Phase-matching of high-order harmonic generation in a semi-infinite gas cell geometry

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Synopsis Phase-matching of high-order harmonic generation in a semi-infinite gas cell geometry is investigated. A systematic study of experimental phase-matching conditions with variation of pressure and focus positions is performed for different focal lengths and in different rare gases. These results are compared to phase-matching simulations.

We study the high-order harmonic generation (HHG) by rare gases in semi-infinite gas cell (SIGC) geometry. This geometry features a straight-forward handling without the need for alignment procedures. Due to the large interaction region and the possibility of high densities, this scheme promises a high photon flux without limit to the pulse repetition rate in contrast to other geometries, i.e. pulsed gas jets.

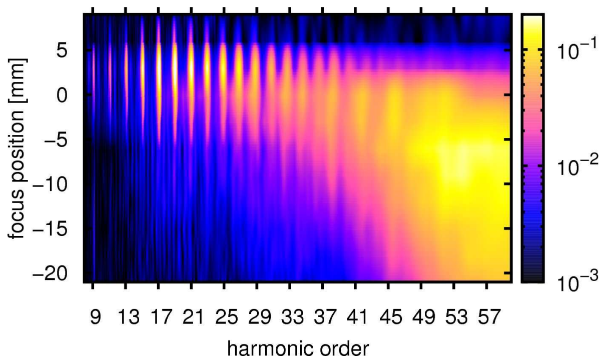

Fig. 1. Experimental map of harmonic yield versus harmonic order and focus position in a SIGC filled with helium.

A systematic study on experimental phase-matching conditions is performed which includes dependency on pressure and the focus position (see Fig. 1). The differences between the phase-matching conditions for a gas with high ionization potential, namely helium, and a gas with low ionization potential, namely xenon, is investigated. Since the gas pressure within the SIGC can be determined accurately, the experimental results can be directly compared to our results of phase-matching simulations (see Fig. 2). In simulations, the harmonic yield in the far field for a SIGC geometry is computed accounting for phase-matching using dipole data from the Lewenstein-model.

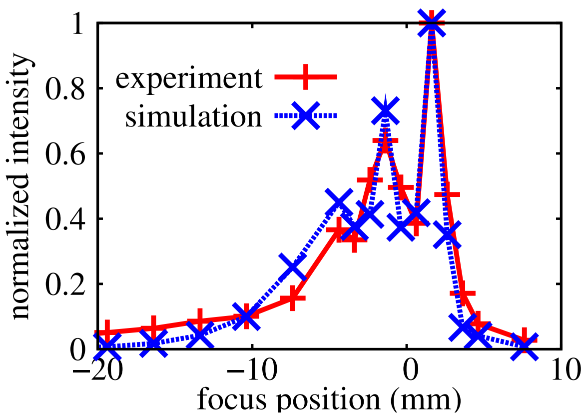

Fig. 2. Comparison of experimental and simulation results for HHG in helium in a SIGC. The harmonic intensity is recorded for various focus positions. For comparison, results from phase-matching simulations at comparable conditions are shown.

The phase-matching is investigated regarding the mentioned dependencies for different focusing. The emphasis of these studies places on short focal lengths to extend towards experimental conditions suited for low-energy pump pulses at high repetition rates. Due to the accurate knowledge and reproducibility of experimental condition in a SIGC, this scheme is a promising tool for the generation of isolated attosecond pulses.

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