§15. Pair Annihilation Effects on Surface Ion Cyclotron Wave in Semi-bounded Electron-positron-ion Plasmas

Jung, Y.-D. (Hanyang Univ.),
Kato, D.

The electron-positron pair annihilation effects on the surface ion cyclotron wave are investigated in magnetized electron-positron-ion plasmas in atmospheres of neutron stars. The dispersion relation of the surface ion cyclotron wave is obtained by the specular reflection boundary condition with the plasma dielectric function. It is shown that the high- and low-frequency modes of the surface ion cyclotron wave could be existed in electron-positron-ion plasmas. For the high-frequency mode, the pair annihilation enhances the wave frequency in large wave number domains (see Fig. 1). However, the pair annihilation effects are found to be negligible for the low-frequency mode. It is also found that an increase of the electron temperature or a decrease of the positron temperature strongly suppresses the wave frequency. Fig. 2 shows that the group velocity is increased strongly by the pair annihilation. In Fig. 3, it is shown that an increase of the magnetic field strongly enhances the group velocity.
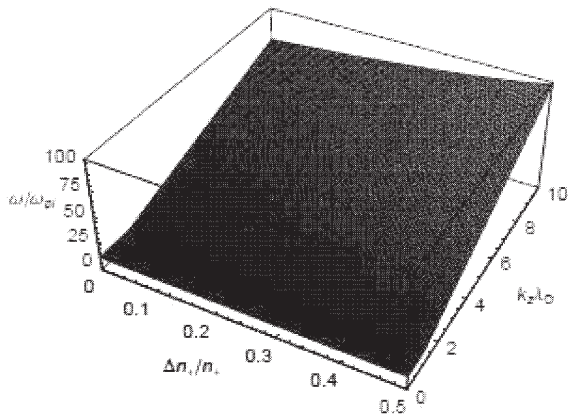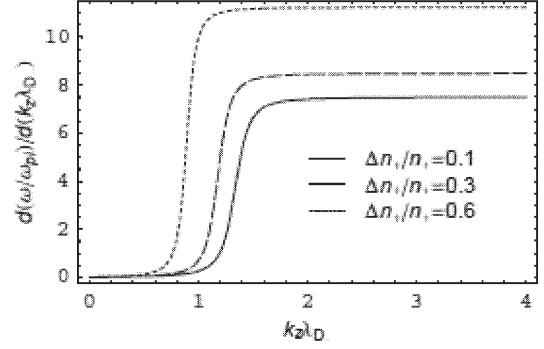

FIG. 2. The group velocity $d(\omega / \omega_{pi}) / d(k_z \lambda_{D_-})$ for the high-frequency mode as a function of $k_z \lambda_{D_-}$ when $\omega_{ci} / \omega_{pi} = 10$, $n_+ / n_- = 1$, and $T_- / T_+ = 1$. The solid line represents the case of $\Delta n_+ / n_+ = 0.1$. The dashed line represents the case of $\Delta n_+ / n_+ = 0.3$. The dotted line represents the case of $\Delta n_+ / n_+ = 0.6$.
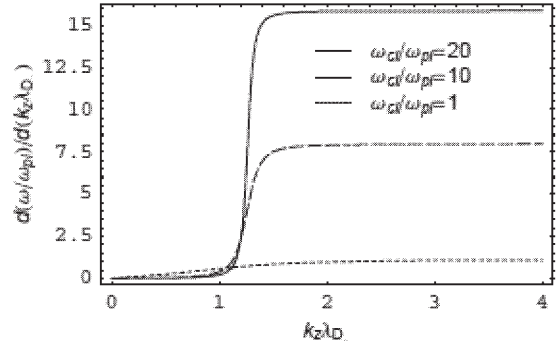

FIG. 3. The group velocity $d(\omega / \omega_{pi}) / d(k_z \lambda_{D_-})$ for the high-frequency mode as a function of $k_z \lambda_{D_-}$ when $n_+ / n_- = 1$, $T_- / T_+ = 1$, and $\Delta n_+ / n_+ = 0.2$. The solid line represents the case of $\omega_{ci} / \omega_{pi} = 20$. The dashed line represents the case of $\omega_{ci} / \omega_{pi} = 10$. The dotted line represents the case of $\omega_{ci} / \omega_{pi} = 1$.

FIG. 1. The three-dimensional plot of the high-frequency mode of ω / ω_{pi} as a function of $\Delta n_+ / n_+$ and $k_z \lambda_{D_-}$ when $\omega_{ci} / \omega_{pi} = 10$, $n_+ / n_- = 1$, and $T_- / T_+ = 1$.