HL 5: Ultra-fast Phenomena

Time: Monday 10:15–12:30 Location: H17

HL 5.1 Mon 10:15 H17

Microscopic description of non-linear polarization spectra of light-harvesting complexes — •Mario Schoth[1], Marten Richter[1], Thomas Renger[2], and Andreas Knorr[1] — [1]Institut für Theoretische Physik, Nichtlineare Optik und Quantenelektronik, Technische Universität Berlin, Germany — [2]Institut für Theoretische Physik, Theoretische Biophysik, Johannes Kepler Universität Linz, Austria

Ultrafast spectroscopic techniques, such as nonlinear polarization spectroscopy [1], are used to investigate photosynthetic systems of higher plants. Performed in the frequency domain, non-linear polarization spectroscopy (NLPF) permits simultaneous measurements of dephasing and energy relaxation rates up to tens of femtoseconds. Within a Bloch equation approach [2], we calculate NLPF spectra of light-harvesting complexes such as the water-soluble chlorophyll binding protein complex (WSCP) microscopically. Hereby, we include self-consistently structural data for the optical transition energies of pigments in protein environments and the spectral density of exciton-vibrational coupling [3]. Furthermore, the influences of inhomogeneous broadening of transition energies are discussed.

[1] W. Beenken, V. May, J. Opt. Soc. Am. B. 14, 11, 2804 – 2810 (1997)
[2] M. Richter, T. Renger, G. Renger, A. Knorr, J. Chem. Phys. 127, 075105 (2007)
[3] T. Renger et al., J. Phys. Chem. B, 111, 10487 – 10501 (2007)

HL 5.2 Mon 10:30 H17

Microscopic theory of two-dimensional THz spectroscopy in quantum well systems — •Sebastian Eiser[1], Marten Richter[1], Carsten Weber[1], Thi Uyen-Kahn Dang[1], Wilhelm Kuehn[2], and Andreas Knorr[1] — [1]Institute of Theoretical Physics, TU-Berlin, Germany — [2]Max Born Institute, Berlin, Germany

Pump-probe and n-wave-mixing experiments are important in order to reveal information about microscopic coupling mechanisms and structural/dynamical relationships. Varying the time delay between the incident pulses and recording the real time dynamics makes the technique inherently two-dimensional. It has been demonstrated in the THz regime [1] that with the combination of a collinear beam setup and electro-optical sampling all orders of n-wave-mixing can be observed at the same time. We have developed a theoretical model for a corresponding nonlinear two-dimensional spectroscopy. We numerically solve the equations of motions within a density-matrix approach, focusing on the influence of the electron-phonon interaction [2] on the nonlinear dynamics. Our investigations are performed on GaAs/AlGaAs quantum wells and show good agreement to experimental findings.

[1] W. Kuehn *et al.*, J. Chem. Phys. **130**, 1 (2009)
[2] S. Butscher *et al.*, Phys. Status Solidi B **241**, 11, R49 (2004)

HL 5.3 Mon 10:45 H17

The spatial structure of longitudinal and transversal fields in focussed terahertz beams — •Stephan Winnerl, Ralf Hubrich, Falk Peter, Harald Schneider, and Manfred Helm — Forschungszentrum Dresden-Rossendorf, Postfach 510119, 01314 Dresden, Germany

While for many applications the terahertz (THz) frequency range is the least technologically developed region of the electromagnetic spectrum, which is often referred to as the THz gap, this region offers unique research opportunities. For example, coherent detection of single cycle and few cycle pulses has been developed in the THz range and is now extended to the full infrared range.

Here we apply coherent detection via electro-optic sampling in ZnTe crystals of different orientation to study amplitude and phase of longitudinal and transversal field components in focused terahertz beams. The THz radiation is generated by two types of scalable photoconductive emitters. The electrode pattern is optimized for generation of linearly polarized beams in one case and radially polarized beams in the second case. We show that these beams can be described well as Bessel Gauss beams, which are solutions of the vector Helmholtz equation. Consistent with the theory we observe a larger amplitude and a smaller spot size for the longitudinal component of a radially polarized beam as compared to a similarly focused linearly polarized beam.

HL 5.4 Mon 11:00 H17

high-power soliton-induced supercontinuum generation and tunable sub-10-fs VUV pulses from kagome-lattice HC-PCFs — •song-jin im, anton husakou, and joachim herrmann — Max-Born-Institute for Nonlinear Optics and Short Pulse Spectroscopy, Max-Born-Str. 2a, D-12489 Berlin, Germany

We propose and theoretically study a novel approach for high-power optical supercontinuum generation in argon-filled kagome lattice hollow core-photonic crystal fibers (HC-PCFs). Argon-filled hollow waveguides with a kagome-lattice cladding are especially interesting for high-power spectral broadening because of anomalous dispersions in the visible and ultraviolet, large core diameters, and high ionization threshold of argon. We predict the generation of high-coherence two-octave broad spectra, with spectral peak power densities of MW/nm up to five orders of magnitude higher than in solid-core PCFs, and with high average coherence of 0.9999. The underlying mechanism differs in an important aspect from that in solid-core PCFs where the supercontinuum arises by the emission of several fundamental solitons; in contrast, in the case of a kagome lattice HC-PCF it arises from a single high-order soliton. A second predicted phenomenon is that the output radiation contains a sub-10-fs vacuum-ultraviolet pulse which carries about 20% of input energy corresponding to few tens of μJ. The spectrum of this pulse is a narrow-band VUV peak which can be tuned by pressure from 400 nm to 120 nm. These high-energy VUV pulses can be identified as the non-solitonic radiation from a high-order soliton at the stage of maximum compression.

15 Min. Coffee Break

HL 5.5 Mon 11:30 H17

Time resolved investigation and resonant sub harmonic driving of confined acoustic phonon modes in freestanding silicon membranes — Mike Hettich[1], •Axel Bruchhausen[1], Raphael Gebs[1], Florian Hudert[1], Daniel Issenmann[1], Olivier Schecker[1], Reimar Waitz[1], Artur Erbe[1], Elke Scheer[1], Adnen Mlayah[2], Jean-Roch Huntzinger[3], and Thomas Dekorsy[1] — [1]Department of Physics and Center of Applied Photonics, Universität Konstanz, Germany — [2]CEMES-CNRS, Université de Toulouse, France — [3]GES-UMR 5650, CNRS, Université Montpellier 2, France

The vibrational dynamics of thin silicon membranes have been investigated by asynchronous optical sampling (ASOPS)[1].

The small thickness of the silicon membranes leads to a confinement of the acoustic phonon modes and therefore to a discretization of the phonon frequency spectrum. Odd harmonics of the fundamental mode (19 GHz for a 221nm thick membrane) up to the 25th order have been observed [2].

In order to measure the phonon lifetimes which exceed the measurement window of 1.2ns the repetition rates of the pump and probe laser are tuned to a subharmonic of the fundamental mode. By using this approach the phonon modes are resonantly driven and in analogy to a mechanical resonator the lifetime and the quality factor of the phonon modes can be determined. We observe a Q-factor of 500 which is a significant value for a nanomechanical resonator at room temperatur.

[1] A. Bartels et al., Rev. Sci. Instr. 78, 035107 (2007).
[2] F. Hudert et al., Phys. Rev. B 78, 201307(R) (2009).

HL 5.6 Mon 11:45 H17

Experimental and theoretical investigations of photocurrents in non-centrosymmetric semiconductor quantum wells — •Huynh Thanh Duc[1], Jens Förstner[1], Torsten Meier[1], Shekar Priyadarshi[2], Ana Maria Racu[2], Klaus Pierz[2], Uwe Siegner[2], and Mark Bieler[2] — [1]Department of Physics and CeOPP, University Paderborn, Warburger Str. 100, D-33098 Paderborn, Germany — [2]Physikalisch-Technische Bundesanstalt, Bundesallee 100, D-38116 Braunschweig, Germany

We compute photocurrents generated by femtosecond single-color laser pulses in non-centrosymmetric semiconductor quantum wells by combining a 14x14 k.p band structure theory with multi-band semiconductor Bloch equations [1]. The transient photocurrents are investigated experimentally by measuring the associated Terahertz emission [2]. The dependencies of the photocurrent and the Terahertz emission on the excitation conditions are discussed for (110)-oriented GaAs quan-

tum wells. The comparison between theory and experiment shows a good agreement.

[1] M. Bieler, K. Pierz, U. Siegner, P. Dawson, H. T. Duc, J. Förstner, and T. Meier, Proc. SPIE, 7214, 721404 (2009).

[2] M. Bieler, K. Pierz, and U. Siegner, J. Appl. Phys. 100, 083710 (2006).

HL 5.7 Mon 12:00 H17

Time-resolved photoluminescence from undoped GaAs/$Al_{0.35}Ga_{0.65}As$ quantum wells quenched by pulsed mid-infrared radiation — •Sabine Zybell[1], Harald Schneider[1], Martin Wagner[1], Stephan Winnerl[1], Klaus Köhler[2], and Manfred Helm[1] — [1]Forschungszentrum Dresden-Rossendorf, Dresden, Germany — [2]Fraunhofer-Institut für Angewandte Festkörperphysik, Freiburg, Germany

There is much interest in the development of ultrafast devices with possible applications in optoelectronics. An important goal consists in ultrafast control of luminescence in light-emitting devices; it is therefore interesting to investigate the effect of abrupt changes in the carrier distribution on the luminescence signal. We present an experimental study of the effects of mid-infrared radiation (MIR) on the photoluminescence (PL) from undoped AlGaAs/GaAs quantum wells. Electron-hole pairs, created by weak near-infrared light pulses, were excited in the system while a delayed MIR pulse induces an ultrafast redistribution of free carriers that results in abrupt quenching of the PL with a subsequent PL recovery. The source of the MIR laser pulses was the free-electron laser facility FELBE at the Forschungszentrum Dresden-Rossendorf. In combination with the synchroscan streak camera, collecting the PL from the electron-hole recombination, it turned out to be a great spectroscopic tool for time-resolved measurements. Using a simple fit function we found PL recovery times between 40 and 150 ps depending on the MIR intensity.

HL 5.8 Mon 12:15 H17

Attosecond dynamics of plasmon formation — •Andrey Moskalenko, Yaroslav Pavlyukh, and Jamal Berakdar — Institut für Physik, Martin-Luther-Universität Halle-Wittenberg, Nanotechnikum-Weinberg, Heinrich-Damerow-St. 4, 06120 Halle, Germany

Using ab-initio methods we calculate the frequencies of collective excitations for a variety of finite systems, such as fullerenes and quasi-spherical large molecules [1]. To unravel how this collective dynamics unfolds upon fast excitations, based on our ab-initio results we developed a method, in the spirit of [2], that captures the ultrafast formation of plasmon modes due to the mean-field fluctuations. The results are illustrated for a pump-probe setup using attosecond XUV pulses.

[1] Y. Pavlyukh and J. Berakdar, Chem. Phys. Lett. 468, 313 (2009).

[2] K. Morawetz, P. Lipavsky, and M. Schreiber, Phys. Rev. B 72, 233203 (2005).