

# **Relativistic High-order Harmonic and Short Pulse Generation**

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High-order harmonic generation (HHG) with relativistically strong laser pulses employing highly charged ions is a promising path towards coherent short wavelength radiation sources. The systems generating harmonics are highly charged ions and the medium in which HHG is realized is an underdense plasma. We discuss several means of increasing the efficiency of rescattering in the relativistic regime and obtaining a strong harmonic signal. This is achieved via assisting the infrared strong laser field with a weak attosecond pulse train of XUV photons, employing strong tailored laser pulses, counterpropagating circularly polarized and equal-handed laser pulses or counterpropagating attosecond pulse trains. In order to give evidence of a macroscopic harmonic yield after propagation through plasma, we investigate the conditions for rendering quasi-phase-matching of the harmonics. High-order harmonic emission in these setups are enhanced by several orders of magnitude in comparison to the case of a single laser wave. This way hard x-ray harmonics and extremely short pulses can be feasible.