Strong-Field Ionization, Rescattering and Target Structure Imaging with Vortex Electrons

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Manifestations of and new possibilities related to vortex electrons in strong-field physics are discussed. We present a theory which extends the foundation of a powerful method of the target structure and dynamics imaging to vortex electrons. The theory enables one to extract the differential cross section (DCS) for elastic scattering of a vortex electron on the parent ion — a new collision property introduced here — from the observable photoelectron momentum distribution (PEMD). We illustrate this by considering strong-field ionisation from $\pi$ orbitals in two atoms Xe and He$^+$ and a molecule O$_2$. The vortex DCS is shown to be sensitive to the target structure. The PEMDs formed by vortex electrons are predicted to be sensitive to the chirality of the target. Extracting vortex DCSs from experimental PEMDs will open a new avenue for rescattering photoelectron spectroscopy.