Exploring sub-cycle ionization dynamics with orthogonally polarized two-color laser pulses

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Angstrom and attosecond control of free electron wave packets is one of the pinnacles of attosecond science. Orthogonally polarized two-color (OTC) laser fields allow to control the motion of field-ionizing electronic wave packets both in time and space [1]. In OTC pulses time and space are connected and thus an attosecond time scale is established in the polarization plane for both the emitted and the re-colliding wave packets [2,3].

In this submission, we report on experiments that use OTC pulses for studying atomic single and double ionization. The three-dimensional momentum vector of electrons and ions from singly and doubly charged neon was measured with the COLTRIMS technique as a function of the sub-cycle shape of the OTC pulses.

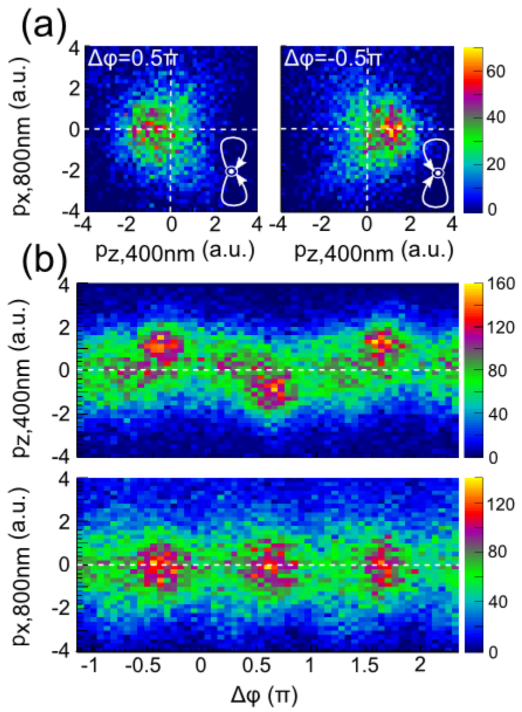

Fig. 1: Sum momentum of the two emitted electrons during double ionization in the OTC polarization plane for two values of Δφ (a) and along the z and x directions over Δφ (b).

By comparison of simulated spectra using the strong field approximation (SFA) and by solving the two-dimensional time-dependent Schrödinger equation (TDSE) within the single active electron approximation, we identify a strong influence of the parent ion's field on the emitted wavepackets. Using the sub-cycle mapping inherent to OTC fields [2,3], we trace back the ion's influence to sub-cycle emission times. We furthermore demonstrate control over the correlation between the two electrons emitted during double ionization upon electron recollsion by tuning the shape of the electric field of the OTC pulses on the sub-cycle scale. Analysis of the spectra of the sum momentum vector (Fig. 1) in terms of their mean values and widths along the polarization directions of the two colors allows obtaining detailed insight into the correlated electron emission dynamics. Our analysis reveals that for certain relative phases Δφ a very strong electron-electron anti-correlation is obtained in very good agreement with theoretical prediction [4].

References:
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