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Coulomb and polarization effects in dynamic imaging with strong laser fields

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Interaction of few-cycle intense infrared laser pulses and attosecond XUV pulses with atoms and molecules opens new avenues for imaging electronic dynamics and molecular structures with sub-Angstrom spatial and sub-femtosecond temporal resolution. These approaches are based on either (i) photo-ionization by an attosecond pulse in the presence of a strong IR field or (ii) on laser-field driven electron recollision with its parent molecule following strong-field ionization of the molecule. Information about electronic dynamics and molecular structures can be recorded either in photoelectron spectra or in the high-frequency radiation emitted during electron recollision with the parent ion. The combination of high temporal and spatial resolution does not come for free. In all approaches, strong laser field is present during the interaction, affecting dynamics of both bound and continuum electrons in a complex way. Quantitative analysis of strong-field approaches requires understanding of both laser-induced polarization effects (bound dynamics) and interplay of ionic potential and strong laser field in the electron motion in the continuum. In this talk I will describe theoretical approaches to analyzing these effects and show how they manifest themselves in photo-electron spectra and in high-frequency emission spectra. In particular, I will describe how electron localization affects spectra of high-frequency emission and how attosecond dynamics of laser-induced polarization can be visualized in photo-electron spectra. Finally, I will analyze scattering phase-shifts and modifications in the photo-electron spectra due to the interplay of the Coulomb field of the parent ion and the strong laser field. This analysis provides foundation and limitations for simple recipes of reconstructing molecular structures in strong-field approaches.