ACCELERATION OF A RELATIVISTIC ELECTRON IN A UNIPOLAR PULSE

D.V. Gavrilenko[1], A.P. Potylitsyn[1,2], A.A. Tishchenko[1]

[1] National Research Nuclear University "MEPhI", Moscow 115409, Russian Federation
[2] National Research Tomsk Polytechnic University, Tomsk 634050, Russian Federation
dvgavrilenko@mephi.ru

Unipolar pulses of electromagnetic radiation — the waves with practically constant electric field — were suggested by Bessonov in 1981 [1], and called "strange waves" even by the author. These are the cut-off parts of a sine wave of radiation, when $\int dt \cdot E(t) \neq 0$. Today the formation of unipolar pulses [2, 3] and their possible applications for acceleration of charged particles [4] are being intensively investigated.

In this report, we consider the laser pulse pursuing an escaping electron: in that case the interaction time of the electron with the radiation increases in γ^2 times, with γ being the Lorentz factor. The numerical estimation on the base of the theory developed shows that the acceleration rate for a pulse duration $T_L = 10^{-14}\,s$ and strength $E_L = 5 \cdot 10^8\,V/cm$ is $58.7\,MeV/cm$, which is very large: say, it exceeds a hundred times the acceleration rate at the most modern classical accelerators/colliders. We also calculate the characteristics of radiation of a relativistic electron in the field of a unipolar pulse and show that the radiation is narrowly directional with a characteristic set of frequencies determined by the pulse duration.

The study was supported by RFBR, grant 19-29-12036, and by the Ministry of Science and Higher education of the Russian Federation, agreement 075-15-2021-1361.

[1] E.G. Bessonov, JETP **53**, 433 (1981).
[2] A.E. Dormidonova *et al*., JETP Letters **115**, 11 (2022).
[3] A.V. Pakhomov *et al*., Phys. Rev. A **95**, 013804 (2017).
[4] R.M. Arkhipov *et al*., Quantum Electron **50**, 801 (2020).

REVIEW OF THE TERAHERTZ EXPERIMENTS ON THE NOVOSIBIRSK FREE-ELECTRON LASER FACILITY

V. Gerasimov[1], V. Kubarev[1], E. Chesnokov[2], A. Vodopianov[3], S. Peltek[4], V. Popik[1], S. Veber[4], B. Knyazev[1], A. Nikitin[6], P. Nikitin[6], I. Khasanov[6], R. Zhukavin[7], Yu. Choporova[1], V. Paveliev[8], O. Kameshkov[1], N. Osintseva[1], V. Kukotenko[1], O. Shevchenko[1], Ya. Getmanov[1], Ya. Gorbachev[1], M. Scheglov[1], N. Vinokurov[1], G. Kulipanov[1]

[1] Budker Institute of Nuclear Physics SB RAS, 630090, Novosibirsk, Russia
[2] Voevodsky Institute of Chemical Kinetics and Combustion SB RAS, 630090, Novosibirsk, Russia
[3] Institute of Applied Physics, 603950, N. Novgorod, Russia
[4] Institute of Cytology and Genetics SB RAS, 630090, Novosibirsk, Russia
[5] International Tomography Center SB RAS, 630090, Novosibirsk, Russia
[6] Scientific and Technological Centre of Unique Instrumentation RAS, 117342, Russia
[7] Institute for Physics of Microstructures RAS, Nizhny Novgorod, 603950, Russia
[8] Samara National Research University, Samara, 443086, Russia
v.v.gerasimov3@gmail.com

For almost 20 years, users from various fields of science have been conducting fundamental research at the unique facility Novosibirsk Free Electron Laser (NovoFEL) of the Siberian synchrotron and terahertz radiation research center.

The combination of unique characteristics of NovoFEL radiation [1], as high spectral power, monochromaticity, wavelength tunability in a wide wavelength range (8–400 μm), spatial and temporal coherence, enable to solve the scientific problems that are inaccessible when using conventional terahertz sources [2].

Among the ongoing work at the NovoFEL, several main streams of research can be stand out (Fig. 1): THz photonics and plasmonics, materials science, THz acousto-optics, ultrafast time-resolved spectroscopy of molecules, optical discharge in gases, THz EPR spectroscopy of molecular magnets and paramagnetic compounds, studies the affect of THz radiation on biological objects.

The most significant results of researches achieved at the Novosibirsk radiation source in recent years will be presented.