2] — [1]Institut für Optik und Quantenelektronik, Jena — [2]Forschungszentrum Dresden Rossendorf, Dresden

Untersuchungen der letzten Jahre haben gezeigt, dass Laserpulse mit Leistungen oberhalb von einigen 10 GW Lichtfilamente in Luft bilden. Wir untersuchen die Beeinflussung der Ausbreitungseigenschaften ultrakurzer intensiver Pulse in optischen Materialien mit phasenmodulierten Lichtimpulsen. Mit Hilfe von evolutionären Algorithmen wurden Impulsformen gefunden, die das Weißlichtspektrum verbreitern bzw. in bestimmten Spektralbereichen intensivieren.

Q 30.6 Di 16:30 Poster C

Optimierte Erzeugung Hoher Harmonischer mittels Pulsformung und Strahlcharakterisierung der Röntgenstrahlung — •Robert Spitzenpfeil, Stefan Eyring, Jan Lohbreier, Dominik Walter, Matthias Weger und Christian Spielmann — Universität Würzburg, Physikalisches Institut, Lehrstuhl für Experimentelle Physik 1

Die von einem standard tabletop Ti:Sa Lasersystem (800nm, 1kHz, 1mJ, 30fs) erzeugte Strahlung wird zur spektralen Verbreiterung durch Selbstphasenmodulation in eine Gaszelle geleitet. In dieser entsteht ein stabliles, selbstführendes Filament. Durch räumliche Formung der Phasenfront vor Eintritt in die Gaszelle durch einen 2D LCD Pulsformer, wird das Filament so beeinflußt, so daß das u.A. der räumliche Chirp der Spektrums minimiert wird. Hierdurch steht der gesamte Querschnitt des Strahls zur anschließenden Rekompression in einem Prismenkompressor zur Verfügung. Mit diesen nun kurzen und intensiven Pulsen erzeugen wir die Hohen Harmonischen in einem Gas-Jet. Die räumliche Charakterisierung der erzeugten Röntgenstrahlen erfolgt mittels eines Knifeedge-Scanners zur M^2 Bestimmung und eines Hartmann-Sensors zur Messung der Phasenfront des Strahls.

Q 30.7 Di 16:30 Poster C

The dependence of the Fe K_α yield on the chirp of the

femtosecond exciting laser pulse — •Martin Silies[1,2], Steffen Linden[1,2], Henrik Witte[1,2], and Helmut Zacharias[1,2] — [1]Physikalisches Institut, Westfälische Wilhelms-Universität, Münster — [2]Centrum für Nanotechnologie, Münster

The hard x-ray yield generated with femtosecond laser pulses is studied for differently chirped irradiating laser pulses. The radiation of a Ti:sapphire CPA laser system (29 fs, 750 μJ, 1 kHz) is focussed onto a iron containing solid state target producing incoherent hard x-ray radiation, Bremsstrahlung as well as target-specific K_α and K_β lines. The hard x-ray yield has been optimized by introducing negative and positive group delay dispersion (GDD) and third order dispersion (TOD) to the femtosecond laser pulse. The K_α yield could be enhanced by a factor of 1.7 and reached $1.9 \cdot 10^8$ Fe K_α photons/s in 4π with the laser pulse positively chirped, and $1.5 \cdot 10^8$ Fe K_α photons/s in 4π with the pulse negatively chirped. When the pulse energy is lowered to about 400 μJ the yield maximum vanishes and only the maximum at positive chirp remains. We explain the behaviour with induced third order dispersion that led to an asymmetric change of the pulse structure. Furthermore the diameter of the x-ray source has been determined by using a pinhole camera to be about 10 μm (FWHM) and therefore also smaller than the diameter of the applied laser pulse. The diameter of the x-ray source was also independent of the chirp of the laser pulse showing that the expansion of the plasma due to the increased pulse duration is negligible.

Q 30.8 Di 16:30 Poster C

The fiber amplifier system for laser cooling of indium atoms

— •Jae-Ihn Kim, Dietmer Haubrich, and Dieter Meschede — Institute for applied physics, University of Bonn, Bonn, Germany

A fiber amplifier system at $\lambda = 976$ nm is demonstrated, which will form the basis for the generation of ultra-violet light at 325 nm, a resonant transition($|5^2D_{5/2},F=7\rangle$-$|5^2P_{3/2},F=6\rangle$) of indium. We have employed a special Yb-doped double-clad fiber(YDCF) in which the inner cladding has a small diameter to increase the pump overlap factor as well as air-hole structures around the inner cladding to increase the numerical aperture. The performance of the YDCF system, such as the slope efficiency and the spectral and polarization characteristics of the output were investigated. The output of the YDCF amplifier will ultimately be frequency-trippled through the use of enhancement cavities.

Q 30.9 Di 16:30 Poster C

Towards the detection of single chromium centers

— •Anoush Aghajani-Talesh, Jimmy Sebastian, Axel Griesmaier, and Tilman Pfau — Universität Stuttgart, 5. Physikalisches Institut

In order to demonstrate the ability of controlled single atom deposition using ultracold chromium, we require reliable methods for the preparation and detection of single chromium atoms. A novel approach tries to convert single deposited chromium atoms into Cr^{3+} centers. It uses an optical detection scheme based on a confocal microscope to detect photo luminescence from single Cr^{3+} centers in a transparent substrate.

Using indiffusion and ion-implantation techniques we have incorporated chromium in lithium niobate ($LiNbO_3$). In $LiNbO_3$, chromium impurities predominantly occur as octahedrally coordinated Cr^{3+}-ions, which decay via a broadband ${}^4T_2 \rightarrow {}^4A_2$ transition with a peak wavelength of 850 nm and lifetime of 10 μs. Using a confocal microscope setup, we were able to perform spatially resolved luminescence measurements. Our results indicate that the detection of single Cr^{3+} centers is feasible, provided the host substrate is sufficiently pure. We therefore extended our investigations to ultra pure fused silica (SiO_2).

Q 30.10 Di 16:30 Poster C

Rb filled Hollow Core Photonic Band-Gap Fibre

— •Wenjia Zhong[1], Christoph Marquardt[1], Ulrik L. Andersen[2], and Gerd Leuchs[1] — [1]Institute of Optics, Information and Photonics (Max Planck Research Group), University of Erlangen-Nuremberg, Günther-Scharowsky-Str. 1, Building 24, 91058 Erlangen, Germany — [2]Department of Physics, Technical University of Denmark, Building 309, 2800 Kgs. Lyngby, Denmark

Hollow core photonic band-gap fibres can guide light in the inner hollow core, surrounded by a microstructure that creates a photonic band-gap. If the hollow core is filled with gaseous or liquid media, a collimated beam with a diameter of only a few micrometers could be guided over many meters inside the media. This is ideal for achieving self-induced transparency (SIT) solitons over large distances.

We developed a method for filling Rb into hollow core fibres. We plan to evaporate the Rb inside the fiber and exploit the nonlinearity inherent in detuned SIT for the generation of squeezed states.

Q 30.11 Di 16:30 Poster C

A precise laser spectrometer for optical cavities

— •Simone Bux, Sebastian Slama, Gordon Krenz, Claus Zimmermann, and Philippe Courteille — Physikalisches Institut der Universität Tübingen, Deutschland

We analyze the coupled dynamics of ultracold atomic clouds interacting with the modes of an optical high-finesse resonator. Therefore, a precise control of the laser frequency is necessary. To avoid excessive heating of the atomic cloud by Rayleigh scattering, the light should be tuned far away from an atomic resonance and the amount of injected laser power should be low. In practice, however, to generate collective coupling, the atom-light detuning has to be sufficiently small. Also, the stabilization of the laser to a cavity resonance requires a minimum amount of injected light.

We present a simple scheme for a laser spectrometer circumventing this problem. We are using two lasers, one probing the cavity resonance on a higher TEM-mode not interfering with the atoms. The other one is close to an atomic resonance and phase-coherently stabilized on the first laser, so that it can be tuned over a cavity resonance. Furthermore, it can be switched quickly. We will present first experimental results of this locking scheme.