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Visualizing electron wavepacket dynamics in a strong laser field

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— Strong-field ionization, combined with 2D electron momentum imaging, has the potential to become a revolutionary tool for probing atomic and molecular structures on the femtosecond timescale. Major features apparent in intense-field photoelectron spectra have been shown to result from electrons scattered by the Coulomb potential that accumulate a different phase and interfere with electron trajectories that do not scatter. However, other features in these photoelectron spectra still remain to be explained. In this work, we use mid-infrared driving lasers to identify new structures in the low-energy photoelectron spectra from atoms, which can be unambiguously attributed to multiple sequential encounters of the laser-driven photoelectrons with the parent ion. This interpretation is obtained using a simple plane-spherical wave model, which provides physical insight into strong-field processes, and quantum-mechanical simulations validate this simple model. Reliably extracting structural information, especially dynamically changing molecules, requires a better understanding of the origin of all the photoelectron spectral features as a function of molecular excitation, orientation, and bond length.

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