European XFEL Joint Theory Seminar

Thursday, 19 October 2023, 16:00

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X-ray pump-probe spectroscopy of electron-nuclear dynamics

X-ray Free Electron laser (XFEL) and high harmonic generation (HHG) sources have opened a new era in science, providing ultrashort, coherent and tunable pulses that enables new types of pump-probe techniques to perform cutting edge experiments in atomic and molecular physics, condensed matter physics, biology, and chemistry. Moreover, XFEL-based nonlinear radiation-matter interaction allows to probe processes and properties inaccessible before via nonlinear X-ray spectroscopies. A broad variety of X-ray pump-probe schemes can be classified by energy of the pump photons inducing vibrational (IR-pump), valence (UV-pump) or core (X-ray-pump) electron excitation and triggering complex electron-nuclear dynamics that can be effectively probed by element and site selective short X-ray pulses. In my talk I will give a brief overview of the theoretical development of various X-ray pump-probe schemes performed in our group during the last few years. I present X-ray probe of IR- [1] and UV-induced [2] nuclear dynamics in the framework of time-resolved X-ray absorption [1, 2] and more sophisticated time-resolved resonant Auger scattering and coincidence techniques [3], give an outlook for X-ray pump X-ray probe techniques for studying interference phenomena on electronic channels [4] and Cohen-Fano interference in recoil-induced rotation [5]. I will also propose a nonlinear scheme for observing XUV-induced Rabi oscillation in superfluoresce [6]. Discussion will include experimental feasibility of various X-ray pump-probe schemes, where feedback from XFEL experts in audience is highly appreciated.

1. J.-C. Liu et al., Phys. Rev. A 103, 022829 (2021); L. Barreau et al, Phys Rev A 108, 012805 (2023).
2. J.-C. Liu et al., New J. Phys. 23, 63030 (2021); V. Savchenko et al., Phys. Rev. A 104, 032816 (2021).
3. Y. P. Zhu et al, Phys. Rev. A 106, 023105 (2022); C. Wang, et al, J. of Phys. Chem. Lett. 14, 5475 (2023).
4. V. Savchenko et al, Phys. Rev. A 104, 13114 (2021).
5. J.-C. Liu et al., J. Chem. Phys. 158, 114304 (2023); Phys. Chem. Chem. Phys. 24, 6627 (2022).
6. J. J. Cui et al, Phys. Rev. Lett 131, 043201 (2023).

Host: Nils Brouwer

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