A 24: Poster – Interaction with VUV and X-ray Light (joint session A/MO)

Time: Wednesday 17:00–19:00 Location: Philo 1. OG

A 24.1 Wed 17:00 Philo 1. OG

Temporal evolution of x-ray fluorescence of highly charged xenon ions under FEL irradiation — •Moritz J. Grunwald-Delitz[1], Thomas M. Baumann[1], Michael Meyer[1], Johan Söderström[2], and Jan-Erik Rubensson[2] — [1]European XFEL, Holzkoppel 4, 22869 Schenefeld, Germany — [2]Department of Physics and Astronomy, Uppsala University, Box 516, 751 20 Uppsala, Sweden

We present the results of x-ray emission spectroscopy (XES) measurements on the interaction of intense x-ray free-electron laser pulses with xenon gas, aiming for a state-resolved exploration of non-linear multi-photon ionization and excitation processes. We utilize the 1D-imaging spectrometer [M. Agåker et al., J. Synchrotron Radiat., 31(5), 2024.] at the SQS instrument of European XFEL and its gas cell sample environment, which allows for studying Xe at a few mbar, a regime where, besides photon-driven processes, electron collisions start to contribute to the highly charged ion and excited state populations. Interestingly, this was not observed during prior studies on neon gas under similar conditions [S.-K. Son et al., Phys. Rev. A, 112(5), 2025, L051101.]. Our measurements monitor the evolution of these contributions over several nanoseconds after the XFEL pulse, revealing a distinct double-peak structure in the time-of-flight distribution.

A 24.2 Wed 17:00 Philo 1. OG

Parametric Mössbauer Radiation Generated by the European XFEL Electron Beam — •Ze-an Peng, Christoph H. Keitel, and Jörg Evers — Max-Planck-Institut für Kernphysik, Heidelberg, Germany

The ultranarrow nuclear resonances of Mössbauer isotopes enable precision spectroscopy and x-ray quantum optical applications, yet they make strong resonant excitation difficult with conventional x-ray sources. Parametric x-ray radiation (PXR), produced when relativistic electrons traverse a crystal, provides a high-quality, low-divergence x- ray source. When the crystal contains Mössbauer nuclei, spectrally narrow parametric Mössbauer radiation (PMR) can be generated under suitable conditions. We develop a general dynamical diffraction theory of PMR for arbitrary emission directions, covering both the conventional diffraction geometry and the more extreme grazing specular diffraction geometry. We show that the new geometry can substantially enhance PMR intensity due to specular diffraction of the electron virtual-photon fields at the crystal surface, which allows radiation to form predominantly outside the crystal and thus avoids strong absorption. We further apply the framework to superradiant PMR (SPMR) generated by microbunched XFEL electron beams, and introduce how superradiant amplification and geometric optimization combine to boost emission. The scheme applies broadly to PXR and PMR from both incoherent continuous- wave electron beam and the XFEL electron bunches, offering a pathway toward intense, coherent, and spectrally narrow Mössbauer x-ray sources.

A 24.3 Wed 17:00 Philo 1. OG

Microcrystalline and thin layers for precision spectroscopy — •Simon B. Diewald[1], Jonas Stricker[1,2], Dennis Renisch[1,2], and Christoph E. Düllmann[1,2,3] — [1]JGU Mainz, Deutschland — [2]HI Mainz, Deutschland — [3]GSI Darmstadt, Deutschland

$^{232}ThF_4$ is a promising host material for high-precision spectroscopy experiments related to the realization of a solid-state nuclear clock based on the ^{229m}Th isomer. We present a compact method for producing thin and microcrystalline $^{232}ThF_4$ layers on silicon, CaF_2, MgF_2, and stainless-steel substrates via thermal evaporation in an ohmic furnace. The produced layers were characterized regarding their homogeneity and provide samples suitable for future high-precision vacuum-ultraviolet spectroscopy. The method provides homogeneous samples suitable for various high-precision spectroscopy and nuclear-physics applications.

A 24.4 Wed 17:00 Philo 1. OG

Accessing ultrafast electron dynamics with single-shot single-particle diffraction imaging and spectroscopy — •Indrani Dey, Jasper Boultwood, José gómez Torres, Frederic Ussling, Yves Acremann, Isabelle Bolliers, Ehsan Hassanpour Yesagi, Linos Hecht, Katharina Kolatzki, Mario Sauppe, Simon Wächter, Changji Pan, Jannis Lehmann, Alessandro Colombo, Björn Senfftleben, and Daniela Rupp — Nanostructures and Ultrafast X-Ray Science, ETH Zurich

Ultrafast electron dynamics are in principle imprinted in diffraction patterns of single nanoparticles but they are difficult to extract. We have developed high-harmonic generation based single-shot single-particle diffractive imaging in the lab with excellent temporal stability and resolution. To gain access to ultrafast laser-driven changes in the electronic properties of an isolated nanoparticle, also the spectral distribution of the diffracted light needs to be recorded, as it reflects the static and dynamic interaction of the intense XUV pulse with the target. It is also crucial for accurate phase retrieval and structural reconstruction, as multi-harmonic contributions blur fine details. We discuss the design and setup for simultaneous recording of single-shot diffraction patterns and spectrum of free-flying particles and present first results. The development of Coherent Diffraction Imaging and Spectroscopy has the potential to enable also novel XFEL-based experiments with few- and sub-femtosecond pulses.