Q 60: Laser Applications I

Time: Friday 11:00–13:00 Location: a310

Q 60.1 Fri 11:00 a310

Evidence for influence of the final-state bandstructure on attosecond photoemission from metals — •Martin Schäffer — Max-Planck-Institut für Quantumoptik, 85748 Garching — Department für Physik, TUM, 85748 Garching

Since 2007, time-resolved photoemission from metals has been studied on the attosecond time-scale. Photoemission is triggered by subfemtosecond XUV photons, and the momentum and energy of the emitted photoelectron is then modulated by the vector potential of an synchronized femtosecond few-cycle NIR-laser-field(streaking). Temporal information of the photoemission can then be extracted with attosecond precision from the resulting spectrogram(electron energy vs. XUV-NIR delay). A lot of experimental results have been obtained, and variety of theoretical treatments aiming at the explanation of these results. However, clear discrimination of the distinct theories in experiment has not been possible till recently.

Here, we focus on the possible influence of the final-state bandstructure. In fact, in an streaking experiment from Magnesium at high XUV photon energies, we have obtained clear evidence that the final-state bandstructure has an effect on the delay in photoemission between electrons emerging from localized core states and from delocalized valence states. This is remarkable because this result clearly supports one of the theories in favor of the other approaches, namely the model of resonant and non-resonant emission. Hence, we made serious progress towards a better understanding of the photoemission process in the time domain.

Q 60.2 Fri 11:15 a310

Wavelength tunable high speed femtosecond pump probe spectroscopy based on supercontinuum generation — •Lukas Ebner, Nico Krauss, and Thomas Dekorsy — Universität Konstanz

Asynchronous optical sampling (ASOPS) based on two synchronized GHz repetition rate oscillators allows performing pump-probe measurements over a time-delay window of 1ns with a signal sensitivity and temporal resolution limited only by shot noise and the pulse duration, respectively [1-3]. Here, we extend the ASOPS scheme towards wavelength tunability by spectral broadening of a GHz repetition rate Ti:sapphire oscillator in a photonic crystal fiber. The resulting supercontinuum supports ultrashort pulses with central wavelengths around 550 nm and 850-1100 nm. First two-colour ASOPS measurements with a pump wavelength of 800 nm and a continuously tunable probe wavelength are demonstrated.

1. Bartels, A. et al., Rev. Sci. Instrum. 78, 035107 (2007). 2. Gebs, R. et al., Opt. Express 18, 5974-5983 (2010) 3. Krauß, N. et al., Opt. Express 23, 18288-18299 (2015)

Q 60.3 Fri 11:30 a310

Femtosecond Yb:KYW laser and applications in time-resolved spectroscopy — Nico Krauss, Gerhard Schäfer, •Changxiu Li, and Thomas Dekorsy — Department of Physics and Center of Applied Photonics, University of Konstanz, D-78457 Konstanz, Germany

High speed asynchronous optical sampling (ASOPS) is an important method for pump-probe experiments based on two femtosecond lasers without a mechanical delay line. An ASOPS system based on a GHz Yb:KYW oscillator and a Ti:sapphire oscillator is reported. The repetition rate offset between two oscillators is stabilized by a phase-locked loop to permit multi-kHz scanning rates. The GHz diode-pumped Kerr-lens mode-locked Yb:KYW oscillator with optical-to-optical efficiency of more than 45% is demonstrated. The time resolution of this system within 1 ns time window is below 350 fs and noise floor below 10^{-6} close to the shot-noise level within an acquisition time of 5 s can be achieved. We discuss applications of this two-colour pump-probe system.

Q 60.4 Fri 11:45 a310

Absolute frequency measurement and phase-locking of a THz quantum cascade laser with 10 GHz Ti:sapphire frequency combs — •Oliver Kliebisch[1], Dirk Heinecke[1], Thomas Dekorsy[1], Hua Li[2], Carlo Sirtori[2], Giorgio Santarelli[3], and Stefano Barbieri[2] — [1]Center for Applied Photonics, University of Konstanz, Konstanz — [2]Laboratoire Matériaux et Phénomènes Quantiques, Universite Paris Diderot, France — [3]Laboratoire Photonique, Numérique et Nanosciences, Université Bordeaux, France

Terahertz quantum cascade lasers (QCLs) play an important role as THz sources for high resolution spectroscopy [1] and frequency metrology. The challenge is to determine the absolute frequency of the QCL. With a dual-comb sampling technique using high repetition rate femtosecond lasers this can be accomplished without using additional frequency references for calibration. The QCL operates at 2.5 THz [2] and is injection locked at 9.72 GHz repetition rate. The femtosecond laser used for electro-optic sampling of the THz QCL electric field is a stabilized 10 GHz repetition rate Ti:sapphire laser [3] which is also used for phase locking the QCL by drive current modulation. Dual-comb spectroscopy is employed by sampling the phase-locked QCL with a second Ti:sapphire laser which is offset locked to the first Ti:sapphire laser. The two down-converted QCL spectra allow the determination of the absolute QCL frequency only limited by the stability and measurement precision of the RF beat mode. [1] L. Consolino et. al.. Nat. Commun., 3, 1040 (2012). [2] S. Barbieri, et. al., App. Phys. Lett 85 1674 (2004). [3] A. Bartels, et. al., Science, 326, 681 (2009).

Q 60.5 Fri 12:00 a310

Lasertätigkeit von Nd:Lu_2O_3 auf den Übergängen $^4F_{3/2} \rightarrow {}^4I_{13/2}$, $^4I_{11/2}$ und $^4I_{9/2}$ im nahen infraroten Spektralbereich — •Patrick von Brunn[1,2], Alexander Heuer[1,2] und Christian Kränkel[1,2] — [1]Institut für Laser-Physik, Universität Hamburg, Luruper Chaussee 149, 22761 Hamburg — [2]The Hamburg Centre for Ultrafast Imaging, Luruper Chaussee 149, 22761 Hamburg

Lu_2O_3 eignet sich hervorragend als Wirtsmaterial für Seltenerddotierte Festkörperlaser. Während mit Yb^{3+}-, Ho^{3+}-, Tm^{3+}- und Er^{3+}-dotiertem Lu_2O_3 bereits ausgezeichnete Laserresultate erzielt wurden, erfolgte bisher keine detaillierte Charakterisierung der Lasereigenschaften von Nd^{3+}-dotiertem Lu_2O_3. Hier berichten wir über unsere Ergebnisse zur Untersuchung der Lasertätigkeit von Nd:Lu_2O_3. Unter Ti:Saphir-Laser-Pumpen wurde Lasertätigkeit auf sechs Übergängen mit Wellenlängen zwischen 951 nm und 1463 nm mit differenziellen Wirkungsgraden von bis zu 65% realisiert. Die Wellenlänge von 1463 nm gehört dabei zu den längsten Wellenlängen, die jemals mit einem Nd-dotierten Kristall demonstriert wurden.

Q 60.6 Fri 12:15 a310

Anregung der Rydbergzustände n = 22, 51, 52 und 64 von $^{40}Ca^+$ mit Vakuum-Ultravioletten-Laserlicht — •Patrick Bachor[1,2], Matthias Stappel[1,2], Jochen Walz[1,2], Thomas Feldker[1] und Ferdinand Schmidt-Kaler[1] — [1]Quantum, Institut für Physik, Universität Mainz, 55099 Mainz — [2]Helmholtz-Institut Mainz, 55099 Mainz

Ein vielversprechender Ansatz für zukünftige Anwendungen in der Quanteninformation sind in Rydbergzustände angeregte Ionen, die in einer Paulfalle gezielt manipuliert werden können. Zum einen können so, aufgrund des für Rydbergzustände modifizierten Fallenpotentials, spezielle Vibrationsmoden designt werden. Zum anderen sind schnelle Verschränkungsoperationen mittels der großen Dipol-Dipol-Wechselwirkung möglich. Wir konnten bisher Anregungen von $^{40}Ca^+$ Ionen in die Niveaus n = 51F, 52F und 64F [1] sowie in das Niveau 22F beobachten.

Eine Herausforderung ist die Erzeugung des benötigten Lichtfeldes im Vakuum-Ultravioletten (VUV) bei 122 nm, die hier erläutert werden soll. Zudem werden die Fortschritte der Rydbergspektroskopie, die Zuordnung der Niveaus, sowie die Linienform in oszillierendem Feld der Paulfalle diskutiert.

[1] Phys.Rev.Lett. 115, 173001 (2015)

Q 60.7 Fri 12:30 a310

Measurement of the nonlinear refractive index of noble gases — Andreas Blumenstein[1], Milutin Kovacev[2], Uwe Morgner[2,3], Peter Simon[1], and •Tamas Nagy[1,2] — [1]Laser-Laboratorium Göttingen e.V., Hans-Adolf-Krebs-Weg 1, 37077 Göttingen — [2]Leibniz Universität Hannover, Welfengarten 1, 30167 Hannover — [3]Laser Zentrum Hannover e.V., Hollerithallee 8, 30419 Hannover

The nonlinear refractive index of rare gases were measured with high precision by characterizing the spectral broadening of short laser pulses

during propagation in a long hollow waveguide. In this way two common problems of nonlinearity measurements could be overcome: the precise determination of the actual light intensity and the accumulation of sufficiently large nonlinearity by using a well-defined geometry and large interaction length. As a result, reliable values could be extracted also for helium and neon which are notoriously difficult to measure due to their very low nonlinearity.

Q 60.8 Fri 12:45 a310

Driving circular currents in super atomic molecular orbitals of fullerenes by light carrying orbital angular momentum — •Jonas Wätzel, Yaroslav Pavlyukh, Alexander Schäffer, and Jamal Berakdar — Institut für Physik, Martin-Luther Universität Halle-Wittenberg, Karl-Freiherr-von-Fritsch-Str. 3, 06120 Halle/Saale

Endohedral molecular magnets are promising candidates for molecular electronics and quantum information processing. For utilization an ultrafast control of the local magnetization is inevitable. We suggest exploiting in Fullerenes the virtual, (super) atomic-like molecular orbitals (SAMOs) to photo-trigger current loops and hence localized magnetic pulses for magnetization

An effective method to steer magnetism is to use inhomogeneous, light carrying orbital angular momentum (OAM). In principle in presence of spin-orbital coupling one may drive the spin directly with such a beam but here we generate surface orbital moment that Zeeman-couples to the well isolated spin active states associated with the endohedral structure.

We found that the generated current is controllable by the frequency, the topological charge, and the intensity of the light. Utilizing Numerical and analytic calculations we find that a UV OAM fs pulse with an intensity 10^{13} W/cm^2 generates nA currents with an associated magnetic field on the scale of few hundreds μT in the centre of the fullerene.