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

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Streaking spectroscopy experiments enable the resolution in time of photo-ionization processes at the natural time scale (tens of attoseconds, \(1 \text{ as} = 10^{-18} \text{ seconds}\)) 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.


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