Attosecond time-resolved spectroscopies from solid surfaces and nanoparticles[1]

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Attosecond time-resolved spectroscopy is a thought-provoking powerful method for investigating the electronic dynamics in atoms [1], and this technique is now being transferred to the scrutiny of electronic excitations, electron propagation, and collective electronic (plasmonic) effects in solids [1-4] and nanoparticles [1,5,6]. Compared with photoemission from isolated gaseous atoms, numerical simulations of such experiments on complex targets require, in addition, the adequate modeling of (i) the target's electronic band structure [1,2], (ii) elastic and inelastic scattering of released photoelectrons inside the solid [2-6], (iii) surface and bulk collective electronic excitations [1,5,6], (iv) the screening and reflection of the assisting IR-laser field at the solid surface [3], (v) the influence of equilibrating residual charge distributions on emitted photoelectrons [1], and (vi) the effect of spatially inhomogeneous plasmonic fields on the photoemission process [2,5,6].

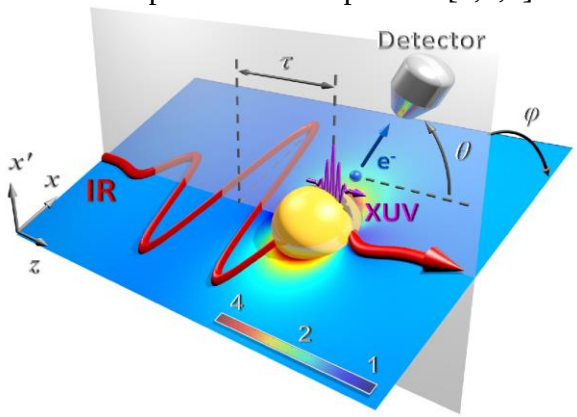

Fig. 1: A single ultrashort attosecond XUV pulse emits electrons into the field of a delayed IR streaking laser pulse, with the polarization direction rotated by the angle φ. The linear color/gray scale represents the local electric-field-strength enhancement for 50 nm radius Au nanospheres exposed to 720 nm incident IR pulses with peak intensity 10^{11} W/cm^2 [5].

This talk will address the extent to which photoelectron propagation in matter and the plasmonic response of nanostructures can be (a) represented in classical [1,6] and quantum mechanical [1-5] simulations and (b) retrieved in IR-streaked XUV [1,2,5,6] and IR-XUV two-photon interference (RABBITT) [3,4] photoemission spectra. As examples, I will discuss our recent numerical results for photoemission from (adsorbate-covered) metal surfaces [2,3] (in comparison with experimental data) and from plasmonic 10 to 200 nm diameter spherical nanoparticles that show how spatio-temporal information of the sub-infrared-cycle plasmonic and electronic dynamics is embedded in time-resolved spectra (Fig.1) [5,6].

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