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Yellow Tower „B“, 5th floor, SEM.R. DB gelb 05 B



Shooting molecular movies of gaseous molecules with a reaction microscope and a high-repetition-rate soft X-ray FEL

Following chemical reactions and structural changes in molecules in real time has been a long-standing dream in physical chemistry. Accordingly, time-resolved single-molecule imaging has been one central aim triggering the development of x-ray free-electron lasers (XFELs). With the advent of XFELs, corresponding studies in the gas phase came into reach. The high repetition rate of the European XFEL finally opens the door to coincidence experiments and the talk will present the successful implementation of this technique using a COLTRIMS reaction microscope at the European XFEL. For example, our experiments demonstrate that photoelectron diffraction imaging of a molecular breakup is finally possible using high-repetition-rate XFELs [1]. Furthermore, molecular-frame photoelectron angular distributions upon double core-hole generation [2] as well as charge-up and fragmentation dynamics after interaction with strong XFEL pulses [3] will be presented. Two other experimental and theoretical studies cover the inner-shell-ionization-induced femtosecond structural dynamics of water molecules [4,5]. With the help of multi-ion coincidence spectroscopy as well as sophisticated theoretical modeling, complex single molecules can be imaged via x-ray multiphoton-induced Coulomb explosion [6]. Moreover, Coulomb explosion imaging of small polyatomic molecules with ultrashort x-ray pulses [7] and resonance-enhanced x-ray multiple ionization of polyatomic molecules [8] will be discussed. Finally, an outlook of x-ray pump / x-ray probe two-color experiments will be given.

REFERENCES

1. G. Kastirke et al., Phys. Rev. X **10**, 021052 (2020).
2. G. Kastirke et al., Phys. Rev. Lett. **125**, 163201 (2020).
3. G. Kastirke et al., Phys. Chem. Chem. Phys. **24**, 27121 (2022).
4. T. Jahnke et al., Phys. Rev. X **11**, 041044 (2021).
5. R. Guillemin et al., Struct. Dyn. **10**, 054302 (2023).
6. R. Boll et al., Nat. Phys. **18**, 423 (2022).
7. X. Li et al., Phys. Rev. Research **4**, 013029 (2022).
8. X. Li et al., Phys. Rev. A **105**, 053102 (2022).

Florian Trinter, born in Bad Hersfeld, Germany, studied physics at the Goethe University Frankfurt from 2005 to 2011. He continued with his PhD at the same university in the Institute for Nuclear Physics in the group of Prof. Dr. Reinhard Dörner, where he defended his thesis “Evolution of Interatomic and Intermolecular Coulombic Decay in the Time Domain” in 2017. In 2018 he changed to Deutsches Elektronen-Synchrotron (DESY) in Hamburg as a Photon Science fellow at the soft X-ray beamline P04 of synchrotron PETRA III as well as to the Fritz-Haber-Institut (FHI) in Berlin as a postdoc. He is now an Emmy Noether group leader for the “Dynamics of photoionization-induced processes in laser-prepared gas- and aqueous-phase samples” at the Molecular Physics department of the FHI, working on liquid-jet photoelectron spectroscopy and COLTRIMS reaction microscopy.

All interested colleagues are welcome to this seminar lecture (45 min. presentation followed by discussion).

Friedrich Aumayr
(LVA-Leiter)

Richard Wilhelm
(Seminar Chair)