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Effect of Ion- Electron Beam Velocity on Alfven Waves in Multi-Component Magnetospheric Plasma- Particle Aspect Analysis

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Abstract- the main objective of present study is to understand the effect of ion-electron beam velocity on the Alfven waves in multi-component magnetospheric plasma by using method of particle aspect approach and using different plasma parameters in auroral acceleration region. Here one component is electron and other three components are the Hydrogen, Helium and Oxygen is mixed. We develop the dispersion relation and field-aligned currents of the Alfven waves with the help of General loss-Cone distribution function. The waves propagating in the direction of the ambient magnetic field along the z-axis are considered. The whole plasma has been considered to consist of resonant and non-resonant particles. It is assume that the resonant particles participate in energy exchange with the wave, whereas non-resonant particles support the oscillatory motion of the waves. Dispersion relation and associated field-aligned currents are evaluated for Alfven waves in the auroral region using particle aspect approach. The estimated results are shows the applications of Alfven waves in multi-component magnetospheric plasma in the auroral acceleration region of interplanetary space plasma as well as the magnetospheric plasma and astrophysical plasmas.

Keywords—*Alfven waves, Multi-ions, Parallel electric fields, , Beam velocity*

I. INTRODUCTION

Firstly, the reality of such waves was theoretically estimate by H. Alfven is called Alfven waves in 1942. This theoretical estimate was of great significance because it created new achievability to transport energy in a one form to another or medium, particle acceleration. An Alfven waves are establish to be prevalent in the universe or nature and laboratory plasmas [1]. An Alfven waves are basically physical phenomenon in magnetized plasma that contribute to a large variety of physical activity in space plasmas that is turbulence plasma heating and acceleration through the magnetic field lines, wave particle-interactions and generation of geomagnetic perturbations. An Alfven waves is the dominant low point- frequency transverse way of magnetized plasma. This wave propagates with the magnetic field and displays a continuous spectrum even in bounded plasma. An Alfven waves play key roles in many naturally occurring interactions. For example, 'changes in the auroral current magnitude', 'spatial configuration', or 'changes in the magnetosphere configuration', propagation of information and An Alfven wave emissions may interact with communication signal, in space plasmas. The study may be applicable in communication system. The observations of many rockets and satellites will be undertaken to explain our theoretical findings.

Measurement from the Fast Auroral Snapshot satellite and the Polar spacecraft have been postulate the existence of small-scale Alfven waves that carry a wide net pointing flux with magnetic field lines towards the earth, in spacecraft measurements[2].The phenomena associated with the Alfven waves in auroral acceleration region can also be examined by in Situ measurements [3]. However, satellite observations, both Fast Auroral Snapshot and Polar satellites are very well suited for studies of auroral acceleration region, field aligned or parallel currents, plasma flow and Alfven waves [4]. These satellite orbits between the upper ionosphere and the lowest reaches of the auroral acceleration region and is theoretically located for performing this study.

Aurora's are created by electrons and protons string earth's atmosphere, when oxygen, hydrogen, helium and nitrogen atoms are hit by these energetic particles, they become excited as they relax to their main state, the emit light is of a characteristic colors, in the auroral acceleration region. The most important aspect of Alfven waves observed in the auroral oval and more recently in the high latitude magnetosphere is their ability to accelerate electrons to energies and in fluxes sufficient to cause visible aurora [5].

Recently, particle aspect approach has been developed for the Alfven waves which are based upon Dawson's theory of Landau damping which was further extended by [6&7] to the analysis of electromagnetic instabilities.

The investigation of charged particle trajectories in the presence of wave study the excitation of wave, their dispersion relations current driven by the waves and the transfer of energy to the particles and hence heating the same sequence of analysis which is referred to as the particle aspect analysis. The main advantage of this approach is to consider the energy transfer between waves and particles, along via the discussion of dispersion relation and growth /damping rate of the waves. In particle approach analysis, a better understanding of particle orbits in the presence of wave is important for predicting confinement, high energy particle loss, heating efficiency and current flow in the presence of waves.

The ion beam in the direction of the wave motion may damp these waves if the ion beam velocity is smaller than the phase velocity of the wave; however, the ion beam opposite to the wave motion may excite the waves, as reported in this paper. The electron beam are inject from the tail side of the magnetosphere at the sub-storm times constituting field-aligned currents and auroral acceleration [8&9]. In the same event, the Alfven waves are also observed by various rockets and satellites, therefore, the electron beam may be the cause of Alfven wave generation which modifies the wave frequency, the anisotropy of the plasma sheet, auroral acceleration region may affect the field aligned current and wave spectrum.

The theory and findings of the investigation are applicable to magnetosphere- ionosphere coupling where parallel current and auroral acceleration are explained in terms of Alfven waves.

II. RELATED WORK

Our previous research work, we have study of Alfven wave in cold magnetized plasma. The wave is assumed to propagate parallel to the static magnetic field. Dispersion relation of Alfven waves are measured in multi-component magnetosphere plasma consisting of mixture of hydrogen (H+), helium (He+) and Oxygen (O+) ions in magnetized cold plasma. It is observed that the effect of multi-ions for different plasma densities on Alfven waves is to enhance the wave frequencies. The results show that ions can be significantly heated and electrons accelerated by Alfven wave. We also reviewed some applications in space and astrophysical plasma. Showing the importance of Alfven waves in multi-component plasma these studies.

An Alfven waves have been studied in auroral acceleration region using plasma kinetic theory. The wave dispersion relation, growth/damping rate and growth length are evaluated for Alfven waves in multi-component magnetospheric plasma. It is observed that the effect of temperature anisotropy on Alfven wave. Our finding is satisfied by the Polar spacecraft and Fast Auroral Snapshot satellite. The effect of parallel electric field with temperature anisotropy on Alfven waves in multi-component magnetospheric plasma by using the method of kinetic approach and using different plasma parameters in auroral acceleration region.

III. METHODOLOGY

We consider plasma under static magnetic field (B_0) in which collisions between particles is neglected. We shall discuss the behavior of an Alfven wave of plane polarization in the form. An Alfven waves is assumed to that at t=0 when the resonant particle are not disturbed. The trajectories of particles are then evaluated within the theoretical of linear theory.

$$KIIB_0, K.B = 0, B = (0,0,K_{II}) andE = (E_{x,} 0.0) \qquad (1)$$

These wave electric fields (EF) considered along the X- axis is of the form

$$E_x = E_1 \cos(K_{II} Z - \omega t) \qquad (2)$$

$$B_y = \frac{cE_1 K_{II}}{\omega} \cos(K_{II} Z - \omega t) \qquad (3)$$

Where E_x and B_y are the electric and magnetic fields of wave. The main interest lies in the behavior of those Alfven waves which satisfy the conditions

$$V_{TIIi\alpha} << \frac{\omega}{K_{II}} << V_{TIIe}, \ \omega << \Omega_{i\alpha}, \Omega_e,$$

Where $\alpha = H^{+,}$ He^+, O^+ ions, $V_{TIIi\alpha}$ and V_{TIIe} are the mean parallel velocity of multi-ions and electrons along the magnetic field , $\Omega_{i\alpha e}$ are gyration frequencies. The equation of motion for the plasma particles is

$$\frac{dv}{dt} = \frac{q}{m_\alpha}\left[E + \frac{1}{c}(v \times B_0) + \frac{1}{c}(v \times B)\right] \qquad (4)$$

Then the electric field vanishes and the magnetic field has the form

$$B = B_x(\hat{x}\cos KZ) + B_y(\hat{y}\sin KZ)$$

Where the condition are valid

$$Z^{Wave} = Z^{Lab} - \left(\frac{\omega}{K_{II}}\right)t$$

$$v^{Wave} = v^{Lab} - \frac{\omega}{K_{II}}$$

We start with the trajectories of free gyration which is given as

$$V_x(t) = V_\perp \cos(\theta - \Omega_{i\alpha} t)$$
$$V_y(t) = V_\perp \sin(\theta - \Omega_{i\alpha} t)$$
$$V_z(t) = V_{II}$$
$$Z = V_{II}(t) + Z_0 \qquad (5)$$

Where, Z_0 is the initial position of the particles in the Z direction. The Gaussian system of units is adopted in this paper and interaction between particles is neglected. The electric field on the right hand side considered to be small perturbed and v can be expressed as a sum of the unperturbed velocity V and the perturbed velocity u, that is v=V+u, u is determined by the following set of equation [10].

$$\frac{du_\perp}{dt} + i\Omega_{i\alpha} u_\perp = \frac{q}{m_\alpha}\left[1 - \frac{V_{II}K_{II}}{\omega}\right] E_1 \cos(K_{II}Z - \omega t)$$

$$\frac{du_{II}}{dt} = \frac{qV_\perp E_1 K_{II}}{m_\alpha \omega} \cos(\theta - \Omega_{i\alpha} t)\cos(K_{II}Z - \omega t) \qquad (6)$$

Where $u_1 = u_x + iu_y$ represents the velocity in transverse direction and u_{II} represents the velocity in parallel direction and Ω_α is a multi ion cyclotron frequency that is

$$\Omega_{i\alpha} = \frac{qB_0}{m_\alpha c}$$

Equation (6) is solved for perturbed velocity of charged particles in the presence of Alfven waves which is given as

$$u_{\perp x} = \frac{q}{m_\alpha}\left[1 - \frac{V_{II}K_{II}}{\omega}\right] E_1 \left[\begin{array}{l} \frac{\Lambda_0}{a_0^2}\sin(K_{II}Z - \omega t) - \frac{\delta}{2(\Lambda_0 - \Omega_{i\alpha})}\sin(K_{Ii}Z - \omega t - \Lambda_0 t + \Omega_{i\alpha} t) \\ - \frac{\delta}{2(\Lambda_0 + \Omega_{i\alpha})}\sin(K_{II}Z - \omega t) - \Lambda_0 t - \Omega_{i\alpha} t \end{array}\right] \qquad (7)$$

$$u_{\perp y} = \frac{q}{m_\alpha}\left[1 - \frac{V_{II}K_{II}}{\omega}\right] E_1 \left[\begin{array}{l} \frac{\Lambda_0}{a_0^2}\cos(K_{II}Z - \omega t) - \frac{\delta}{2(\Lambda_0 - \Omega_{i\alpha})}\cos(K_{Ii}Z - \omega t - \Lambda_0 t + \Omega_{i\alpha} t) \\ + \frac{\delta}{2(\Lambda_0 + \Omega_{i\alpha})}\cos(K_{II}Z - \omega t) - \Lambda_0 t - \Omega_{i\alpha} t) \end{array}\right] \qquad (8)$$

$$u_{IIZ} = \frac{qV_\perp K_{II}}{2m_\alpha \omega} E_1 \left[\begin{array}{l} \frac{1}{(\Lambda_0 - \Omega_{i\alpha})}\sin(K_{Ii}Z - \omega t + \theta - \Omega_{i\alpha} t) + \frac{1}{(\Lambda_0 + \Omega_{i\alpha})}\sin(K_{II}Z - \omega t - \theta + \Omega_{i\alpha} t) \\ - \frac{\delta}{(\Lambda_0 - \Omega_{i\alpha})}\sin(K_{II}Z - \omega t - \Lambda_0 t + \theta) - \frac{\delta}{(\Lambda_0 + \Omega_{i\alpha})}\sin(K_{II}Z - \omega t - \Lambda_0 t - \theta) \end{array}\right] \qquad (9)$$

Where, δ=0 for the non-resonant and δ=1 for resonant particles

And

$$\Lambda_0 = V_{II}K_{II} - \omega,\ a_0^2 = \Lambda_0^2 - \Omega_{i\alpha}^2,\ \Omega_{i\alpha} = \frac{qB_0}{m_\alpha c}$$

The resonant particles condition is given by $V_{II}K_{II}-\omega=0$. These equations (9) represent the perturbed velocities of the charged particles in the presence of Alfven waves and have vast application in plasma heating processes, confinement device and the space plasma.

To evaluate the density perturbation affected by velocity perturbation due to Alfven waves, we consider particles with the same initial condition and let its number density by

$$n(r,t,v) = N_0(v) + n_1(r,t,v) \qquad (10)$$

Where, $n_1$is perturbed density which can be derived from the equation (10)

$$\frac{dn_1}{dt} = -N_{i\alpha}(v_{i\alpha}) \times (\nabla.u)_{i\alpha} \qquad (11)$$

On integration

$$n_1 = -N_0(v)\int \frac{\partial}{\partial Z} u_Z\, dt \qquad (12)$$

The quasi-neutrally yields to the equation

$$n_e \approx n_{i\alpha} or (n_{H^+} + n_{He^+} + n_{O^+})$$

Thus we evaluate the density perturbation association with the particle velocity

$$\frac{dn_1}{dt} = -N_{H^+}(v_{H^+}) \times (\nabla.u)_{H^+} + (-N_{He^+}(v_{He^+})(\nabla\cdot u)_{He^+}) + (-N_{O^+}(v_{O^+})(\nabla\cdot u)_{O^+}$$

For non-resonant particles

$$n_1 = -\frac{qV_\perp K_{II}^2 N_{H^+}(v_{H^+})}{2m_{H^+}\omega} E_1\left[\frac{1}{(\Lambda_0 - \Omega_{H^+})^2}\sin(K_{Ii}Z - \omega t + \theta - \Omega_{H^+} t) + \frac{1}{(\Lambda_0 + \Omega_{H^+})}\sin(K_{II}Z - \omega t - \theta + \Omega_{H^+} t)\right]$$

$$-\frac{qV_\perp K_{II}^2 N_{He^+}(v_{He^+})}{2m_{He^+}\omega} E_1\left[\frac{1}{(\Lambda_0 - \Omega_{He^+})^2}\sin(K_{Ii}Z - \omega t + \theta - \Omega_{He^+} t) + \frac{1}{(\Lambda_0 + \Omega_{He^+})}\sin(K_{II}Z - \omega t - \theta + \Omega_{He^+} t)\right]$$

$$-\frac{qV_\perp K_{II}^2 N_{O^+}(v_{O^+})}{2m_{O^+}\omega} E_1\left[\frac{1}{(\Lambda_0 - \Omega_{O^+})^2}\sin(K_{Ii}Z - \omega t + \theta - \Omega_{O^+} t) + \frac{1}{(\Lambda_0 + \Omega_{O^+})}\sin(K_{II}Z - \omega t - \theta + \Omega_{O^+} t)\right] \qquad (13)$$

Similarly, for resonant particles

$$n_1 = -\frac{qV_\perp K_{II}^2 N_{i\alpha}(v_{i\alpha})}{2m_{i\alpha}\omega} E_1 \left[\begin{array}{l} \frac{1}{(\Lambda_0 - \Omega_{i\alpha})^2}\sin(K_{II}Z - \omega t + \theta - \Omega_{i\alpha}t) + \frac{1}{(\Lambda_0 + \Omega_{i\alpha})^2}\sin(K_{II}Z - \omega t - \theta + \Omega_{i\alpha}t) \\ - \frac{1}{(\Lambda_0 - \Omega_{i\alpha})^2}\sin(K_{II}Z - \omega t - \Lambda_0 t + \theta) - \frac{\delta}{(\Lambda_0 + \Omega_{i\alpha})^2}\sin(K_{II}Z - \omega t - \Lambda_0 t - \theta) \\ - \frac{t}{(\Lambda_0 - \Omega_{i\alpha})}\cos(K_{II}Z) \end{array} \right]$$

To evaluate the current, dispersion relation, we use the zero order distribution function [11&12] N (V) of the form

$$N(V) = N_0 f_\perp(V_\perp) f_{II}(V_{II}) \tag{14}$$

Where,

$$f_\perp(V_\perp) = \left(\frac{m}{2\pi T_\perp}\right)\exp\left(-\frac{mV_\perp^2}{2T_{\perp i\alpha}}\right) \tag{15}$$

And

$$f_{II}(V_{II}) = \left(\frac{m}{2\pi T_\perp}\right)^{1/2} \exp\left(-\frac{m(V_{II} - V_b)^2}{2T_{IIi\alpha}}\right) \tag{16}$$

From equation (14-16)

$$N(V) = N_0 \frac{1}{\pi^{3/2} V_{T\perp}^2 V_{TIIi\alpha}} \exp\left(-\frac{V_\perp^2}{V_{T\perp}^2} - \frac{(V_{II} - V_b)^2}{V_{TIi\alpha I}^2}\right) \tag{17}$$

Where, $V_{T\perp}$ and V_{TII} are the perpendicular and parallel thermal velocity. V_b is beam velocity and N_0 is the background plasma density.

Current

To evaluate the perturbed current per unit wavelength in the multi- component on Alfven waves, we use the following set of equations

$$J_{i\alpha,e} = 2\pi \int_0^\lambda ds \int_0^\infty V_\perp dV_\perp \int_{-\infty}^{+\infty} dV_{II} \times q\left[(N + n1)(V + u) - NV\right]$$

And

$$J_{i\alpha,e} = J_{i\alpha} - J_e \tag{18}$$

Where, ds represent the length of magnetic field line elements and k_s= k.r. Equation (18) considers current per unit wavelength and not the current density per square centimeter [13]. The right hand side terms of equation (18) involves density perturbation $n_1$and the velocity perturbation u which contain the oscillatory terms. If the integral ∫ ds are not performed, the evaluated current will be oscillatory. To find out the average values, the current is evaluated per unit wavelength. These currents represent the distributed currents over the entire wavelength and equation (18) represents the average value of this distributed current over a wave length of the Alfven waves. We obtain the multi-ionic and electron current per unit wavelength with the help of equations (9, 13&18).

The multi-ionic current per unit wavelength can be written as

$$J_{zi\alpha,} = -\frac{3e\Omega_{pi\alpha}^2 E^2 K_{II}^2 V_{T\perp i\alpha}^2}{8\omega c m_{i\alpha}\Omega_{i\alpha}^4} \tag{19}$$

The electron current per unit wavelength can be written as

$$J_{ze,} = \frac{3e\Omega_{pe}^2 E^2 K_{II}^2 V_{T\perp e}^2}{8\omega c m_e \Omega_e^4} \tag{20}$$

Thus, the multi-component current per unit wavelength flowing along the magnetic field in the presence of Alfven waves is given as

$$J_{z,} = -\frac{3eE^2 K_{II}^2}{8\omega}\left(\frac{\omega_{pe}^2 V_{T_{\perp e}}^2}{\Omega_e^4 m_e} + \frac{\omega_{pH^+}^2 V_{T_{\perp H^+}}^2}{\Omega_{H^+}^4 m_{H^+}} + \frac{\omega_{pHe^+}^2 V_{T_{\perp He^+}}^2}{\Omega_{He^+}^4 m_{He^+}} + \frac{\omega_{pO^+}^2 V_{T_{\perp O^+}}^2}{\Omega_{O^+}^4}\right) \tag{21}$$

The average values of perpendicular currents become zero in the first order. Here q=+e for ions and q=-e for electrons is used and $\omega_{pi\alpha,e}=(4\pi N_0 e^2/m_{i\alpha,e})^{1/2}$ is the plasma frequency. $V_{T\perp i\alpha,e}=(2T_{\perp i\alpha,e}/m_{i\alpha,e})^{1/2}$ is the perpendicular component of thermal velocity where the temperature T is expressed in the unit of energy, $\Omega_{i\alpha,e}$ is the cyclotron frequency.

Dispersion relation

The dispersion relation is evaluated with help of wave equation in the form

$$\frac{\partial^2 E_1}{\partial z^2} = \frac{4\pi}{c^2}\frac{\partial J_x}{\partial t} + \frac{1}{c^2}\frac{\partial^2 E_1}{\partial t^2} \tag{22}$$

The time derivative $\frac{\partial}{\partial t}$ replaced by –iω and $\frac{\partial}{\partial z}$ replaced by ik, we obtain the following equation

$$(c^2 k_{II}^2 - \omega^2)E = 4\pi i\omega J_z$$

Substituting the value of J_z in terms of perturbed velocity u_x and perturbed density n_1, the dispersion relation for Alfven wave is evaluated as

Dispersion relation for electron particles

$$\omega = V_A K_{II}\left[1 - \frac{3\pi e E_1}{2V_A^2}\left(\frac{\omega_{Pe}^2 V_{T_{\perp e}}^2}{m_e \Omega_e^4} + V_b^2\right)\right]^{\frac{1}{2}} \tag{23}$$

Dispersion relation for multi-component particles

$$\omega = V_A K_{II}\left[1 - \frac{3\pi e E}{2V_A^2}\left(\frac{\omega_{Pe}^2 V_{T_{\perp e}}^2}{m_e \Omega_e^4} + \frac{\omega_{pH^+}^2 V_{T_{\perp H^+}}^2}{m_{H^+}\Omega_{H^+}^4} + \frac{\omega_{pHe^+}^2 V_{T_{\perp He^+}}^2}{m_{He^+}\Omega_{He}^4} + \frac{\omega_{pO^+}^2 V_{T_{\perp O^+}}^2}{m_{O^+}\Omega_{O^+}^4} + V_b^2\right)\right]^{\frac{1}{2}} \tag{24}$$

Here, the dispersion relation for multi-component particles shows in equation (24). We notice that the dispersion relation of Alfven wave is modified by thermal and beam velocities of multi-particles. In case five the terms are zero, the dispersion relation reduces to well-known form. The current driven by Alfven wave is modified through the dispersion relations. In this model, the wave frequency ω is considered as real and the principle part of plasma dispersion function is used and coupling of compressional mode is not considered [14].

Again from equation (23-24), modified temperature anisotropy dispersion relation of Alfven waves in multi-ions magnetospheric plasma are evaluated.

$$\omega = V_A K_{II}\left[1-\frac{1}{2V_A^2}\times A_e \times V_{T\perp e}^2\right]^{\frac{1}{2}}$$

And,

$$\omega = V_A K_{II}\left[1-\frac{1}{2V_A^2}\times A_e \times V_{T\perp e}^2 + (A_H + A_{He} + A_O)\times(V_{TH_\perp}^2 + V_{THe_\perp}^2 + V_{TO_\perp}^2)\right]^{\frac{1}{2}} \quad (25)$$

Where,

$A_e = T_{IIe}/T_{\perp e}$, $A_H = T_{HII}/T_{H\perp}$, $A_{He} = T_{IIHe}/T_{\perp He}$, $A_O = To_{II}/T_{\perp O}$

IV. RESULTS AND DISCUSSION

The following plasma parameters are used to estimate the wave frequency and field -aligned current per unit wavelength which may be suitable to auroral acceleration region [15-19].

$$B_0 = 4300nT, \Omega_{H^+} = 412s^{-1}, \Omega_{He^+} = 103s^{-1}, \Omega_{O^+} = 26s^{-1}, v_{Te} = 5.9\times10^5 cms^{-1},$$

$$\omega_{PH^+} = 9.31\times10^4 s^{-1}, \omega_{PHe^+} = 3.292\times10^4 s^{-1}, \omega_{Po^+} = 1.646\times10^4 s^{-1}, v_{TH^+} = 4.37\times10^7 cms^{-1},$$

$$v_{THe^+} = 4.01\times10^6 cms^{-1}, v_{TO^+} = 3.9\times10^6 cms^{-1} E_1 = 50mV/m, v_{T\perp H^+} = 3.5\times10^4 cms^{-1},$$

$$v_{T\perp He^+} = 2.5\times10^4 cms^{-1}, v_{T\perp O^+} = 1.5\times10^4 cms^{-1},$$

Figure 1 shows the variation of wave frequency (ω) with propagating wave vector (k_{II}) for different values of electron beam velocity (V_b). It is clearly seen that the effect of electron beam reduces the frequency when the electron beam is along the magnetic field and in the direction of propagating wave vector (k_{II}) and wave velocity gets modified in the presence of beam in the plasma which is dispersion less medium for the Alfven wave.

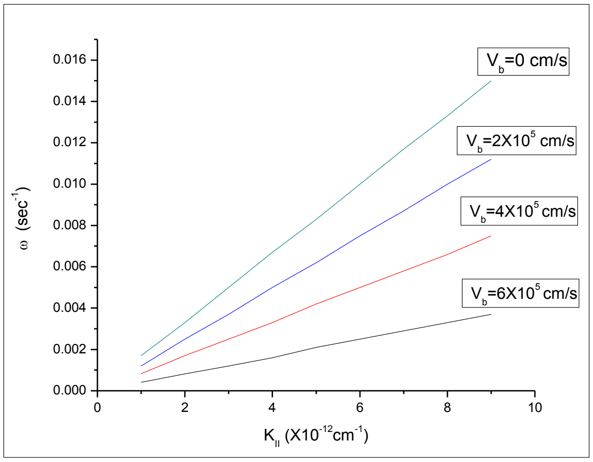

Figure 1.Variation of wave frequency (ω) versus wave number K_{II} for different values of electron beam velocity (V_b).

Figure 2 shows the variation of wave frequency (ω) with propagating wave vector (k_{II}) for different values of multi-component beam velocity (V_b). It is clearly observed that the effect of multi-component beam reduces the frequency when the multi-component beam is along the magnetic field and in the direction of propagating wave vector (k_{II}) and the wave velocity which gets modified in the presence of beam in the plasma which is dispersion less medium for the Alfven wave.

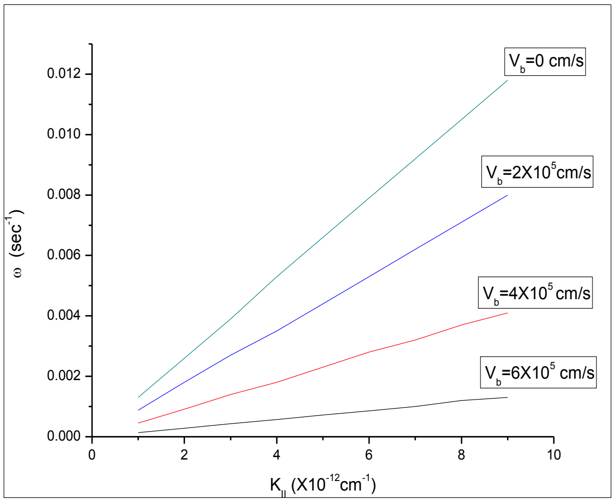

Figure 2 Variation of wave frequency (ω) versus wave number (K_{II}) for different values of multi-component beam velocity (V_b)

Figure 3 show the variation of field-aligned current per unit wavelength with propagating wave vector (k_{II}) for different values of electron beam velocity. It is observed that current decreases with increases of propagating wave vector (k_{II})as well as V_b. The effect of electron beam parallel to magnetic field is to decrease the parallel current by diverging it to the perpendicular current. Thus, the closer currents may be constituted towards the ionosphere and the field aligned current reversal may occur during the auroral acceleration processes.

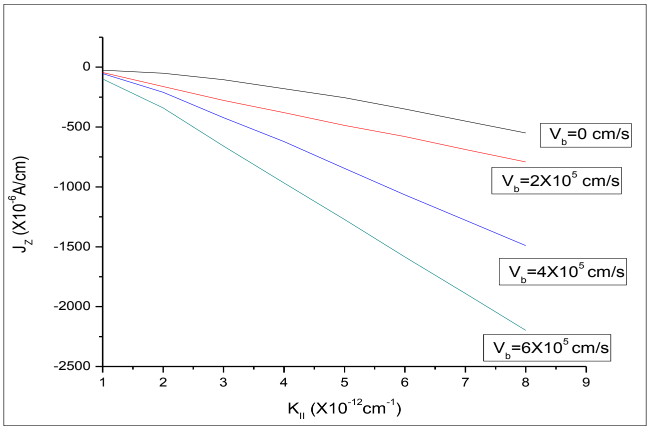

Figure 3 Field-aligned current per unit wavelength J_Z versus wave number (K_{II}) for different values of electron beam velocity (V_b)

Figure 4 show the variation of ionic current per unit wavelength with propagating wave vector (k_{II}) for different values of multi-component (one component is electron (e) and other three components are the Hydrogen (H+), Helium (He+) and Oxygen (O+) ions are mixed) beam velocity. It is observed that current decreases with increases of propagating wave vector (k_{II}) as well as multi-beam velocity (V_b). The effect of multi-component beam parallel to magnetic field is to decrease the parallel current by diverging it to the perpendicular current.

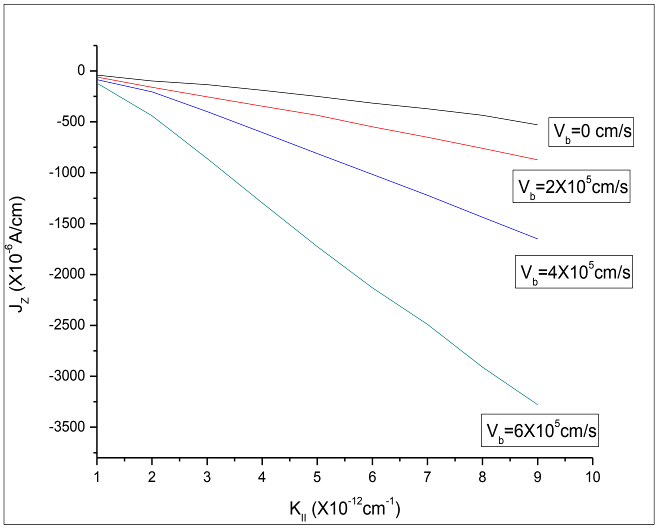

Figure 4 Field-aligned current per unit wavelength (J_Z) versus wave number (K_{II}) for different values of multi-component beam velocity (V_b)

Figure 5 shows the variation of wave frequency (ω) with propagating wave vector (k_{II}) for different values of temperature anisotropy (A_e). We notice that the wave frequency increases with propagating wave vector (k_{II}) but decreases with the increases of temperature anisotropy. Thus, the temperature anisotropy observed in the distant magnetotail and the auroral acceleration region also modifies the wave spectrum.

Figure 6 shows the variation of wave frequency (ω) with wave number (k_{II}) for different values of temperature anisotropy (A_e, A_H^+, A_{He}^+ and A_O^+). We notice that the wave frequency increases with k_{II} but decreases with the increases of temperature anisotropy. Thus, the temperature anisotropy observed in the distant magnetotail and the auroral acceleration region also modifies the wave spectrum.

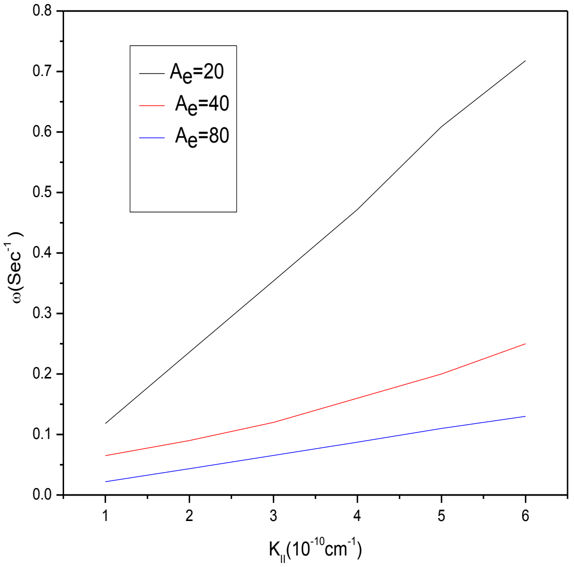

Figure 5 shows the variation of wave frequency (ω) with wave
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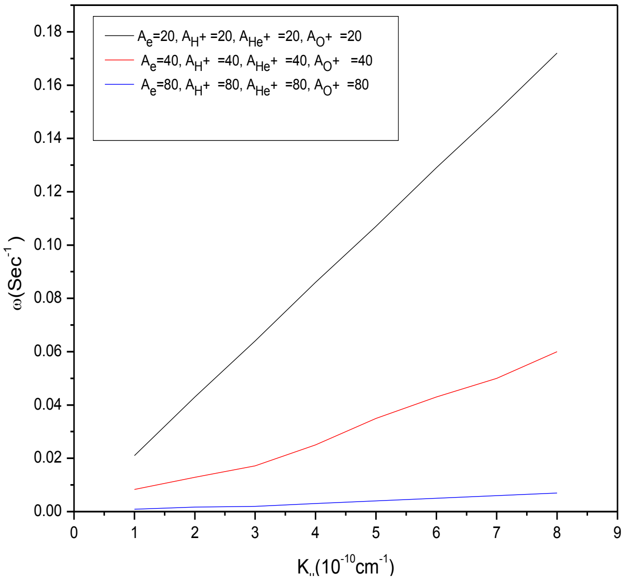

Figure 6 shows the variation of wave frequency (ω) with wave number (k_{II}) for different values of temperature anisotropy (A_e, A_H^+, A_{He}^+ and A_O^+).

V. CONCLUSION AND FUTURE SCOPE

In the present investigation, we have using the trajectories of particles which is evaluated within the theoretical of linear theory and found that the effect of electron beam reduces the frequency when the electron beam is along the magnetic field and in the direction of propagating wave vector (k_{II}) and wave velocity gets modified in the presence of beam in the plasma which is dispersion less medium for the Alfven wave. It is observed that current decreases with increases of propagating wave vector or wave number propagating wave vector (k_{II}) as well as multi-beam velocity (V_b). The effect of multi-component beam parallel to magnetic field is to decrease the parallel current by diverging it to the perpendicular current. We notice that the wave frequency increases with k_{II} but decreases with the increases of temperature anisotropy. Thus, the temperature anisotropy observed in the auroral acceleration region also modifies the wave spectrum. We have analyzed the dispersion relation of propagating waves in plasma comprising electrons and ions which will be mile stone in future in plasma world. . In many astrophysical and laboratory plasmas more than a single ion species is present. In multi-species plasma due to the occurrence of multiple resonances and cutoffs the propagation of Alfven waves is strongly affected. The results are interpreted for the magnetosphere in space plasma. Result shows in figure 1-6.

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