Multi-photon two-color ionization of atoms by femtosecond pulses

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We will discuss processes involving multi-photon ionization of atomic systems by circularly polarized femtosecond pulses. In particular, emphasis will be placed on the influence of the field helicities on the photoelectron angular distribution (PAD).

We first analyze the characteristics of atomic ionization induced by circularly polarized two-color femtosecond pulses. Two-pathway interferences between nonresonant one-photon and resonant two-photon ionization in the vicinity of an intermediate resonance are considered in detail for atomic hydrogen. Using circularly polarized radiation opens up a rich field of possible further investigations [1]. The properties of the PAD are obtained by solving the time-dependent Schrödinger equation and also by employing a second-order nonstationary perturbative approach. The general dependence of the PAD (see Fig. 1) on the intensities, helicities of the harmonics, pulse lengths, and carrier envelope phases is considered in detail. It is demonstrated that one can control the dominant direction of electron emission.

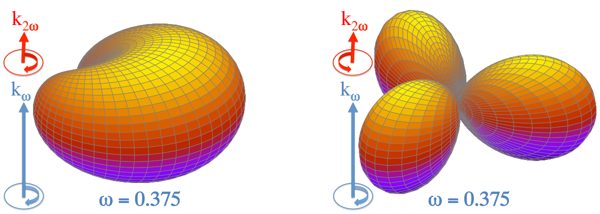

Figure 1. PAD in atomic hydrogen for a mixture of co-rotating (left) and counter-rotating (right) fields of the fundamental and the second harmonic. The fundamental frequency is tuned to the $1s \to 2p$ resonant transition ($\omega = 0.375$ a.u.).

Next, we discuss a recent study concerning the ionization of helium induced by circularly polarized XUV and optical fields [2]. The XUV pulse (peak intensity 10^{13}W/cm^2) first ionizes He and then sequentially pumps the remaining electron from the He$^+$ ground state to the excited $3p$ state, while the optical field (10^{12}W/cm^2), which can either be co-rotating or counter-rotating with respect to the XUV field, ionizes He$^+$ via multi-photon absorption. The obtained theoretical photoelectron spectra, as well as the PAD corresponding to the low-energy peak at 200 meV, are presented in Fig. 2 for both mutual helicities. We will discuss the observed large circular dichroism (CD) and its strong variation as a function of the optical laser intensity. The CD changes sign at the surprisingly low intensity of about $1.5{\times}10^{12}$W/cm^2. Comparison with recent experimental results [2] will be presented at the conference.

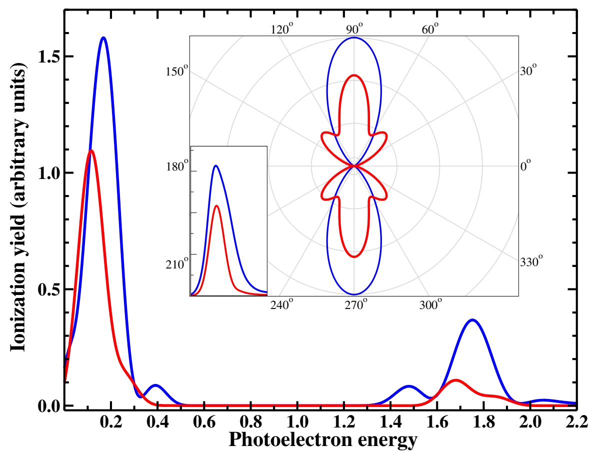

Figure 2. Theoretical photoelectron spectra for He$^+$ in the case of co-rotating (blue) and counter-rotating (red) XUV and optical fields. The inset shows the PADs corresponding to the lowest emission peaks.

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References

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[2] Ilchen M *et al.* 2016, *in preparation*

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