A 6: Attosecond Physics I (joint session A/MO)

Time: Monday 17:00–18:45 Location: N 1

Invited Talk A 6.1 Mon 17:00 N 1

Measurement of neon photoemission delays and double-core-hole Auger-Meitner lifetime using Angular Streaking — •Lars Funke[1], Sara Savio[1], Lasse Wülfing[1], Niclas Wieland[2], Markus Ilchen[2], and Wolfram Helml[1] — [1]Fakultät Physik, Technische Universität Dortmund, Germany — [2]Institut für Experimentalphysik, Universität Hamburg, Germany

The extreme brightness of X-ray free electron lasers allows probing non-linear processes in atoms and molecules in single-shot measurements. The addition of a temporal reference, e.g. through an Angular Streaking setup, enables the direct measurement of observables previously only accessible indirectly.

Here, we report on a European-XFEL measurement that simultaneously yields relative emission delays for multiple transitions triggered by 990 eV photons in neon. Specifically, we are able to clock 1s, 2s and 2p photoelectrons, single- and double-core-hole Auger-Meitner electrons at the same time, owing to a multi-resolution time-of-flight detector setup covering a broad electron energy range.

A 6.2 Mon 17:30 N 1

Observation of sub-cycle ponderomotive acceleration via near-field-induced low-energy stripes (NILES) — •L. Seiffert[1], J. Heimerl[2], S. Meier[2], A. Herzig[1], F. Lòpez Hoffmann[2], D.M.B. Lesko[2], S. Hillmann[2], S. Wittigschlager[2], T. Weitz[2], T. Fennel[1,3], and P. Hommelhoff[2,4] — [1]Institute of Physics, University of Rostock, Germany — [2]Department of Physics, Friedrich Alexander University Erlangen-Nuremberg, Germany — [3]Department of Life, Light and Matter, University of Rostock, Germany — [4]Faculty of Physics, Ludwig Maximilian University Munich, Germany

Ponderomotive acceleration of electrons in strong fields is typically regarded as a cylce-averaged effect and hence mostly associated with long pulses. However, recently, subcycle sensitivity of the ponderomotive acceleration effect has been reported for electrons injected into the strong near-field gradient of a sharp metal tip by a few-cycle optical waveform [1]. In this talk the recent observation of this effect which manifests in the direct electrons part of carrier-envelope-phase-dependent electron spectra in the form of near-field-induced low-energy stripes (NILES) will be discussed from a theoretical point of view. These stripes allow the tracking of direct and rescattered electron emissions on subcycle timescales and provide access to the electron momentum width at emission.

[1] J. Heimerl at al., Nat. Phys. (2025)

A 6.3 Mon 17:45 N 1

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.

A 6.4 Mon 18:00 N 1

Structured light for enhanced attosecond chiral sensing — •Nicola Mayer[1], Anne Weber[1], Daniele Toffoli[2,3], Margarita Khokhlova[1], and Emilio Pisanty[1] — [1]Attosecond Quantum Physics Group, King's College London, London (United Kingdom) — [2]Dipartimento di Scienze Chimiche e Farmaceutiche, Università degli studi di Trieste, Via L. Giorgieri 1, I-34127, Trieste, Italy — [3]IOM-CNR, Istituto Officina dei Materiali, 34149, Trieste, Italy

Chirality is an ubiquitous phenomenon in nature, spanning many orders of magnitude in length, from the cosmic scale in spiraling galaxies to the microscopic one in chiral molecules. The interaction of polychromatic synthetic chiral light beams (SCL) with chiral molecules is expected to enhance chiral signals in observables such as HHG or photoelectron yield. Here, we show that by using vector-vortex beams with radial and azimuthal polarization, the chirality of SCL beams carrying a chiral topological charge can be increased by two orders of magnitude, leading to a huge enhancement in chiral signals. We prove theoretically such enhancement by using an ab-initio based strong-field approximation approach to describe HHG in fenchone and camphor, with state-of-art saddle point methods to describe polychromatic three-dimensional quantum orbits in the continuum. Our results bring the goal of experimental proof of these techniques closer to reach, both in chiral molecules as well as in atoms.

A 6.5 Mon 18:15 N 1

Absolute photoemission timing in noble gases — •Maximilian Forster[1], Maximilian Pollanka[1], Sven Paul[1], Christian Schröder[1], Pascal Freisinger[1], Anatoli Kheifets[2], and Reinhard Kienberger[1] — [1]Chair for laser and x-ray physics, E11, Technische Universität München, Germany — [2]Research School of Physical Sciences, The Australian National University, Canberra ACT 0200, Australia

We measured the photoemission time delay in noble gases, namely neon and xenon across different photon energies using the attosecond streaking technique.

The photoemission delay of neon, being the first ever evidence of atomic delay, has received repeated attention by both experimental and theoretical investigations due to the large cross section and convenient properties of neon. As a helium reference is no possible for neon, we used iodoemthane as a chronoscope. The internal delay between Ne2s and Ne2p can be extracted simultaneously, allowing for a consistency check with previous experiments conducted only with neon.

The Xenon states Xe4d and Xe5s can be measured straightforward relative to helium and are compared to theoretical calculations.

A 6.6 Mon 18:30 N 1

Attosecond XUV-XUV Fourier Transform Spectroscopy of Autoionizing Rydberg States in Molecular Nitrogen — •Ignacio Martínez Casasús[1], Oleg Kornilov[2], Arnaud Rouzée[2], Luis Bañares Morcillo[1,3], and Tobias Witting[2] — [1]Departamento de Química Física, Facultad de Ciencias Químicas, Universidad Complutense de Madrid, 28040 Madrid, Spain — [2]Max Born Institute, Max-Born-Straße 2A, 12489 Berlin, Germany — [3]Instituto Madrileño de Estudios Avanzados IMDEA-Nanoscience, Faraday, 9, 28049 Madrid, Spain

We introduce attosecond XUV-XUV Fourier transform spectroscopy to investigate the autoionizing Rydberg states of molecular nitrogen. Phase-locked XUV pulse pairs are generated through high-harmonic generation and delayed with sub-10-attosecond timing precision. The first pulse prepares a coherent superposition between the molecular ground state and a set of high-lying Rydberg states. The second pulse probes the evolving coherence, imprinting delay-dependent modulations onto the population of autoionizing levels. These modulations are subsequently read out via the photoelectron spectra resulting from autoionization into different ionic continua. Fourier analysis of the delay-dependent photoelectron yields provides information about transition energies, coherence dynamics and vibrationally resolved ionization cross-sections.