Intracycle interference in laser assisted XUV atomic hydrogen ionization

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Synopsis We present a theoretical study of ionization of the hydrogen atom due to an XUV pulse in the presence of an IR laser with both electric fields linearly polarized in the same direction. By means of a very simple semiclassical model we explain the photoelectron (PE) spectrum as the interplay of *intra-* and *intercycle* interferences.

Laser assisted photoemission (LAPE) corresponds to two-color multiphoton ionization, where one of the fields has high frequency compared to the other. Depending on the pulse durations, two regimes can be distinguished: (i) the XUV pulse is much shorter than the IR period, i.e., streak camera [1], and (ii) the XUV pulse is longer than the laser period [2], with the ensuing formation sidebands (SBs) due to the absorption/emission of additional laser photons.

In this work we focus on the second regime for atomic hydrogen photoionizaton. Within the semiclassical model [3], the electron spectrum can be explained in terms of *intracycle* interferences stemming from trajectories within the same optical cycle and *intercycle* interference stemming from trajectories released at different cycles. The PE espectra are characterized by peaks at energy values given by

$$E_n = n\omega_L + \omega_X - I_p - U_p \tag{1}$$

modulated by the intracycle interference pattern. In Eq. (1), $\omega_{X(L)}$ is the frecuency of XUV(IR) pulse, I_p is the ionization potential, U_p the ponderomotive energy and n is the number of absorbed / emitted IR photons.

From the Fig. 1(a) for emission parallel to the polarization axis, the *intercycle* interference arises as the coherent superposition of the electron trajectories born at different optical cycles giving rise to SBs equally spaced by ω_L. Besides, the *intracycle* interference arises as the coherent superposition of the two electron trajectories released in the same optical cycle and giving rise to the modulation of the SBs. For emission perpendicular to the polarization axis, the intracycle interference pattern can also be thought as the interference between electron trajectories born at each half cycles of the same optical cycle (*intrahalfcycle*) and interference between trajectories from the first and the second half cycle of the laser (*interhalfcycle*). The destructive *interhalfcycle* interference explains the characteristic SBs separated by twice the IR photon energy, as we can see in Fig. 1(b). Our calculations are in good agreement with quantum results within the strong field approximations and the numerical solution of the time-dependent Schrödinger equation [3].

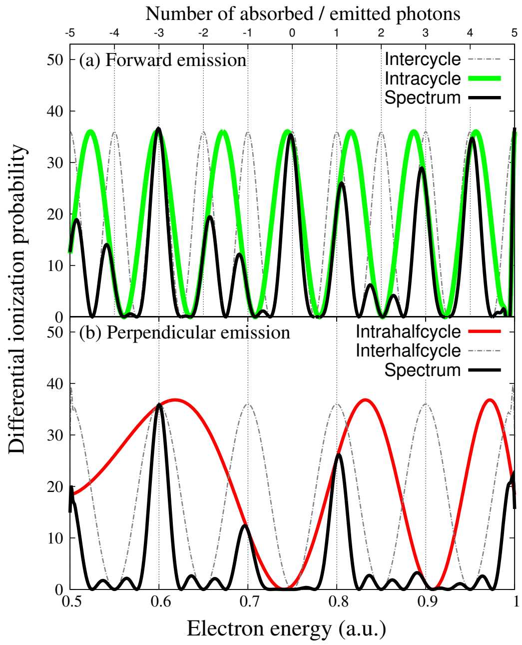

Figure 1. Photoelectron spectra in (a) the forward and (b) the perpendicular directions (black line). The color line depicts the intra- and intercycle interferences. Vertical lines exhibits the positions of the SBs according to Eq. (1). The IR laser amplitude is $F_{L0} = 0.05$ and $\omega_L = 0.05$. $\omega_X = 1.5$ and duration of the XUV is two IR cycles

References

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