Phase matching control of attosecond pulses for XUV continuum generation

W. Holgado[1], C. Hernández-García[1,2], B. Alonso[1,3], M. Miranda[4], F. Silva[3], L. Plaja[1], H. Crespo[3], I. J. Sola[1]

[1]Grupo de Investigación en Óptica Extrema (GIOE), Universidad de Salamanca, Pl. de la Merced s/n, E-37008 Salamanca, Spain

[2] JILA, University of Colorado at Boulder. 440 UCB Boulder, CO 80309-0440, USA

[3]IFIMUP-IN and Dep. Física e Astronomia, Univ. Porto, R. do Campo Alegre 687, 4169-007 Porto, Portugal

[4] Department of Physics, Lund University, P.O. Box 118, SE-221 00 Lund, Sweden

Corresponding author: warein@usal.es

Abstract

We present observations of the emission of XUV continua in the 20-37 eV region by high harmonic generation (HHG) with 4 fs. Under adequate chirp and phase matching conditions, which allow to control the relative delays and phases between individual attosecond pulses, the resulting interference will yield a coherent continuum without the need of an isolated attosecond burst.

Introduction

XUV continua is of high interest for different applications, such as spectral interferometry and spectroscopy. High-order harmonic generation (HHG) is the most common technique for obtaining coherent continua in that region of the spectrum, but they are usually obtained only when a single attosecond pulse is produced, and this implies gating techniques or sub-3-fs IR driving pulses. In this work we demonstrate a new approach for the generation of continuum spectra in the XUV range by exploiting the microscopic and macroscopic properties of HHG.

Experimental Results

It is known that spectral phase of the driving IR pulse affects the structure of the HHG spectra [1]. We have observed that negatively chirped NIR pulses, together with phase matching effects, can produce continuous spectral structures even at relatively low harmonic orders (20-35 eV in our case). When the chirp is adjusted there is a broadening in the spectrum, which eventually becomes a continuum. Fig. 1(a) shows the HHG spectra obtained in Kr when a negatively chirped pulse is used (4 fs of duration without chirp), with CEP stabilized [2]. We have observed this effect with longer driving pulses (up to 7 fs of Fourier limit duration).

Theoretical Discussion

Theoretical simulations including propagation effects [3] show good agreement with experiments (Fig. 1(b)), highlighting the role of both chirp and phase matching for obtaining XUV continua. It is shown clearly that several attosecond pulses are emitted in the train (Fig. 1(b) insets), however, depending on the NIR pulse conditions, those attosecond pulses can interfere so as to yield a continuum spectrum instead of the more usual multi-peaked harmonic like spectrum.

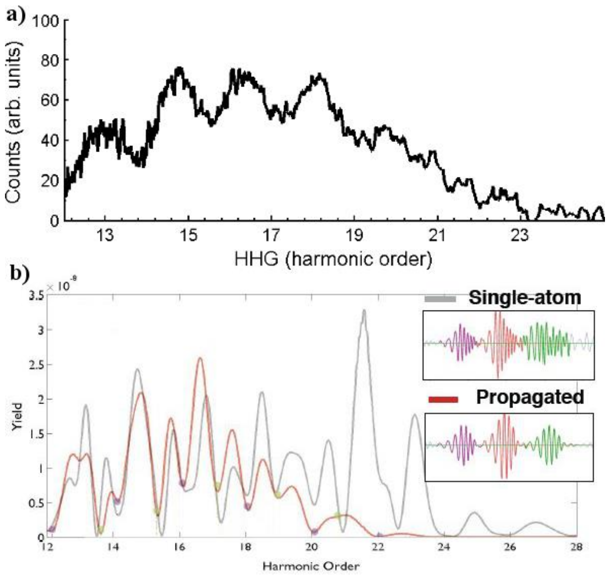

Fig. 1. **(a)** HHG spectrum generated by negatively chirped pulses in Kr. The pulse duration without chirp is 4 fs. **(b)** Simulated HHG spectra (inset: electric field in time domain for single atom and propagated cases). Grey line: single atom response. Red line: including propagation

In conclusion, we have shown experimentally and theoretically that by controlling the IR pulse chirp and the phase matching conditions, the pattern of spectral interference among several attosecond pulses can be changed in order to yield a continuum spectrum.

References

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