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Time-resolved photoelectron emission from atoms and surfaces: the photoeffect revisited[1]

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Streaking spectroscopy experiments enable the resolution in time of photo-ionization processes at the natural time scale (tens of attoseconds, 1 as = 10^{-18} seconds) of the motion of valence electrons in atoms and solids. This ultrahigh time resolution allows the observation of an apparent "delay-time" *difference* between the release and detection of photoelectrons from different initial states of atoms and solids. These delays are typically of the order of tens of attoseconds and are a measure of the net quantum phase that is accumulated during the *entire* photoemission process, including the release, propagation, and detection of the photoelectron. I will discuss different interpretations of and contributions to photoemission delay times based on the comparison of calculated time-resolved photo-electron spectra with recent experiments [1,2]. In particular, for time-resolved photo-emission from metal surfaces [3,4], we find our calculated electron spectra to be very sensitive to details in the modeling of dielectric-response and electron-propagation effects during the laser-assisted XUV excitation and emission process [5]. The sensitivity of photoemission time delays to the plasmonic response of solid surfaces suggests the time-resolved observation of collective (plasmonic, excitonic, etc.) excitations in atoms, nano-particles, and solids.

[1] C.-H. Zhang and U. Thumm, *Phys. Rev.* A **82**, 043405 (2010);
[2] *Phys. Rev.* A **84**, 033401 (2011);
[3] *Phys. Rev. Lett.* **102**, 123601 (2009);
[4] *Phys. Rev.* A **84**, 065403 (2011);
[5] *Phys. Rev.* A **84**, 063403 (2011).

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