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Control of attosecond light polarization in two-color bicircular fields

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Circular or highly elliptical femtosecond and attosecond pulses in the extreme ultraviolet spectral range present numerous applications in chiral-sensitive light-matter interactions1,2. Until recently, such radiation has only been available at large-scale facilities, where the time resolution is above 100 femtoseconds. Generation of coherent light sources with attosecond duration and controllable ellipticity will enable complementary studies on ultrafast time-scales.

An elegant approach to the generation of such pulses consists of combining a circularly polarized fundamental field with a counter-rotating second harmonic3. This scheme leads to harmonic peaks at (3N+1) and (3N+2) lines, with the helicity of the fundamental field and the second harmonic, respectively, while 3N harmonics are absent due to symmetry. Recent theoretical studies4,5 have shown that when neon is ionized by such bicircular fields, a considerable amount of suppression of the (3N+2)-lines is observed in the high harmonic spectrum. The reason behind this effect is still not well understood and thus, while these works opened the way to the generation of elliptically polarized attosecond pulses, control over such ellipticity is still to be achieved. In this work, we provide an in-depth analytical analysis of the high harmonic generation process in two-color counter-rotating circular fields6,7. We do so using an analytical model based on the strong field approximation and by solving the time-dependent Schrödinger equation in the single-active electron approximation for both helium and neon, comparing our predictions to experiment. In particular, we derive three propensity rules which are responsible for the suppression of the (3N+2)-lines in the high harmonic spectrum of neon. By changing the relative intensity between the two fields, we show that we can coherently control the ellipticity of the generated attosecond bursts.

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