Upper-hybrid absorption of electromagnetic waves in high $\beta$ devices

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Resonant heating of electrons with microwaves is one of the most efficient ways to increase the electron temperature of magnetically confined plasmas. Recent progress in plasma confinement in axially symmetric magnetic traps led to the achievement of high-$\beta$ regimes, in which the ratio between plasma kinetic pressure and the magnetic field pressure ($\beta$) is of the order of unity [1,2]. Under these circumstances $\omega_{pe} \gg \omega_{ce}$, i.e. the Langmuir plasma frequency $\omega_{pe}$ is essentially greater than the electron cyclotron frequency $\omega_{ce}$. Therefore, the use of common schemes of electron cyclotron heating based on direct launch of electromagnetic waves from the vacuum window meets obvious difficulties because the resonance region is screened by dense plasma for all electromagnetic modes except waves propagating strictly along the external magnetic field.

Linear transformation of high-frequency electromagnetic waves in quasi-electrostatic waves provides a convenient way to heat overdense plasma in perspective open traps. However, this process has a number of peculiar features which significantly distinguish it both from the case a strong magnetic field, which is used for plasma heating in toroidal magnetic traps and other low-$\beta$ devices, and from the case of Langmuir wave excitation in non-magnetized plasmas [3]. This work presents a detailed theoretical study of these features.