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Attosecond reversible and irreversible electron dynamics in strong optical fields

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Attosecond pump-probe spectroscopy has opened up the possibility to study light-matter interaction with unprecedented time resolution. In this talk, I will present the results of our experiment-theory collaboration, where we apply attosecond transient absorption spectroscopy to follow the sub-laser-cycle electron dynamics of atomic xenon during strong-field tunnel ionization. The electron dynamics of 'fuzzy'xenon is found to exhibit two opposite types of electron motion induced by an intense, nearinfrared laser: one corresponds to an irreversible, monotonic ion build-up process as predicted by widely used tunnel ionization models; another one is associated with a reversible, periodic electron displacement due to transient ground-state polarization. Albeit well known in the weak-field regime, the role of polarization has so far been largely unnoticed, both experimentally and theoretically, in the strong-field regime. Such a dichotomy of electron dynamics in strong optical fields is expected to have an even larger impact on the strong-field-driven behavior of spatially extended, complex physical systems.

Primary author: CHEN, Yi-Jen (CFEL, DESY)

Presenter: CHEN, Yi-Jen (CFEL, DESY)

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