Study of Electron Cyclotron Resonance Acceleration by Cylindrical TE$_{011}$ Mode

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Abstract : In this work, we present results from analytical and numerical studies of the electron acceleration by a TE$_{011}$ cylindrical microwave mode in a static homogeneous magnetic field under electron cyclotron resonance (ECR) condition. The stability of the orbits is analyzed using the particle orbit theory. In order to get a better understanding of the interaction wave-particle, we decompose the azimuthally electric field component as the superposition of right and left-hand circular polarization standing waves. The trajectory, energy and phase-shift of the electron are found through a numerical solution of the relativistic Newton-Lorentz equation in a finite difference method by the Boris method. It is shown that an electron longitudinally injected with an energy of 7 keV in a radial position r=Rc/2, being Rc the cavity radius, is accelerated up to energy of 90 keV by an electric field strength of 14 kV/cm and frequency of 2.45 GHz. This energy can be used to produce X-ray for medical imaging. These results can be used as a starting point for study the acceleration of electrons in a magnetic field changing slowly in time (GYRAC), which has some important applications as the electron cyclotron resonance ion proton accelerator (ECR-IPAC) for cancer therapy and to control plasma bunches with relativistic electrons.

Keywords : Boris method, electron cyclotron resonance, finite difference method, particle orbit theory, X-ray

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