Study of electronic and structural dynamics by means of time-resolved photoelectron spectroscopy and diffraction

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Photoelectron spectra and angular intensity distributions contain a wealth of information about the electronic and atomic structure in surfaces. When used with pulsed light in a pump-probe setup the dynamics of quasi-particles can be studied great detail. Here we extend this method to so-called photoelectron diffraction experiments by recording the angular intensity distribution of photoelectrons emitted from well-defined states. Similar to holographic imaging, interference of the directly emitted and the scattered electron waves produces a complex pattern from which the atomic environment of the emitter can be deduced.

Photoelectrons have the additional virtues that the choice of the emitting electron state determines the chemical nature of the emitter atom, and that the final temporal resolution in a pump-probe experiment will be determined by the cross correlation of the pump and probe light pulses, only. Photoelectron diffraction can be observed using both, x-ray and extreme ultraviolet (XUV) light for the photoelectron excitation. Therefore, infrared pump - XUV probe experiments are readily available on a laboratory scale using high-harmonics setups. After an introduction into photoelectron diffraction we will present by first proof-of-principle experiments in Bi how electronic and atomic dynamics can be disentangled, and finally give an outlook into forthcoming experiments.