Iranian Journal of Physics Research, Vol. 16, No. 4, 2017

Investigating the growth rate in a free-electron laser with a laser wiggler and plasma background

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(Received 23 December 2013 ; in final form 15 May 2016)

Abstract

In this paper, a free-electron laser (FEL) growth rate with a laser wiggler in which plasma background is used to generate short wavelengths in x-ray regimes, has been investigated theoretically. A linearly polarized laser pulse, due to having short wiggler periods (in μm range) is able to produce coherent radiations in x-ray regions and can be applied as a planar wiggler in a FEL. Phase velocity of the laser pulse in presence of plasma background decreases .In this case, the electron beam can be in synchronism with the laser pulse and enters the interaction region with less energy which leads to producing x-ray pulses by low enegy beams, without requiring high beam energies. This configuration allows obtaining higher frequencies than conventional FELs (with magnetostatic wigglers) for a device. Employing a perturbation analysis for the momentum transfer, continuity, and Maxwell equations, the dispersion relation for system has been derived and the effect of plasma density variation on growth rate of a free electron laser with a laser wiggler and plasma background has been discussed. In addition, cross section of electron trajectories for different values of axial magnetic field has been simulated by using fourth order Runge-Kutta method. Results shows that by increasing plasma density, growth rate for group I and II decreases, while for group III increases.

Keywords: free-electron laser, growth rate, dispersion relation, plasma background

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