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Attosecond pulse trains from long laser-gas interaction targets

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Many experiments in attosecond physics require high XUV photon flux as well as a clean attosecond pulse train (APT) temporal structure. Temporal characterization of high-order harmonic generation (HHG) in long interaction targets is thus of high interest. HHG being a very inefficient process, a large effort has been made to increase the amount of XUV photons emitted per infrared laser pulse. Besides quasi phase-matching in a modulated capillary[1], loose driving laser focusing conditions and subsequent self-channeling have shown to significantly increase the conversion efficiency[2]. We characterized the temporal structure of APTs generated during the self-channeling of an intense IR driving laser pulse. Our first results indicate, however, that the temporal structure of the APT generated during the HHG process might be affected by quantum path interference and spectral phase distortion due to the self-channeling process itself. In particular, our measurements show that the relative spectral phase between consecutive harmonics can strongly vary depending on the target length and the position of the laser focus with respect to the target. In general for short gas targets, no clean APT structure can be expected since the individual attosecond pulses carry significant chirp. For longer targets, however, we observe a flattening of the harmonic spectral phase, resulting in near-transform-limited attosecond pulse trains. A complete analysis of the process is complex and involves detailed knowledge of the spatial and temporal evolution of the self-channeling driver laser pulse throughout the gas target.

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