Interference effects in one-photon and two-photon ionization by femtosecond VUV pulses due to an intermediate state

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Two-pathway coherent control of photoionization and photodissociation has attracted much attention during the past two decades, from both experiment and theory alike. In experiments with X-ray free electron lasers (XFELs) a mixture of fundamental and higher harmonic frequencies is produced, which may be used in a coherent control scheme.

We theoretically studied interference effects in two-pathway ionization by the fundamental (two-photon ionization) and its second harmonic (one-photon ionization) when the two-photon channel is affected by an intermediate atomic resonance. While interference between the amplitudes of one- and two-photon ionization does not contribute to the total yield, an effect may appear in the photoelectron angular distribution (PAD) [1-3]. As an indicator for the two-pathway coherence, we use the asymmetry of the PAD with respect to the plane perpendicular to the electric field,

$$A(\theta) = [W(\theta) - W(\pi - \theta)] \,/\, [W(\theta) + W(\pi - \theta)] \ . \qquad (1)$$

Here $W(\theta)$ is the intensity of the electron flux at an angle θ relative to the direction of the linear polarization of the XFEL. The asymmetry (1) depends on the XFEL parameters: the photon energy, the relative phase between the harmonics, their intensity, etc.

The process is exemplified by ionization from the hydrogen H(1s) state in the vicinity of the 1s-2p transition. Figure 1 shows the photon-energy dependence of the asymmetry $A(0)$ for different pulse durations, at a fixed peak laser intensity of 10^{12} W/cm^2 and the intensity of the second harmonic set to 5% of the fundamental. Predictions for other XFEL parameters, new analytical results, and those obtained by solving the time-dependent Schrödinger equation will be presented at the conference.

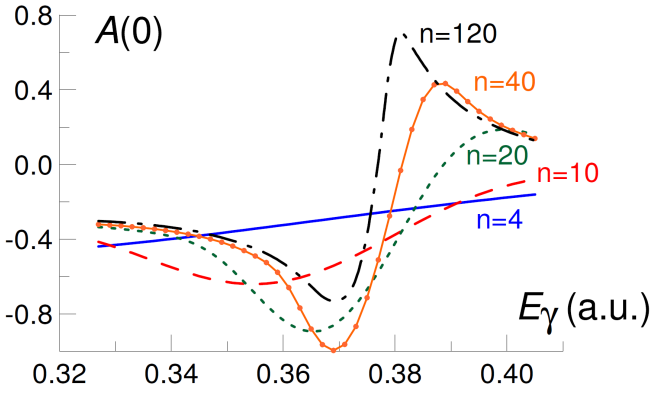

Figure 1: *Asymmetry in the PAD for zero relative phase and time delay between the fundamental and second harmonics; n indicates the number of optical cycles in the laser pulse with a sin^2 envelope. The above results were obtained by nonstationary perturbation theory.*

References

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