Tailoring THz radiation by controlling tunnel photoionization events in gases

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Applications ranging from nonlinear terahertz spectroscopy to remote sensing require broadband and intense THz radiation which can be generated by focusing two-color laser pulses into a gas. In this setup, THz radiation originates from the buildup of the electron density in sharp steps of attosecond duration due to tunnel ionization, and subsequent acceleration of free electrons in the laser field. We show that the spectral shape of the THz pulses generated by this mechanism is determined by superposition of contributions from individual ionization events. This provides a straightforward analogy with linear diffraction theory, where the ionization events play the role of slits in a grating. This analogy offers simple explanations for recent experimental observations and opens new avenues for THz pulse shaping based on temporal control of the ionization events. We illustrate this novel technique by tailoring the spectral width and position of the resulting radiation using multi-color pump pulses.

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