Laser-Plasma Generation of Tunable Few-Cycle Mid-Infrared Pulses

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We examine a new method for generation of the coherent few-cycle mid-infrared pulses. The method utilizes the gas ionization by ultrashort incommensurate two-color laser pulses. These incommensurate two-color pulses contain the fields at two different frequencies. One of the frequencies is detuned from the doubled value of the other one. Such incommensurate pulses can be obtained with the use of the nonlinear crystal (for example, BBO or KDP) or with the use of the optical parametric amplifier. In the latter case, the main (in the respect of intensity) field component has greater central frequency than the weaker field has; and the frequency of the weaker field can be reasonably easy tuned around the halved value of central frequency of the main field, which stays fixed [1].

We calculate the electron current which is excited by such two-color pulse in a gas during ionization through the use of the semiclassical approach both analytically and numerically and find out that the low-frequency component of that current can have central frequency in the mid-infrared range, which can be controlled by tuning the frequency of the weaker optical field. The full-dimensional simulations based on the quantum-mechanical approach (the solution of the 3D time-dependent Schrödinger equation) support the results obtained from the semiclassical approach. We estimate energy radiated by that current and discuss the possibilities of employing the phenomenon for creating the tunable source of coherent few-cycle mid-infrared pulses.

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