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Advanced photoelectron spectroscopy with femtosecond lasers

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Abstract: With the recent development of material science, knowledge of the electronic structure has become increasingly important. As one of the most general tools to study the electronic band structure of solids, angle-resolved photoelectron spectroscopy (ARPES) can provide an intuitive picture of the energy and momentum distribution of electrons. In contrast to conventional ARPES experiments at synchrotron facilities or with laboratory discharge lamps, the combination of ARPES with femtosecond lasers allows to study the ultrafast electron dynamics in the intense electric field of light with femtosecond time resolution.
In this talk, ARPES with laser-based light sources will be introduced. Specific examples of the more advanced ARPES experiments using a home-built megahertz high-order harmonic generation (HHG) light source will be provided [1]. The application of the HHG light source allows laboratory ARPES experiments with a widely tunable photon energy range from 15 to 40 eV [2].More importantly, the HHG-based ARPES setup paves the way toward double photoemission (DPE) experiments, where a pair of photoelectrons is excited upon the absorption of one single photon [3]. Since the interaction between electrons is a necessary ingredient of the DPE process, DPE spectroscopy has the potential to directly characterize electron correlation in condensed matter ranging from magnetic materials to transition metal oxides, as well as superconductors [4].

[1] C.-T. Chiang et al., App. Phys. Lett. 101, 071116 (2012). [2] C.-T. Chiang et al., New J. Phys. 17, 013035 (2015).
[3] A. Trützschler, M. Huth, and C.-T. Chiang et al., Phys. Rev. Lett. 118, 136401 (2017). [4] C.-T. Chiang et al., Prog. Surf. Sci. 95, 100572 (2020).