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Multiphoton Ionization of Atoms and Molecules with Soft and Hard X-rays

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We have recently extended our previous investigations of the multiphoton ionization of heavy atoms, such as Kr and Xe [1, 2], and of high-Z atom containing molecules [3] from the soft into the hard X-ray range as well as into the XUV regime. Using the 100-nm focus environment at LCLS, we were able to reach peak intensities up to 10^{19}W/cm^2 at photon energies between 5 to 9 keV. This allows studying atomic and molecular ionization processes under unprecedented X-ray intensities and, in particular, under the identical conditions where typical coherent diffractive imaging experiments are performed. Our results are thus important benchmarks for calculating radiation damage effects in FEL-based X-ray imaging experiments. Using new micro-focusing capabilities at FLASH, we also extended our studies into the XUV range between 70 and 200 eV photon energy and observed significantly higher charge states than previously reported. I will present the results from our recent measurements at LCLS and FLASH and discuss the different multiphoton ionization mechanisms that play a role in the XUV, soft, and hard X-ray range.

[1] B. Rudek *et al.*, Nature Photon. **6**, 858 (2012)
[2] B. Rudek *et al.* Phys. Rev. A **87**, 023413 (2013)
[3] B. Erk *et al.*, Phys. Rev. Lett. **110**, 053003 (2013)