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ON THE POSSIBILITY OF POWERFUL DISCHARGE CURRENT PULSES CREATION AT A CLOSED SURFACE AND EXCITATION BY THEM OF TERAHERTZ RADIATION *)

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Electromagnetic radiation of terahertz (THz) domain possesses unique features, attractive to both fundamental and applied studies. Non-ionizing nature of interaction allows one to apply THz pulses in different areas of science, such as chemistry, biology and medicine. Molecule orientation and alignment, detection of inclusions in matter and reflective time domain polarization spectroscopy are among numerous applications of THz radiation. These and many other applications of THz pulses require possibility for both polarization features control and achieving of a high intensity of the radiation.

Some of the most efficient schemes of powerful THz generation are based on use of laser-driven localized discharge current pulses in metallic wires as a source [1]. Formation of a fast powerful discharge current pulse is possible via irradiation of such an extended conducting target with a short laser pulse [2, 3]. Parameters of the THz pulse, radiated by the current, are controlled by the geometrical parameters of the target. For the current pulses, propagating with the speed, close to that of light, the target size of a few dozens of microns is required to obtain the frequency of the radiation of the order of one THz.

This work considers a mechanism of powerful THz radiation generation with a controlled polarization via laser-driven discharge current in a conducting target in terms of numerical kinetic modelling and analytical model. It is shown that with a certain interaction geometry, the discharge pulse may be directed along the target surface predominantly to the propagation direction of the driving laser pulse. For that, it is at least necessary that the laser pulse has enough high intensity and is not too long. Consideration of a closed elliptical target allows one to generate elliptically polarized THz pulse [4]. Main features of the radiation, such as degree of ellipticity and frequency, are determined by the geometrical shape of the target. The direction of the radiation field rotation, in turn, is determined by the direction of the discharge current motion along the wire. According to a quantitative estimation, modern petawatt lasers may allow to achieve powers of the THz pulses on the terawatt scale with the described setup.

References

[1]. K. Quinn et al., Physical Review Letters, 102 (19), 194801 (2009).
[2]. N. Bukharskii, Iu. Kochetkov, Ph. Korneev, Applied Physics Letters, 120 (1), 014102 (2022).
[3]. N. Bukharskii, Ph. Korneev, Matter and Radiation at Extremes, 8 (4), 044401 (2023).
[4]. N. Bukharskii, E. Dmitriev, Ph. Korneev, Photonics, 10 (7), 803 (2023).

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