# Breaking of a nonlinear wake wave excited by a laser pulse during its interaction with a semi-infinite plasma

**Kuznetsov S V**

Joint Institute for High Temperatures of the Russian Academy of Sciences, Izhorskaya 13 Bldg 2, Moscow 125412, Russia

shenau@rambler.ru

An analytical study of the penetration of a laser pulse of relativistic intensity into a semi-infinite rarefied plasma with a transition layer at the boundary, carried out in one-dimensional geometry, made it possible to clarify the properties of the wake wave generated by the laser pulse and the conditions for its breaking [1]. It is shown that the wake wave generated after the laser pulse passing through the diffuse plasma boundary is irregular not only in the transition layer, but also in a certain region of the plasma density plateau near the boundary. The thickness of this region on the plasma plateau is equal to the amplitude of the oscillations of electrons, whose longitudinal oscillations are excited by a laser pulse. The phase velocity of the wake wave in this area depends on the spatial coordinate, and each phase of the oscillation has its own phase velocity. It was found that the process of wake wave breaking has a threshold character and becomes possible if the total energy of longitudinal oscillations of electrons exceeds the gamma factor determined by the group velocity of the laser pulse on the plasma density plateau. Thus, the breaking threshold is independent of the shape of the transition layer at the plasma boundary.
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