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Lehrstuhl für Experimentelle und Angewandte Physik

Prof. Dr. Rupert Huber

Seminar

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Exploring petaherz-scale solid state physics by attosecond high-harmonic-based ultrafast spectroscopy

With a tremendous advance in attosecond extreme-ultraviolet (EUV) high-order harmonics sources in the last decade, a novel research field studying the ultrafast interaction ofan light field with solid electron system on the time scale comparable to a single cycle of light field has recently attracted a great deal of attention [1-3]. The light-field driven electronic response will offer opportunities for developing future ultrafastfunctionalities of solid-state devices with an operational speed of light frequency, namely petahertz (PHz: 1015 Hz). For such response, an interplay between an intraband drift motion and an interband transition of electrons coherently driven by light fieldis essential for electron dynamics. In addition to this coherent motion, electrons suffer from decoherence and relaxation induced by mainly the electron-electron scattering with a typical time constant of less than 10 fs. Moreover, there is a possibilitythat the band dispersion also dynamically changes by light field in the case of relatively high intensity field. Thus, the petahertz-scale solid state physics will promote us to open the frontier of novel ultrafast spectroscopic techniques.
From this point of view, we have been exploring various spectroscopic techniques that enable us to track the dynamical electrons in both energy and momentum space with an unprecedentedtemporal resolution of from a few femtosecond down to attosecond in solid state materials. In this talk, we introduce our recent research activities in the development of attosecond high-order harmonic sources [4], and ultrafast EUV spectroscopy techniquesbased on them [5]. We applied our developed attosecond transient absorption spectroscopy and sub-5-fs angle-resolved photoemission spectroscopy (ARPES) to various solid electron systems from wide-gap semiconductors to 2D materials.

References

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