A 22: Poster – Attosecond Physics

Time: Wednesday 17:00–19:00 Location: Tent

A 22.1 Wed 17:00 Tent

Towards attosecond temporal resolution with split-and-delay units at FLASH — •Matthias Dreimann, Michael Wöstmann, Tobias Reiker, Victor Kärcher, and Helmut Zacharias — Center for Soft Nanoscience, Universität Münster, Germany

The development of ultrashort FEL pulses with few-fs and sub-fs pulses is a research field in the FEL community with promising applications. One of these applications are pump/probe experiments with ultrashort FEL pulses, as the temporal dynamic of the system is a key to the fundamental understanding of its underlying physics. Split-and-delay units have extensively contributed in this type of experiments, typically providing 'jitterless' temporal resolution in the range of some hundred attoseconds. Considering the sub-femtosecond pulse duration of recent ultrashort pulses a further improvement of the temporal resolution is mandatory.In this contribution we propose methods to improve the temporal resolution of split-and-delay units down to some attoseconds.

A 22.2 Wed 17:00 Tent

Bilobran-Angelo entropic distance in coherently and incoherently-driven high-harmonic generation — •Arlans Juan Smokovicz de Lara, Ulf Saalmann, and Jan-Michael Rost — Max-Planck-Institute für Physik komplexer Systeme

Since its discovery, high harmonic generation (HHG), as a process nonlinear in the number of photons, has been realized with intense *classical* light. Recently, progress has been made towards a quantum mechanical description of the harmonic modes, enabling the creation of nonclassical intense light pulses [1], which promises new quantum effects in the interaction with matter. In particular, thanks to said quantum description of the modes, we can now treat interesting quantum mechanical properties, for instance the realism of measurements in the context of the Bilobran-Angelo entropic distance [2]. We will present first results of said quantity in the contexts of coherently-driven [3] and incoherently-driven [4] in HHG in pristine graphene.

[1] M. Lewenstein, M. F. Ciappina, E. Pisanty, J. Rivera-Dean, P. Stammer, Th. Lamprou and P. Tzallas, Nature Physics **17**, 1104 (2021).

[2] A. L. O. Bilobran and R. M. Angelo, EPL **112** 40005 (2015).

[3] J. Rivera-Dean, P. Stammer, A. S. Maxwell, Th. Lamprou, A. F. Ordóñez, E. Pisanty, P. Tzallas, M. Lewenstein and M. F. Ciappina, Phys. Rev. B **109**, 035203 (2024).

[4] P. Stammer, Phys. Rev. Research **6**, L032033 (2024).

A 22.3 Wed 17:00 Tent

A Beamline for soft X-ray attosecond spectroscopy — •Naglis Kriunas[1,2], Fabian Scheiba[1,3,4], Rafael d. Q. Garcia[1,3], Maximilian Kubullek[1,3], Miguel Silva[1,3], Roland E. Mainz[1,3,4], Giulio Maria Rossi[1,4], and Franz X. Kärtner[1,3,4] — [1]Center for Free-Electron Laser Science CFEL and Deutsches Elektronen-Synchrotron DESY, Notkestraße 85, 22607 Hamburg, Germany — [2]School of Chemistry, University of Edinburgh, The King's Buildings, West Mains Road, Edinburgh EH9 3JJ, UK — [3]Physics Department, University of Hamburg, Luruper Chaussee 149, 22761 Hamburg, Germany — [4]The Hamburg Centre for Ultrafast Imaging, Luruper Chaussee 149, 22761 Hamburg, Germany

We present the layout of our newly developed attosecond beamline. To improve the soft X-ray detection, we implemented a high efficiency reflective zone plate spectrometer. A differentially pumped transient absorption cell allows for gas phase experiments with organic molecules. Our sub-cycle parametric waveform Synthesizer (PWS) [1] allows for sub-fs pump duration in multi-photon/strong-field interaction. This, jointly with tunable isolated attosecond pulses with photon energies from the XUV up to 450 eV enables attosecond resolution in both, pump and probe. A precise dispersion management scheme and phase stabilization paves the way for quantum control in photochemical reactions.

[1] Rossi, G.M. et al. Sub-cycle millijoule-level parametric waveform synthesizer for attosecond science. Nat. Photonics 14, 629-635 (2020). https://doi.org/10.1038/s41566-020-0659-0

A 22.4 Wed 17:00 Tent

High harmonic generation in a non-Hermitian Su-Schrieffer-Heeger chain — •Milad Jangjan and Dieter Bauer — Rostock university, Rostock, Germany

Investigating high harmonic generation (HHG) in the One-Dimensional Su-Schrieffer-Heeger (SSH) model with gain and loss is very interesting because it combines nonlinear optical response (HHG) and non-Hermitian physics. We carry out numerical simulations to study how the transmission of energy changes and the gain and loss dynamics affect the band structure, and polarization currents, which are on the very basis of HHG. Our findings show that gain/loss affects the harmonic spectra, the cutoff energies, and some harmonics significantly differ from the response of the Hermitian SSH model. In addition, we identify the trait characteristics of exceptional points in the HHG spectrum, which is a new way to probe non-Hermitian physics through ultrafast nonlinear optics. In this study, we have not only improved our understanding of HHG in non-Hermitian systems but also introduced new ways of making tunable ultrafast light sources and examining topological signatures in materials that are gain/loss-engineered.

A 22.5 Wed 17:00 Tent

Photoemission Timing of Xe adsorbed on Pt(111) over a wide range of Xe layers — •Sven-Joachim Paul[1], Luc Tremel[1], Jasper Aeschlimann[1], Peter Feulner[2], and Reinhard Kienberger[1] — [1]Chair for laser and x-ray physics, E11, Technische Universität München, Germany — [2]Surface and Interface Physics, E20, Technische Universität München, Germany

We report on attosecond streaking measurements of the electron photoemission process from the platinum (111) surface covered by xenon.

Attosecond streaking enables measuring relative time delays in photoemission from energetically different bound electronic states. This experiment addresses three states: Xe4d, Xe5s, and the Pt valence band.

Photoemission delays in these states have been observed for surface coverages ranging from 0.25 monolayers to 11 monolayers.

From a coverage of 3 monolayers, the Xe5s state became visible, enabling an internal delay measurement of the Xe states even without the need for the platinum valence band as a reference.

As xenon is a dielectric medium, the streaking field already acts in the adsorbed layers. Therefore, these measurements are more similar to gas phase measurements than experiments, which only address states of metals. On top of that, by comparing the photoemission delays for different layer thicknesses, the penetration depth of the streaking field can be estimated.

A 22.6 Wed 17:00 Tent

Noise Parametrization and Simulation for Attosecond Streaking — •Luc-Fabrice Tremel, Sven-Joachim Paul, Maximilian Forster, and Reinhard Kienberger — Chair for laser and x-ray physics E11, Technische Universität München, Germany

We address the extraction of noise parameters from attosecond streaking measurements and their influence on the performance of the restricted time-dependent Schrödinger equation (rTDSE) algorithm for photoemission time delay retrieval. The development and application of noise parameter extraction techniques reveal an energy and target-specific behavior of multiplicative noise not accounted for in previous works. This insight and the retrieved parameters from real attosecond streaking measurements allow a refinement of streaking simulation methods. Using these simulations to study the influence of noise on the rTDSE method confirm that an increase in noise results in a broader spread of retrieved delays but no directional shift, affirming the application of the rTDSE retrieval method for the analysis of attosecond streaking measurements. The developed tools allow future projects to be based on spectrograms more closely resembling those observed in the experiment.

A 22.7 Wed 17:00 Tent

A rigorous and universal approach for highly-oscillatory integrals in attosecond science — •Anne Weber[1], Job Feldbrugge[2], and Emilio Pisanty[1] — [1]Attosecond Quantum Physics Laboratory, King's College London, WC2R2LS London, UK — [2]Higgs Centre for Theoretical Physics, University of Edinburgh, UK

Light-matter interactions within the strong-field regime, such as high-harmonic generation, typically give rise to highly-oscillatory integrals,which are often solved using saddle-point methods. Not only do these methods promise a much faster computation, but they also inform a more intuitive understanding of the process in terms of quantum orbits, as the saddle points correspond to interfering quantum trajectories (think Feynman's path integral formalism). Despite these advantages, a sound understanding of how to apply saddle-point methods to highly-oscillatory integrals in a rigorous way, and with algorithms which work uniformly for arbitrary configurations and laser drivers, remains lacking. This hinders our ability to keep up with state-of-the-art experimental setups which increasingly rely on tightly-controlled laser waveforms. Here, I will introduce the key ideas of Picard-Lefschetz theory – the foundation of all saddle-point methods – and their implementation. Using high-harmonic generation and above-threshold ionisation as examples, I will show how those ideas provide a robust framework for the fast computation of integrals, as well as a widely-applicable algorithm to derive the relevant semiclassical quantum orbits that underlie the physical processes.