Counterintuitive angular shifts in the photoelectron momentum distribution for atoms in strong few-cycle circularly laser pulses

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Synopsis We have recently developed a method for solving the time-dependent Schrödinger equation for a diatomic molecule (atom) interacting with a strong few-cycle elliptically polarized laser pulse. Here we present the first fully ab initio calculations of the photoelectron momentum distributions for a circularly polarized laser pulse interacting with an atom. Furthermore, we provide a precise quantum mechanical explanation of counterintuitive shifts in the dominant direction of electron ejection, observed in a recent experiment [P. Eckle et.al. Science **322**, 1525 (2008)]. Our results underline the importance of including both the laser field and the Coulomb interaction in the description.

There has recently been a growing interest in the ionization of atom and molcules by intense few-cycle elliptically polarized laser pulse. This motivates the development of applicable theory in this regime.

We have recently developed a method for solving the TDSE for a diatomic molecule (or atom) interacting with a strong few-cycle elliptically polarized laser pulse. The method is an extension of the method presented in [1] to the case of a general elliptically polarized pulse. It is based on the fact that the Hamiltonian is sum of operators cylindrically symmetric around different axis.

Here we present the first fully *ab-initio* calculations of the photoelectron momentum distributions for a few-cycle circularly polarized pulse interacting with an atom. Based on these calculations, we are able to provide a precise quantum mechanical explanation of the conterintuitive angular shifts in the dominant direction of electron ejection, observed in a recent experiment [2]. The dominant direction of ejection does not coincide with the axis defined by the vector potential at field maxima, as predicted by standard theories like the strong-field approximation (SFA) or the ADK tunneling theory.

A comparison with the commonly used SFA reveals an important short-coming of the SFA (ADK tunnelling theory) for a few-cycle circularly polarized laser pulse interacting with an atom. Our results clearly reveal the importance of including the combined effects of the Coulomb and laser fields in the desription.

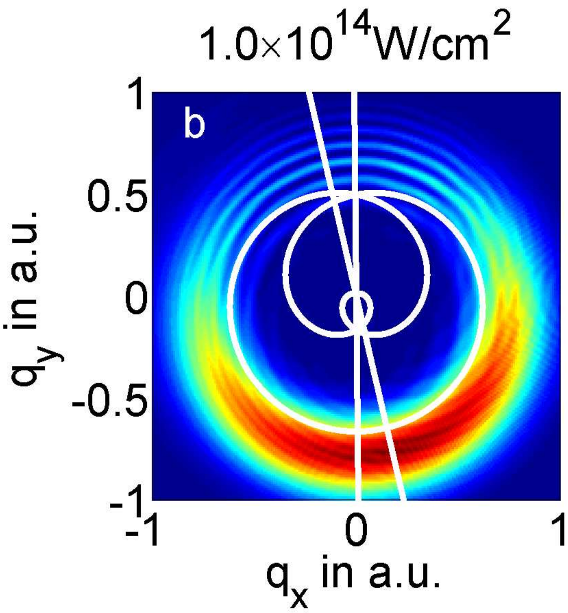

Fig. 1. Momentum distributions in the plane of polarization $dP/dq_x dq_y dq_z|_{q_z=0}$ for strong-field ionization of H(1s). The curves shows the vectorpotential with opposite sign, while the straight lines in highlight the angular shift (see text). The 800 nm, $I = 10^{14}$W/cm^2 laser field is circularly polarized, and contains 3 optical cycles

References

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