Q 56: Ultrakurze Laserpulse: Anwendungen 3

Time: Thursday 14:30–15:45 Location: SCH A215

Q 56.1 Thu 14:30 SCH A215

Role of Ferroelectric Domain Distribution and Shape in Čerenkov Second Harmonic Generation — •Philip Roedig, Mousa Ayoub, Jörg Imbrock, and Cornelia Denz — Institut für Angewandte Physik and Center for Nonlinear Science (CeNoS), Westfälische Wilhelms-Universität Münster, 48149 Münster, Germany

Nonlinear parametric processes are known to depend critically on phase matching between the phase velocities of the interacting waves. Phase matching is mostly achieved by using conventional methods like crystal birefringence or quasi-phase matching (QPM) techniques.

Recently, it was pointed out that unpoled ferroelectric crystals can also be used for frequency conversion in nonlinear optics being considered as randomly structured domain media that allow e.g. for tunable phase-matched second-harmonic generation (SHG) practically in the whole transparency range of the crystal. Two characteristic emission configurations, namely planar and Čerenkov geometries, were suggested.

In this contribution, we systematically study the characteristics of Čerenkov second-harmonic generation in multi-domain χ^2 strontium barium niobate crystals by femtosecond laser pulses. Starting from an unpoled sample having a random domain distribution, different degrees of disorder are experimentally generated, offering a possibility to achieve deformation in the shape and distribution of the ferroelectric domains. This results in an enhancement of the efficiency conversion of such type of second harmonic generation and features remarkable modulations in the SH intensity emission patterns.

Q 56.2 Thu 14:45 SCH A215

Hystereseeffekte in einem Rückkoppelsystem zur Superkontinuumserzeugung — •John Wetzel, Nicoletta Brauckmann, Michael Kues, Petra Gross und Carsten Fallnich — Institut für Angewandte Physik, Westfälische Wilhelms-Universität, Münster, Deutschland

Bei der Erzeugung von Superkontinua wird schmalbandiges Licht durch das Zusammenwirken von Dispersion mit nichtlinearen Prozessen wie beispielsweise Selbstphasenmodulation, Vier-Wellen-Mischung und Raman-Streuung spektral verbreitert.

In unserem experimentellen Aufbau werden Superkontinua durch Einkopplung von Femtosekunden-Laserimpulsen aus einem Titan:Saphir-Laser in eine mikrostrukturierte Glasfaser innerhalb eines Ringresonators erzeugt. Durch die so realisierte optische Rückkopplung überlagern die Superkontinuumsimpulse mit den folgenden Pumpimpulsen, was zu wesentlichen Auswirkungen auf die Eigenschaften der erzeugten Superkontinua führt. Das System zeigt nichtlineare Dynamiken von stationären Zuständen über Periodenvervielfachung und Grenzzyklen bis hin zu chaotischem Verhalten. Die Einstellung dieser Dynamiken hängt stark von der Phase der Überlagerung ab, die über die Länge des Ringresonators eingestellt wird. Es wurde gezeigt, dass die Phase genutzt werden kann, um zwischen verschiedenen Systemzuständen definiert zu schalten.

Die hier präsentierten experimentellen und numerischen Ergebnisse zeigen, dass beim Wechsel zwischen verschiedenen Regimen nichtlinearer Dynamiken durch Phasenänderung Hystereseeffekte auftreten.

Q 56.3 Thu 15:00 SCH A215

Measuring the carrier-envelope phase of ultra-intense few-cycle laser pulses — •Felix Mackenroth, Antonino Di Piazza, and Christoph H. Keitel — Max-Planck-Institut für Kernphysik, Saupfercheckweg 1, D-69117 Heidelberg (Germany)

In order to produce ultra-strong laser fields tight temporal focussing of the laser field down to only a few cycles of the carrying electromagnetic wave is usually required. In such few-cycle pulses physical phenomena exhibit a dependence on the relative phase between the carrier wave and the envelope function, also known as the carrier-envelope phase (CEP). It is therefore desirable to have available a determination scheme for the CEP, which in principle can operate at arbitrarily high intensities. Conventional schemes based on atomic physics only allow determination of the CEP of laser fields with intensities up to about 10^{16} W/cm^2, which is well below already available peak laser intensities of the order of 10^{22} W/cm^2 [1]. We show that the CEP of such intense pulses can in principle be determined from the angular distribution of the photons emitted by an electron via multiphoton Compton scattering off the strong few-cycle laser pulse [2].

[1] V. Yanovsky et al., Opt. Express **3**, 16 (2008).
[2] F. Mackenroth, A. Di Piazza, and C. H. Keitel, Phys. Rev. Lett. **105**, 063903 (2010).

Q 56.4 Thu 15:15 SCH A215

A split operator method for the Klein-Gordon equation with applications to ultrashort laser-matter interaction — •Matthias Ruf, Heiko Bauke, and Christoph H. Keitel — Max-Planck-Institut für Kernphysik, Saupfercheckweg 1, D-69117 Heidelberg

The quantum dynamics of ultrashort high-intensity laser-matter interaction necessitate a relativistic treatment. Many problems may be treated by numerical means only. Here, we present a numerical scheme to solve the time evolution of the Klein-Gordon equation via the split operator method. Typical split operator methods act alternately in position and momentum space and, therefore, require the computation of a Fourier transform in each time step. In the two-component representation of the Klein-Gordon equation [1], however, the kinetic energy operator is nilpotent. This allows one to perform the split operator method for the Klein-Gordon equation entirely in position space and this way to avoid the computation of a Fourier transform.

We have implemented a position space split operator method [2] for the solution of the time-dependent Klein-Gordon equation with arbitrary electromagnetic fields. The parallel implementation is based on domain decomposition. In our presentation, we describe the computational details and address various physical applications, such as the ionization of highly charged hydrogenlike ions or electron-positron pair creation from vacuum.

[1] H. Feshbach and F. Villars, Rev. Mod. Phys. **30**, 24 (1958)
[2] M. Ruf, H. Bauke and C. H. Keitel, J. Comp. Phys. **228**, 9092 (2009)

Q 56.5 Thu 15:30 SCH A215

Light field control of electronic motion in condensed matter — •Agustin Schiffrin[1], Tim Paasch-Colberg[1,2], Daniel Gerstner[2], Nicholas Karpowicz[1], Sascha Mühlbrandt[2], Joachim Reichert[2], Johannes V. Barth[2], Reinhard Kienberger[1,2], Ralph Ernstorfer[1,2,3], and Ferenc Krausz[1,4] — [1]Max-Planck-Institut für Quantenoptik, Garching, Germany — [2]Technische Universität München, Germany — [3]Fritz-Haber-Institut, Berlin, Germany — [4]Ludwig-Maximilians-Universität, München, Germany

The advent of intense few-cycle near infrared (NIR) laser pulses with stable and tunable carrier envelope phase (CEP) has enabled the control of electromagnetic fields with attosecond time precision [1]. Here we aim at exploiting these few-cycle NIR optical fields with well-defined CEP to generate and control the motion of charge carriers within heterogeneous nanoscaled solid state interfaces. We demonstrate the generation of directly measurable photocurrents in unbiased gold-coated SiO_2 nanogaps, whose magnitude and directionality can be tuned with the laser CEP. This effect vanishes with the increase of the laser pulse duration. We claim that such phenomenon is the signature of optically induced electron tunneling at the metal-dielectric interface with subsequent acceleration of the charge carrier in the ultrashort laser field. This ultrafast current injection at a nanoscaled condensed matter system represents a first step towards femtosecond lightwave electronics.

[1] Baltuska, A. et al. "Attosecond control of electronic processes by intense light fields" Nature **421**, 611-615 (2003).