Study of mechanisms of second-harmonic generation of femtosecond laser pulse during plasma production in the presence of quasi-dc electric field

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In this paper, we investigate the mechanisms of the second-harmonic generation (SHG) during the interaction of the femtosecond laser field with gas in the presence of an external quasi-dc electric field. Based on the numerical solution of the time-dependent Schrödinger equation for hydrogen atoms, we find the ranges of parameters (intensity and wavelength) of the laser pulse, where the second harmonic is generated by four-wave mixing based due to the response of bound electrons or ionization-induced multiwave mixing due to the response of free electrons. In the latter case, the SHG occurs on the time scale of gas ionization (the growth of the plasma density), which is much shorter than the laser pulse duration due to the very strong dependence of the ionization rate on the electric field strength. Due to this, the parameters of laser pulses corresponding to the ionization mechanism of SHG are attractive for implementing sampling methods of measuring the waveforms of broadband terahertz radiation based on the SHG of probe laser pulse with variable time delay related to the terahertz field. The work was partially supported by the Russian Foundation for Basic Research (Grant No. 20-32-70213).