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Interaction of an electron with unipolar pulses of arbitrary shape

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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. Now the term "unipolar" is used in a wider meaning and in the literature [2-3] they consider such pulses in which the electrical area $\int dt \cdot E(t) \neq 0$ is not equal to zero. Today the formation of unipolar pulses [4] and their possible applications for acceleration of free charged particles [5], as well as for interaction with electrons of atoms of the medium [2] are being intensively investigated.
Nevertheless, the question of the radiation generated by the interaction of relativistic electrons with unipolar pulses has still little been explored. In this report we calculate the trajectory of a charged particle in a unipolar pulse of arbitrary shape, which allows us to find the field of radiation generated in the process. We show that in the case of unipolar pulses in the Bessonov's understanding the radiation has a characteristic spectrum determined by the pulse duration, which opens up possibilities for its tuning as well as for the generation of radiation of a wide spectrum. We also calculate the energy acquired by the charge during the interaction, which allows us to precise the approximations used in [5]. Separately, the particular cases of parallel/antiparallel wave vectors and electron momenta are analyzed. They are of especial interest, because the head-on collision is a case of maximum intense radiation, and anti-head-on collision is a way of acceleration of the electrons in the field of a unipolar pulse.

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