Q 59: Lasers II

Time: Friday 11:00–13:00 Location: HS 1015

Q 59.1 Fri 11:00 HS 1015

Low Repetition Rate Optical Frequency Combs for Precision Spectroscopy — •Muhammad Thariq[1], Francesco Canella[1,2,3], Johannes Weitenberg[1,4], Fabian Schmid[1,5], Paras Dwivedi[1,6], Gianluca Galzerano[3], Theodor W. Hänsch[1,6], Thomas Udem[1,6], and Akira Ozawa[1] — [1]Max-Planck-Institut für Quantenoptik, 85748 Garching, Germany — [2]Dipartimento di Fisica, Politecnico di Milano, 20133 Milan, Italy — [3]Istituto di Fotonica e Nanotecnologie - Consiglio Nazionale delle Ricerche, 20133 Milan, Italy — [4]Fraunhofer-Institut für Lasertechnik ILT, 52074 Aachen, Germany — [5]Institute for Quantum Electronics, ETH Zürich, 8093 Zurich, Switzerland — [6]Fakultät für Physik, Ludwig-Maximilians-Universität München, 80799 Munich, Germany

High harmonic generation (HHG) can be used to generate extreme ultraviolet (XUV) frequency combs (FCs) for precision spectroscopy. Unfortunately, HHG requires very high peak power for frequency conversion. In this work, we propose to use a low repetition rate FC to drive HHG, where the repetition rate is reduced using an AOM-based pulse picker, while the peak power of the FC is increased, allowing HHG to be performed at moderate average powers. A 40 kHz repetition rate FC is demonstrated from a 40 MHz repetition rate mode-locked Yb:KYW oscillator. Pulse amplification to 4.175 μJ pulse energy is achieved using multi-stage Yb:LuAG amplifiers, with future plans to reach up to 50 μJ. The results show the prospect of generating XUV frequency combs with average powers below 10 W, making XUV FCs more accessible to researchers across disciplines.

Q 59.2 Fri 11:15 HS 1015

Methods for focusing VUV laser light onto a single ^{229}Th ion — •Tamila Rozibakieva[1], Irtiza M. Hussain[1], Lilli Löbell[1], Daniel Moritz[1], Kevin Scharl[1], Johannes Weitenberg[2], Markus Wiesinger[1], Stephan H. Wissenberg[2], and Peter G. Thirolf[1] — [1]Ludwig-Maximilians-Universität München (LMU) — [2]Fraunhofer Institute for Laser Technology (ILT), Aachen

Direct frequency-comb spectroscopy is a promising way for narrow-band nuclear laser excitation. The combination of a VUV frequency comb being developed at Fraunhofer ILT and a cryogenic Paul trap set up at LMU Munich as part of the ERC synergy project "Thorium Nuclear Clock", will enable us to excite the isomeric first excited state in ^{229}Th using laser radiation of 148.7 nm wavelength, an important step towards the realization of a nuclear clock that can be used to search for new physics beyond the standard model. For the single-ion nuclear clock, a laser-cooled $^{229}Th^{3+}$ ion must be irradiated with a single mode of a frequency comb with narrow bandwidth. When focusing to a spot with a diameter of 3 μm, we envisage sufficient laser radiation intensity for driving nuclear Rabi oscillations. For such tight focusing of a VUV beam on a single ion, it is important to choose the proper optical elements that minimize optical aberrations and power losses due to interaction with optical materials. Different methods and simulations for focusing a VUV beam down to 3 μm, such as a spherical mirror, an off-axis parabolic mirror and an achromatic lens, will be presented. Funding: ERC Synergy project, Grant Agreement No. 856415 and BaCaTec (grant 7-2029-2).

Q 59.3 Fri 11:30 HS 1015

Spectroscopic isotope separation in hot rubidium vapor — •Timon Damböck[1], Denis Uhland[1], Gunnar Langfahl-Klabes[1], Robert Löw[2], and Ilja Gerhardt[1] — [1]Leibniz Universität Hannover, Appelstrasse 2, 30167 Hannover — [2]Universität Stuttgart, Pfaffenwaldring 57, 70569 Stuttgart

Whether for medical applications, radiation protection or the utilization in physical metrology – having access to a pure or enriched amount of a single isotope can be a major advance. Natural abundant rubidium is composed of ^{85}Rb and ^{87}Rb. Since these isotopes differ in their nuclear spin, the hyperfine groundstates are spectrally well separated. Our experimental setup consists of two vapor cells which are interconnected by a capillary. Resonant high power lasers are used to exert a light induced drift on the individual rubidium isotopes [1]. Changes in isotope concentration in the cells are measured using absorption spectroscopy. This talk will discuss our progress to enrich and separate rubidium isotopes in hot atomic vapor using light induced drift.

[1] Okamoto, M. et al. Observation of Light-Induced Drift Effect of Rubidium by Using Two Diode Lasers for Pumping and Re-Pumping. Materials Transactions. 49, 11 (2008), pp. 2632-2635.

Q 59.4 Fri 11:45 HS 1015

Bioelectronics with ultrashort pulses — •Hrvoje Skenderović[1], Mario Rakić[1], and Vedran Djerek[2] — [1]Institute of Physics, Bijenicka cesta 46, 10000 Zagreb, Croatia — [2]Physical Department University of Zagreb, Bijenička cesta 32 cesta

Two dimensional golden electrodes are drawn on a flexible polyimide sheet by ultrashort laser pulses. Laser parameters for efficient ablation of the metal (about 10 nm thin) without damaging the PI substrate (about 50 micrometers thin) were investigated. The fabrication is optimised by spatial beam shaping.

Q 59.5 Fri 12:00 HS 1015

Nonliner Dynamics in Optical fibers for Sensing — •Glitta Rosalia Cheeran, Bennet Fischer, and Mario Chemnitz — Leibniz Institute of Photonic Technology

The study of nonlinear dynamics in optical fibers has attracted significant attention due to their applications in multi-frequency laser engineering and nonlinear imaging. In particular, supercontinuum generation, a complex nonlinear process that leads to the generation of new frequencies over hundreds of terahertz, has emerged as a versatile ultra-broadband source of light. This complex process depends on various factors, including the properties of the input pulse and the optical fiber involved. Our objective is to exploit the phase and amplitude sensitivity of supercontinuum generation for sensing by examining alterations of the spectral features of the output spectrum when an ultrashort pulse travels through a highly nonlinear fiber. The aim is to comprehend this nonlinear behavior through numerical methods and utilize these dynamics to create highly sensitive devices that can measure both the amplitude and phase of a sample object with high accuracy. In the presentation, we will introduce the uncommon concept of utilizing supercontinuum generation as a sensor instead of a source. We demonstrate a model sensing system, featuring an artificial spectral resonance as a narrowband frequency window, called "bit", within the spectral bandwidth of a 100 fs input pulse defined around 1550 nm. The sensitivity of supercontinuum spectra is then measured using different statistical methods. The next step is to utilize the simulation to examine realistic gas or liquid resonances.

Q 59.6 Fri 12:15 HS 1015

Ophthalmic Surgeries with Picosecond Laser Pulses — •Michael Körber[1,2], Jakob Fellinger[3], Milan Fritsche[1], Andreas Giese[1], Konstantina Kostourou[4], Daniel Kopf[3], Manfred Kottcke[1], Francesco Luciani[5], Josef M. Schmidbauer[2,5], Jonathan Wenk[1], and Bernd Braun[1] — [1]Nuremberg Institute of Technology, Nuremberg, Germany — [2]Paracelsus Medical University, Nuremberg, Germany — [3]MONTFORT Laser GmbH, Götzis, Austria — [4]NANEO Precision IBS Coatings GmbH, Lindau, Germany — [5]Klinik Nürnberg Nord, Nuremberg, Germany

We demonstrate the advancement of various ophthalmic surgeries by using picosecond laser pulses. The surgeries evaluated were iridotomy, capsulotomy, selective laser-trabeculoplasty and lens fragmentation. The tests were executed on porcine eyes. We used a standard two-stage 12 ps laser and a novel ultra-compact 130 ps laser, as well as state-of-the art Nd:YAG nanosecond lasers as reference to current surgery methods. The picosecond results were significantly better in all aspects tested compared to nanoseconds: The pulse energy could be lowered to some tens of microjoule instead of some millijoule, and the tissue ablation is more precise, more deterministic and less frayed. Furthermore, we measured large differences in shock wave pressures between the pulse lengths. Similar differences were found for the heat input. The results could be transferred to human tissue samples and showed the same advantages. In summary, we achieved substantial benefits with picosecond laser pulses. Thus, the ultra-compact picosecond laser provides a stable basis for a new generation of ophthalmic lasers.

Q 59.7 Fri 12:30 HS 1015

Far-field petahertz sampling of plasmonic fields — •Kai-Fu Wong[1,2], Weiwei Li[3,4], Zilong Wang[3,4], Vincent Wanie[2], Erik Månsson[2], Dominik Hoing[1,5], Johannes Blöchl[3,4], Thomas

Nubbemeyer[3,4], Andrea Trabattoni[2,6], Holger Lange[1,5], Francesca Calegari[1,2], and Matthias F. Kling[3,4,7] — [1]The Hamburg Centre for Ultrafast Imaging, Universität Hamburg, Luruper Chaussee 149, 22761 Hamburg, Germany — [2]Center for Free-Electron Laser Science, DESY, Notkestr. 85, 22607 Hamburg, Germany — [3]Max Planck Institute of Quantum Optics, MPQ, Hans-Kopfermann-Straße 1, 85748 Munich, Germany — [4]Ludwig-Maximilians-Universität München, LMU, Am Coloumbwall 1, 85748 Munich, Germany — [5]Institute of Physical Chemistry, Universität Hamburg, Grindelallee 117, 20146 Hamburg, Germany — [6]Institute of Quantum Optics, Leibniz Universität Hannover, Welfengarten 1, 30167 Hannover, Germany — [7]SLAC National Accelerator Laboratory, Stanford University, 2575 Sand Hill Rd, Menlo Park, 94025 California, USA

We demonstrate the realtime observation of linear plasmonic fields by optical field sampling. A comparison between non-resonantly and resonantly excited samples shows that dephasing features of the resonantly excited case sustain into the far-field domain. Our findings also demonstrate the ability to manipulate the spectral properties of ultrashort laser pulses by plasmonic samples, which can act as metasurfaces.

Q 59.8 Fri 12:45 HS 1015

X-ray photon diagnostics at the European X-ray Free Electron Laser — •Jan Grünert, Joakim Laksman, Jia Liu, Wolfgang Freund, Tuba Conka Yildiz, Florian Dietrich, Naresh Kujala, Theophilos Maltezopoulos, and Andreas Koch — European XFEL, Holzkoppel 4, 22869 Schenefeld

The European X-ray Free-Electron Laser (European XFEL), the world's largest and brightest X-ray free-electron laser, went into operation in 2017. It is a large-scale accelerator-based photon source that provides beams of ultrashort (femtosecond), highly coherent and very intense (exceeding 10^{13} photons per pulse) X-ray pulses at high repetition rate (up to 4.5 MHz) to scientific users in various fundamental science fields like bio-molecular dynamical structure determination, femtosecond chemistry, materials research under extreme conditions and many more.

This contribution provides an overview of the x-ray photon diagnostics for this facility, the diagnostics commissioning and their application for commissioning of the facility as well as exciting results from the first years of user operation. The beam properties assessed by photon diagnostics include per-pulse intensity, beam position and shape, lateral dimensions, spectral properties and temporal characteristics.

This contribution strives to provide an overview for newcomers to the field of ultrafast X-ray science, but at the same time include new developments and recent results, which will be mentioned for the experts.