# Unravelling time-resolved photoemission by attosecond streaking

S. Nagele[1], R. Pazourek[1], J. Feist[2], and J. Burgdörfer[1]

[1]*Institute for Theoretical Physics, Vienna University of Technology, 1040 Vienna, Austria, EU*
[2]*Departamento de Física Teórica de la Materia Condensada, Universidad Autónoma de Madrid, 28049 Madrid, Spain, EU*
stefan.nagele@tuwien.ac.at

With the advent of phase-controlled few-cycle infrared (IR) laser fields and extreme-ultraviolet (XUV) attosecond light pulses the direct observation and control of electronic motion on its natural time scale has become possible [1]. One of the most important experimental techniques is attosecond streaking which is an XUV-IR pump-probe method that enables time domain studies of photoionization for atoms, molecules, and solids with unprecedented resolution [2]. The challenge in interpreting the obtained time delays lies in disentangling the intrinsic temporal shift of the photoionization process, the so-called Eisenbud-Wigner-Smith (EWS) delay (which corresponds to the group delay of the emitted photoelectron wavepacket), and additional measurement-induced contributions caused by the probing IR field in the streaking setup.

We present theoretical studies based on accurate quantum-mechanical simulations of attosecond streaking for one- and two-electron systems obtained by directly solving the time-dependent Schrödinger equation. On the one-electron level we identify effects of the probing IR field on the extracted streaking delays in the entrance (initial state) and in the exit (continuum) channel for atomic photoemission [3]. On the multi-electron level we investigate the effect of electronic correlations on the time delays and explore their influence in the presence of the probing streaking field [4]. In particular, we study shake-up ionization in helium as a prototypical example for a highly correlated ionization process [5].

We show that the EWS time delays for photoionization are accessible in attosecond streaking when all measurement-induced effects are properly accounted for. We quantify the contributions to the streaking time shifts with attosecond precision and provide benchmarks for future experiments.

References:
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