PIC simulation of electron acceleration in an underdense plasma

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Abstract
One of the interesting Laser-Plasma phenomena, when the laser power is high and ultra intense, is the generation of large amplitude plasma waves (Wakefield) and electron acceleration. An intense electromagnetic laser pulse can create plasma oscillations through the action of the nonlinear pondermotive force. electrons trapped in the wake can be accelerated to high energies, more than 1 TW. Of the wide variety of methods for generating a regular electric field in plasmas with strong laser radiation, the most attractive one at the present time is the scheme of the Laser Wake Field Accelerator (LWFA). In this method, a strong Langmuir wave is excited in the plasma. In such a wave, electrons are trapped and can acquire relativistic energies, accelerated to high energies. In this paper the PIC simulation of wakefield generation and electron acceleration in an underdense plasma with a short ultra intense laser pulse is discussed. 2D electromagnetic PIC code is written by FORTRAN 90, are developed, and the propagation of different electromagnetic waves in vacuum and plasma is shown. Next, the accuracy of implementation of 2D electromagnetic code is verified, making it relativistic and simulating the generating of wakefield and electron acceleration in an underdense plasma. It is shown that when a symmetric electromagnetic pulse passes through the plasma, the longitudinal field generated in plasma, at the back of the pulse, is weaker than the one due to an asymmetric electromagnetic pulse, and thus the electrons acquire less energy. About the asymmetric pulse, when front part of the pulse has smaller time rise than the back part of the pulse, a stronger wakefield generates, in plasma, at the back of the pulse, and consequently the electrons acquire more energy. In an inverse case, when the rise time of the back part of the pulse is bigger in comparison with that of the back part, a weaker wakefield generates and this leads to the fact that the electrons acquire less energy.

Keywords: particle in cell simulation, overdense and underdense plasma, wakefield, electron acceleration, accelerators

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