Investigation of Self-Fields Effects on Dispersion Relation in a Helical Wiggler with Ion-Channel Guiding

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It is known that the self–electric and self–magnetic fields induced by charge and current densities of the electron beam have significant effects on the operation of a free-electron laser[1]. Recently, more exact calculations of self–fields and analysis of their effects on electron dynamics and gain have been published[2, 3]. The purpose of this paper is to investigate the effects of self–fields on dispersion relation in a free-electron laser with helical wiggler and ion-channel guiding. A sixth degree polynomial dispersion equation showing coupling of electromagnetic and space-charge waves by the wiggler magnetic field is derived. Numerical solutions of the polynomial equation yield the complex wave number k as a function of the wave frequency ω. These solutions are used to study growth rate. A numerical study of the growth rate in the presence of the self–fields is presented and compared with the growth rate in the absence of the self–fields. It is shown that for helical wiggler and ion-channel guiding the growth rate decreases due to the self-fields. The growth rate decrement increases with increasing electron beam density.

Keywords: *free-electron laser, dispersion relation, growth rate, and ion-channel guiding.*

References:

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