Channel Separation of Secondary Generated Radiation in Atomic Gases Irradiated by Orthogonal XUV and Infrared Pulses

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Interaction of an intense infrared (IR) pulse with an atomic target in the presence of extreme-ultraviolet (XUV) pulses induces additional channels of secondary generated radiation (SGR) for the high-order harmonic generation (HHG) process. In an intense IR field the HHG process is realized through the three-step scenario, which consists in the tunneling, propagation, and recombination [1,2]. One of these additional channels (XUV-assisted HHG channel) originates from the absorption of XUV photon ω_{XUV} at the moment of recombination resulting in the formation of a second XUV-induced plateau with an extended cutoff from ω_c to $\omega_c + \omega_{\mathrm{XUV}}$, where ω_c is the classical plateau cutoff in the IR field [3]. Harmonics on the additional plateau can be utilized for several practical applications, such as HHG-based spectroscopy [3], attosecond pulse metrology [4, 5], and visualization of contributing closed classical trajectories in the IR field [6]. Another channel is the second-harmonic generation (SHG) of the XUV pulse by an IR-dressed atom [7]. If the XUV pulse is much shorter than the IR-field period, the amplitude of SHG is proportional to the magnitude of IR field at the instant corresponding to the time delay between IR and XUV pulses. Thus, the measurement of the time-delay dependence of SHG yield makes possible to retrieve the temporal profile of the squared IR field and it provides an alternative to the streak camera for detecting an IR field. However, if the doubled XUV frequency belongs to the interval from ω_c to $\omega_c + \omega_{\mathrm{XUV}}$, the XUV-assisted HHG channel interferes with the XUV SHG channel which can thereby negatively affects the use of these channels in mentioned applications.

This work shows that the XUV SHG and the XUV-assisted HHG channels can be well separated in the orthogonal geometry of the linearly polarized XUV and IR pulses. Measuring the components of secondary-generated radiation along IR and XUV field polarization vectors provides access to the XUV SHG channel and the XUV-assisted HHG channel. Our numerical results based on the solution of the three-dimensional time-dependent Schrödinger equation for moderate intensities of the IR and XUV pulses, which do not significantly ionize an atomic target, confirm the applicability of proposed technique of SGR channels separation [8].

References

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