EMISSION OF TERAHERTZ WAVES during INTERACTION OF LASER PULSE WITH Dense HOT PLASMA

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The generation of terahertz (THz) radiation in the interaction of a laser pulse with a dense plasma was theoretically studied in publications [1, 2]. The generation of THz radiation was considered in [1] under conditions where the high-frequency skin effect is satisfied for laser and THz radiation. In the publication [2], the case when the regime of the anomalous skin effect for THz waves and the high-frequency skin effect for laser radiation is realized. In this paper, we consider the generation of THz pulses under conditions of an anomalous skin effect, both for THz and for laser radiation under the action on the supercritical plasma.

The penetration of a focused laser pulse into supercritical plasma under the conditions of anomalous skin effect is considered by using the Vlasov kinetic equation. The spatial and time dependences of the laser field in plasma are obtained for a laser pulse of finite width and duration. The excitation of low-frequency electromagnetic fields in plasma under the action of laser radiation is analyzed by solving the kinetic equation for plasma electrons. A boundary value problem for low-frequency fields is solved, and their spatial distributions in plasma and vacuum are obtained. The spatial structure of the low-frequency signal in vacuum in the far zone is calculated, and its frequency for case of a femtosecond laser pulse is shown to lie in the THz band. The physical characteristics of THz radiation are considered. The spectral composition of THz radiation is studied as a function of the degree of laser focusing. It is shown that, for a tightly focused laser pulse, the emission spectrum contains a wide spectral peak at a frequency on the order of the reciprocal laser pulse duration. As the transverse size of the laser pulse increases, the spectral maximum shifts toward lower frequencies. The directional pattern of THz radiation is studied, and it is shown that, for a tightly focused laser pulse, THz waves propagate almost along the plasma boundary. As the size of the laser focal spot rises, the propagation angle of THz emission with respect to the plasma surface increases and, for a wide laser pulse, THz radiation propagates practically along the normal to the plasma boundary. It is found that, for fixed values of the energy and duration of the laser pulse, the total energy of the THz pulse is maximal in the regime of tight focusing of laser radiation. It is shown that, under the conditions of anomalous skin effect for laser radiation, the energy of the generated THz signal is independent of the plasma density and proportional to the square of the electron temperature. The applicability conditions of the theory are given and the characteristics of the THz pulse for typical parameters of modern laser plasma experiments are estimated.

References

1. A.A. Frolov, Plasma Phys. Rep. 2007. V. 33. P. 1014.
2. S.A. Uryupin and A.A. Frolov, JETP. 2012. V. 114. P. 878.