Quantum Path Interferometry using Chirped High-order Harmonic Generation

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High-order harmonic generation (HHG) is a process usually described by a three-step model in which (i) an atom is ionized in a strong field which (ii) may accelerate the electron and force it back to its parent ion where (iii) it might recombine [1]. The electrons follow two major classes of trajectories in step (ii), termed the short and long trajectories, depending on the excursion time of the electron.

These three steps have been helpful to understand the basic principles of HHG, but the finer details are not captured in this crude model. The emission of the radiation is strongly dependent on the quantum paths of the electrons and each harmonic will have an intrinsic chirp, depending on which trajectory (short/long) that it originates from [2]. By chirping the driving field, the intrinsic chirp can be enhanced or cancelled leading to spectral broadening or narrowing, respectively. Since the emitted radiation from the short and the long trajectories overlap spectrally and spatially in the far-field, we can observe the interference between them [3] and control it by varying the chirp of the driving field. This is an analogue of an interferometer in that we can control the chirp of the individual "arms", akin to how one controls the path length in a conventional interferometer.

Experimental data is compared to time-dependent Schrödinger equation calculations and a simple interference model based on Gaussian beams. The different interferences observed hint at the possibility of reconstructing the temporal structure of the full attosecond pulse train.

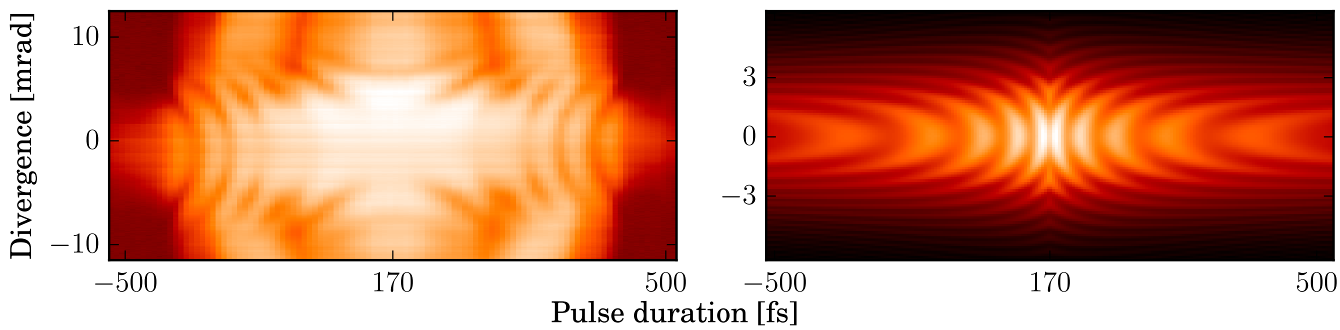

Figure 1: *Spatial lineouts of the 17th harmonic of 1030 nm, for different pulse durations. A negative sign of the duration corresponds to negative chirp (red edge first, blue edge last) and vice versa. To the left, experimental data are shown, while to the right, the results from the simple Gaussian model are shown.*

References

[1] P. B. Corkum, Phys. Rev. Lett., **71**(13), 1994–1997, (1993)
[2] K. Varjú *et al.*, J. Mod. Optic., **52**(2–3), 379–394 (2005)
[3] A. Zaïr *et al.*, Phys. Rev. Lett., **100**(14) (2008)