A 20: Attosecond Science III

Time: Tuesday 14:00–15:45 Location: K 1.011

Invited Talk A 20.1 Tue 14:00 K 1.011

Attosecond Streaking in Dielectrics — •L. Seiffert[1], Q. Liu[2,3], S. Zherebtsov[2,3], A. Trabattoni[4,5], P. Rupp[2,3], M. C. Castrovilli[6], M. Galli[4,6], F. Süssmann[2,3], K. Wintersperger[2], J. Stierle[2], G. Sansone[4,6], L. Poletto[6], F. Frassetto[6], I. Halfpap[7], V. Mondes[7], C. Graf[7], E. Rühl[7], F. Krausz[2,3], M. Nisoli[4,6], T. Fennel[1,8], F. Calegari[5,6,9], and M. Kling[2,3] — [1]Universität Rostock — [2]MPQ Garching — [3]LMU München — [4]Politecnico di Milano — [5]Center for Free-Electron Laser Science, DESY — [6]National Research Council of Italy — [7]FU Berlin — [8]MBI Berlin — [9]University of Hamburg

Scattering of electrons in dielectrics is at the heart of laser nanomachining, light-driven electronics, and radiation damage. Accurate theoretical predictions of the underlying dynamics require precise knowledge of the low-energy electron transport involving elastic and - even more important - inelastic collisions. Here, we demonstrate real-time access to electron scattering in isolated SiO_2 nanoparticles via attosecond streaking [1]. Utilizing semiclassical Monte-Carlo trajectory simulations [2,3] we identify that the presence of the field inside the dielectric cancels the influence of elastic scattering, enabling selective characterization of the inelastic scattering time [4].

[1] R. Kienberger et al., Nature 427, 817-821 (2004)
[2] F. Süßmann et al., Nat. Commun. 6, 7944 (2015)
[3] L. Seiffert et al., Appl. Phys. B 122, 1-9 (2016)
[4] L. Seiffert et al., Nat. Phys. 13, 766-770 (2017)

Invited Talk A 20.2 Tue 14:30 K 1.011

Controlling the refraction of ultrashort XUV pulses — Lorenz Drescher, Oleg Kornilov, Tobias Witting, Geert Reitsma, Jochen Mikosch, Marc Vrakking, and •Bernd Schütte — Max-Born-Institut, Berlin

Refraction is widely found in nature and is important for many applications. For instance, refractive lenses and prisms are indispensable tools that are extensively used to control the properties of light beams at visible, infrared and ultraviolet wavelengths. The lack of refractive lenses and prisms in the XUV range is due to the large absorption and the low capability of bending light in this spectral region.

Here we demonstrate control over the refraction of ultrashort XUV pulses by applying a gas density gradient across the XUV beam profile that leads to spectral dispersion and refraction of the beam. The deflection of XUV radiation is particularly large for spectral components close to atomic and molecular resonances, and the experimental results are well reproduced by simulations. Control of the sign and the strength of refraction in different spectral regions is demonstrated by varying the gas pressure, the gas jet position and its composition. The gas jet thereby acts as a deformable prism in the XUV range. We further show temporal control and characterization of the refracted XUV radiation by applying a moderately intense NIR laser pulse.

In the future, our concept may be exploited to measure transient refractive index changes in the XUV region. Furthermore, our results may be the first step towards the design of an XUV refractive lens, which would provide novel opportunities in ultrafast XUV science.

A 20.3 Tue 15:00 K 1.011

Topological effects in high-harmonic generation by linear chains — •Helena Drüeke[1], Kenneth Hansen[2], and Dieter Bauer[1] — [1]Institute of Physics, University of Rostock, 18051 Rostock, Germany — [2]Department of Physics and Astronomy, Aarhus University, DK-8000, Denmark

High-harmonic generation (HHG) in the two topological phases of a finite, one-dimensional, periodic structure is investigated using a self-consistent time-dependent density functional theory (TDDFT) approach [1,2]. For harmonic photon energies smaller than the band gap, the harmonic yield is found to differ up to fourteen orders of magnitude for the two topological phases. This giant topological effect is explained by the degree of destructive interference in the harmonic emission of all valence-band electrons, which strongly depends on whether topological edge states are present or not.

[1] Kenneth K. Hansen, Tobias Deffge, Dieter Bauer, *High-order harmonic generation in solid slabs beyond the single-active-electron approximation*, Phys. Rev. A 96, 053418 (2017).
[2] Dieter Bauer, Kenneth K. Hansen, *High-harmonic generation in solids with and without topological edge states*, (submitted) arXiv:1711.05783.

A 20.4 Tue 15:15 K 1.011

Finite system effects on high harmonic generation: from atoms to solids — •Kenneth Hansen[1], Dieter Bauer[2], and Lars Bojer Madsen[1] — [1]Department of Physics and Astronomy, Aarhus University, DK-8000, Denmark — [2]Institute of Physics, University of Rostock, 18051 Rostock, Germany

Using time-dependent density field theory (TDDFT)[1] high harmonic generation (HHG) has been studied in one-dimensional structures of intermediate sizes from a single nucleus upto hundreds of nuclei. The well known HHG cutoff for atomic systems is observed to extent linearly with system size and is found to converge into previously observed cutoffs for bulk solids only for large systems. The change from atomic HHG to solid state HHG is observed from system sizes of 6-8 nuclei and is first fully converged at system sizes of 60 nuclei. The systems size dependence of the observed HHG cutoffs is found to follow the limitations of movement of classical electron-hole pairs in the band structure. Because of the correlation between recombination energy and electron-hole propagation length high energy recombination events are not possible in small systems, but become available for larger systems resulting in the change of the cutoff energies with system size. When varying the field intensity we observe that the cutoffs move linearly with the intensity even for small systems that are far from a true bulk solid.

[1] Kenneth K. Hansen, Tobias Deffge, Dieter Bauer, *High-order harmonic generation in solid slabs beyond the single-active-electron approximation*, Phys. Rev. A 96, 053418 (2017).

A 20.5 Tue 15:30 K 1.011

Simulation of Brunel harmonics from laser-driven dielectric solids — •Benjamin Liewehr[1], Björn Kruse[1], Christian Peltz[1], Peter Jürgens[2], Anton Husakou[2], Mikhail Ivanov[2], Marc Vrakking[2], Alexandre Mermillod-Blondin[2], and Thomas Fennel[1,2] — [1]Institut für Physik, Universität Rostock, Albert-Einstein-Str. 23, D-18051 Rostock — [2]Max-Born-Institut für Nichtlineare Optik und Kurzzeitspektroskopie, Max-Born-Str. 2A, D-12489 Berlin

The onset of ultrafast structural modification of dielectric materials is accompanied by a wealth of non-linear phenomena, ranging from rapid ionization over local plasma formation, to high-harmonic generation (HHG)[1]. Brunel harmonics [2], being one of the possible nonlinear wave-mixing processes, are a promising optical probe for quantitative plasma diagnostics on the femtosecond time scale as they encode the ultrafast evolution of the plasma density due to sub-cycle ionization dynamics.

Using a simplified rate-equation-based ionization-radiation model we investigate optimal conditions for generating Brunel harmonics and study the qualitative signatures in the harmonic signal. The predictions from the continuum model are further compared with results from three-dimensional, microscopic particle-in-cell (MicPIC) simulations [3]. The emerging similarities and differences will be discussed.

[1] H. Liu et al., Nature Phys. 13, 262 (2017)
[2] F. Brunel, J. Opt. Soc. Am. B 4, 521 (1990)
[3] Ch. Peltz et al., New J. Phys. 14, 065011 (2012)