Particle simulation of forward Raman instability in a low-density plasma

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Abstract

Propagation of Electromagnetic wave in a plasma in the equilibrium state can cause instability. Investigating the situations in which this kind of instability occurs and grows is an important issue. In this paper, Raman instability in plasma is analyzed by particle simulation method. In terms of physical investigation, plasma is a very complicated environment and experimentally too expensive. Also, when such an environment is subjected experiment, it shows nonlinear behavior. To avoid these problems, we used particle simulation method to study Raman instability. Here, we model the mentioned instability with a nonrelativistic 2D electromagnetic PIC simulation code. As plasma consists of electrons and ions, it is simulated by particle method. It is supposed that ions for having a large potential form a uniform background, although electron's dynamic is derived from Newton-Lorentz equations. In this article, it is shown that when a plane EM wave propagates in plasma, a longitudinal wave with adequately large amplitude starts to grow, which means Raman instability has occurred. The growth rate of longitudinal wave is in agreement with the theoretical results. Charge separation and bunching are observed by particles phase space investigation, which shows the accuracy of the written code in the creation and growth of longitudinal waves.

Keywords: Raman instability, PIC simulation, plasma, electromagnetic waves, growth rate

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