ON THE CONDITIONS OF INJECTION AND ACCELERATION OF ELECTRONS IN A GAUSSIAN LASER BEAM [[1]](#footnote-1)\*)

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A.J. Castillo and V.P. Milant’ev

Peoples Friendship university of Russia, Moscow, Russia, milantyev\_vp@pfur.ru

An extensive amount of works has been dedicated to the problem of laser-driven acceleration in which the laser field is, in general, considered in the paraxial approximation in the form of Gaussian beams of different modes. Mainly it is assumed that the electron is initially at the focus of the beam. Relevant researches (e.g. [1-3]) have considered diverse ways that an electron bunch enters the region of interaction with the laser radiation. Particularly, in the paper [1] it has been studied the acceleration of relativistic electrons injected sideways at a certain angle into a propagating fundamental mode laser Gaussian beam. It has been shown that the character of the motion of the electron depends substantially on the intensity of the laser beam, which is defined by the non-dimensional parameter $g=eE/mcω$. When $g\leq 1$ the electron crosses the laser beam without changing its energy according to the Lawson-Woodward theorem. If $g>1$, the electron may be reflected by the beam and acquire a substantial amount of energy. Here we consider the features of the motion related to the variation of the initial values for the dynamical variables of electrons injected at a fixed angle into a laser beam. The radiation field is described as a linear or circular polarized Gaussian beam of the fundamental mode. We present a Runge-Kutta numerical solution of the relativistic equations of motion. We show that, for $g\leq 1$ and initial energy $ γ\_{0}=32$ (in the dimensionless form) the electron gains and loses energy as it crosses the laser beam's focal region in accordance with [1]. At relativistic intensities ($g>1)$ with the same initial conditions, we observe the effect of reflection and acceleration of electrons by the laser beam (as well as in [1]). Moreover our calculations show that certain injection conditions provide not only the reflection of the electron but also its penetration into the laser beam, obtaining a significant amount of energy. A similar effect of reflection and refraction of electrons by electromagnetic fields was explored in work [4]. We perform a detailed analysis of the effects of initial conditions for the electron's dynamical variables on the character of interaction between the electron and the laser beam. It is shown that the efficiency of the acceleration of relativistic electrons by the field of an infinite laser beam is very sensitive to the slightest changes in the parameters of injection. We obtain the conditions of effective injection under which the higher gain of the electron energy is reached. For instance, for a laser intensity of $ 100 TW$ ($g=4),$ the electron acquires energy $∆γ\~600$ with an initial energy $ γ\_{0}=32$.

References

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