Electron Acceleration and heating in the OVERLAPING region of INTENSE PICOSECOND laser pulses

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A typical situation in the experiment on the interaction of high-power short laser radiation with a plasma is the case when the incident and reflected beams of radiation overlap. The mechanisms of absorption of laser energy, electron acceleration and heating by overlapping relativistic strong laser beams near the sharp plasma-vacuum interface when irradiated by relativistically strong laser radiation, are still not identified. The efficiency of laser energy absorption and heating of electrons is determined by the parameters of the laser radiation and the target. The high contrast as well as the sharp plasma-vacuum boundary creates unique conditions for the development of stochastic instability in complex fields, see, for example, [1–5], which are a combination of incident and reflected pulses, as well as quasistationary fields [5], induced near the plasma-vacuum interface. Recent experiments indicate the formation of a hot component in the spectrum of electrons with a temperature several times higher than their ponderomotive energy, which was observed when the target surface was irradiated with several beams [1] or in a single beam, where the incident and reflected waves overlap, when irradiated with a flat [4] or curved target surface [5].

This report discusses the acceleration and heating of electrons of complex EM fields resulting from the interference of several overlapping laser beams of relativistic intensity and picosecond duration in the vicinity of the sharp plasma-vacuum interface. To study the heating and acceleration of electrons, the test particle method was used to calculate the trajectories of electrons in given EM fields, as well as a quasilinear theory, the evolution of the momentum distribution function in the diffusion process for a particular but important case, the dynamics in two counter-propagating waves.

It is shown that the acceleration process proceeds in two stages: the primary slow stochastic heating and the fast regular acceleration following it in the process of resonant interaction of a particle with one of the waves of the considered wave packet. The spectra of accelerated electrons are well described by an exponential distribution with a characteristic temperature several times greater than the ponderomotive energy, that is in qualitative agreement with experimental results.

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