Q 20: Ultrashort Laser Pulses and Biophotonics

Time: Tuesday 14:00–15:45 Location: f435

Q 20.1 Tue 14:00 f435

Rescattering and space-charge trapping in strong-field photoemission from a macroscopically extruded nanoblade — •Timo Paschen[1], Ryan Roussel[2], Christian Heide[1], Lennart Seiffert[3], Joshua Mann[2], Björn Kruse[3], Philip Dienstbier[1], Thomas Fennel[3], James Rosenzweig[2], and Peter Hommelhoff[1] — [1]Department Physik, Friedrich-Alexander-Universität Erlangen-Nürnberg (FAU), 91058 Erlangen — [2]UCLA Physics and Astronomy, Los Angeles, CA 90095-1547 — [3]Institut für Physik, Universität Rostock, 18051 Rostock

We demonstrate strong-field-induced photoemission from a nanometer-sharp tungsten-covered silicon blade structure. The pronounced plateau and cut-off features observed in electron energy spectra confirm the presence of elastic rescattering in the enhanced near-fields at the surface of the one-dimensional nanostructure [1,2]. For highest intensities, charge densities in excess of 10^4 electrons per laser pulse and maximum kinetic energies of 1 keV are found. Furthermore, we find a change of photoemission regimes from a field-driven rescattering regime to space-charge limited emission. Accompanying time-dependent Schrödinger equation (TDSE) simulations, reproducing all salient features of the electron spectra, are presented. The above-mentioned observations make this new nanostructure a model system both for the investigation of rescattering on μm scales and light-matter interaction in the space-charge regime.

[1] M. Krüger et al., New J. Phys. 14, 085019 (2012).
[2] S. Thomas et al., New J. Phys. 17, 063010 (2015).

Q 20.2 Tue 14:15 f435

Saturated Femtosecond Stimulated Raman Scattering for Sub-Diffraction-Limited Label-Free Imaging — •Thomas Würthwein[1], Niels Irwin[1], and Carsten Fallnich[1,2] — [1]Institute of Applied Physics, University of Münster, Corrensstraße 2, 48149 Münster, Germany — [2]MESA+ Institute for Nanotechnology, University of Twente, Enschede 7500 AE, The Netherlands

We present a scheme for a sub-diffraction-limited Raman microscope. The scheme combines the concept from stimulated depletion microscopy with femtosecond stimulated Raman scattering. The suppression of the Raman signal in a three-beam setup with only two involved wavelength-components was accomplished by the saturation of the Raman scattering. A reduction of the Raman signal of up to 79 % could be measured, with only a single Raman resonance involved. Based on this signal suppression a resolution enhancement by a factor of 2 could be verified in a first proof-of-concept measurement, opening up a pathway towards label-free sub-diffraction-limited Raman imaging.

Q 20.3 Tue 14:30 f435

Characterization of sub-10 fs UV pulses using XPW dispersion scan — •Ayhan Tajalli[1,2], Thomas Kalousdian[3], Martin Kretschmar[3], Sven Kleinert[1,2], Uwe Morgner[1,2,4], and Tamas Nagy[3] — [1]Institute of Quantum Optics, Leibniz Universität Hannover, Hannover, Germany — [2]Cluster of Excellence PhoenixD (Photonics, Optics, and Engineering-Innovation AcrossDisciplines), Hannover, Germany — [3]Max Born Institute for Nonlinear Optics and Short Pulse Spectroscopy, Berlin, Germany — [4]Laser Zentrum Hannover e.V., Hannover, Germany

The characterization of ultrashort UV pulses is a rather challenging task, as these pulses are extremely prone to material dispersion and space-time distortions. Moreover, the pulse characterization techniques in this spectral region should adapt another form of nonlinearity than second harmonic or sum frequency generation processes, as the frequency converted signal might lie in difficult spectral ranges. Consequently, the well-known characterization techniques such as FROG have successfully implemented degenerate four-wave mixing processes. However, these techniques suffer from rather bad signal to noise ratio and low sensitivity due to necessity of splitting the wave front. Here, the measurement of 8 fs Deep-UV pulses is performed using a dispersion scan (d-scan) device. We incorporate cross-polarized wave generation, as the nonlinear process. Since d-scan has a single-beam geometry, no beam splitting is necessary, which dramatically improves the sensitivity of the measurement. Accordingly, we can measure Deep-UV pulses with energy as low as 85 nJ with high fidelity.

Q 20.4 Tue 14:45 f435

Optical Kerr Gating with an ultrashort laser pulse — •Dominik Horstmann, Michael Stumpf, and Georg Pretzler — Institut für Laser- und Plasmaphysik, Heinrich-Heine-Universität Düsseldorf

We implemented an Optical Kerr Gate with switching times on a fs-time scale using an ultrashort laser pulse from the Ti:Sa-laser system PHASER in Düsseldorf. Therefore, the laser pulse is split into an intense gate beam and a less intense signal beam that are focussed on the Kerr medium under a very small angle. While the gate-beam must be well characterized for reproducible operation of the gate, a wide range of optical pulses (intensities, spectral content) can be diagnosed this way. In order to optimize the Kerr Gate we investigated different Kerr media such as fused silica and tellurite glasses. Furthermore, different signal pulses were applied. We show that the arrangement works reliably over a large range of parameters.

Q 20.5 Tue 15:00 f435

Attoseconds on a Chip - Time Domain Measurement of a Near-IR Transient — •Felix Ritzkowsky[1], Mina Bionta[2], Marco Turchetti[2], Yujia Yang[2], Karl Berggren[2], Franz Kärtner[1], and Phillip Keathley[2] — [1]Deutsches Elektronen Synchrotron (DESY) & Center for Free-Electron Laser Science, Notkestraße 85, 22607 Hamburg, Germany — [2]Research Laboratory of Electronics, Massachusetts Institute of Technology, 77 Massachusetts Avenue, Cambridge, MA 02139, USA

We report on a cross-correlation technique based on perturbation of local electron field emission rates that allows for the full characterization of arbitrary electric fields down to 4 fJ using plasmonic nanoantennas. Plasmonic nanoantennas in combination with ultrafast, few-cycle laser pulses allow for highly non-perturbative experiments that have previously only been demonstrated in the gas phase with high power, low repetition rate laser systems. By exploiting the plasmonic excitation in a metallic nanostructured device, electric field strengths exceeding $\sim$30 GV m^{-1} can be reached at the nanostructure with optical pulse energies of several tens of pJ. This enables sub-cycle attosecond electron bursts to be coherently driven by the electric near field of the plasmon, which we use to sample the near-infrared field-transients at the nanoantenna tip *in-situ*. These results are a strong indicator that this technique can resolve electric fields in amplitude and phase with a potential PHz bandwidth. Such an integrated field-sampler will enable time-domain spectroscopy methods similar to those that have been pioneered in the THz to be applied from the visible through the infrared.

Q 20.6 Tue 15:15 f435

$NaYF_4$:Yb,Er Upconversion Nanoparticles: Analysis of Energy Loss Processes — •Bettina Grauel[1], Christian Homann[2], Christian Würth[1], Ute Resch-Genger[1], and Markus Haase[2] — [1]Bundesanstalt für Materialforschung und -prüfung (BAM), Berlin — [2]Universität Osnabrück

Lanthanide-based upconversion nanoparticles are anti-Stokes emitters with narrow, sharp emission bands in the UV and Vis spectrum, while excited in the NIR. Their luminescence efficiency is affected by lattice defects (especially near the surface), solvent moluecules, surface ligands, and lanthanide doping concentrations, and can vary over several orders of magnitude. By using carefully-designed particles with different sizes, inert shell thicknesses, and doping concentrations, lifetimes and excitation power-dependent quantum yields are recorded and a comprehensive analysis of different energy loss channels is presented. The measurement results are underlined by simulations using a rate equation model system with a nine-level Erbium energy scheme.

Q 20.7 Tue 15:30 f435

Rapidly tunable all-fiber light source for live multicolor coherent Raman imaging — •Maximilian Brinkmann[1,2], Tim Hellwig[1,2], and Carsten Fallnich[1] — [1]Institute of Applied Physics, University of Münster, Germany — [2]Refined Laser Systems GmbH, Münster, Germany

We present multicolor coherent Raman imaging (CRI) with rapid wavelength tuning within only 5 ms between successive images. In order to visualize rapidly evolving or moving samples in coherent Raman imaging (CRI) with high chemical specificity, successive images at mul-

tiple vibrational resonances have to be acquired at video-rate speed. Recent approaches to video-rate multicolor CRI, based on parallel laser amplifiers or spectral focusing techniques, allowed wavelength switching on a timescale of (sub)milliseconds, but only across a bandwidth of 300 cm^{-1} at maximum, significantly limiting the chemical specificity. In contrast, the here presented light source is tunable within 5 ms across the wide spectral range between 700 and 3530 cm^{-1}. Therewith, the wavelength can be tuned in a frame-by-frame manner adequate for multicolor image acquisition with up to 100 frames/s. For a first demonstration, we have applied the light source for visualizing lipids and deuterated dimethyl sulfoxide (dDMSO) in mouse ear tissue with coherent anti-Stokes Raman scattering. Rapid switching of the excitation wavelengths to target 2130 cm^{-1} and 2845 cm^{-1} within only 5 ms allowed, without the need for a relative delay adjustment between pump and Stokes beam, to visualize how dDMSO has penetrated from the surface down to about 60 μm deep in the skin.