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To study the parallel inhomogenous electric field with kappa distribution function on kinetic Alfven waves in dusty plasmas

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Abstract : The effect parallel of electric field with kappa distribution function by investigating the basic assumption and using the method of particle aspect analysis is evaluated. The dispersion function, growth rate and growth length of the kinetic Alfven waves in homogeneous plasma have been obtained. The wave is assumed to propagate parallel to the static magnetic field. The effect of parallel electric field and kappa distribution function with dust particle charge on kinetic Alfven waves in magnetosphere plasma is to enhance the damping/growth rate with increases the growth length of kinetic Alfven waves in low βcase. The results are interpreted for the space plasma parameters appropriate to the auroral acceleration region in magnetosphere plasma. The applicability of the finding is discussed for auroral acceleration phenomena.

***IndexTerms* - kinetic Alfven wave, Magnetoplasma, Auroral acceleration region, kappa distribution function, temperature anisotropy, dusty plasma, parallel electric field.**

I. INTRODUCTION

Kinetic Alfvén waves are of great importance in laboratory and space plasmas. These waves may play an important role in energy transport, in driving field- aligned currents, in particle acceleration and heating, and in explaining inverted-V structures in magnetosphere-ionosphere coupling and in solar flares and the solar wind.[1-10] Electric field parallel to the magnetic fields play a major role in the transport of mass , momentum and energy in the auroral zone . Direct measurement have revealed that the quasi stationary parallel electric fields believed to be responsible for particle acceleration can be of large amplitude[11-17]. The parallel electric field amplitudes were shown to be anti correlated with the plasma density with no apparent correlation with the current density[12,15]. Dusty plasmas contain charged dust grains that can be treated as additional ionic species with very distinct and unusual characteristics like high and variable charges and even higher masses[18]. The first dust and plasma measurements by a rocket within a radar beam during a PMSE event revealed a close correlation between the dust charge density and the backscatter signal[19,20] . The most surprising result was , however , that strong PMSE was present even when the dust charge density was very low . There are many processes whereby dust cloud act as a source of electrons . These are photoelectric emission , thermionic emission , secondary electron emission by ion impact , electron field emission , radioactivity and exo-electron emission which takes place during the deformation of crystals and may be due to the rapture of chemical bonds. The above process may be which dust can be lead to the production of electron and ions . This is accomplished through the setting up of strong local electric field's which lead to the electrical breakdown of the surrounding medium . Charge seperation due to contact or turboelectric charge transfer between dust grains can also lead to large local am bipolar electric fields, once again leading to electrical break-down , as may be happening during Volcanic eruption and thunderstorms.The S3-3 satellite mission established that auroral acceleration is a near earth process, often less than 8000 km in altitude. Subsequent missions verified this finding. fast observation also suggests both high and low- altitude eceleration regions. The polar observations now conclude that the majority of auroral acceleration is below 2 R_E in altitude[21-22].

Collective phenomena in dusty plasma are of great importance provided that the number density of charged dust grain is sufficiently high within a Debye sphere. The field of dusty plasma is recently growing rapidly because of its potential application in space and astrophysical situation[23-25]. The main aim of this study is to investigate the effect of ion and electron on the kinetic Alfven wave in the presence of an inhomogeneous electric field in the auroral region by using particle aspect analysis. The theory is based on Dawson's theory of Landau damping which was further extended by many researcher[26-28].observations of electric fields in the ionosphere and the magnetosphere using various techniques have led to important advances in the understanding of magnetosphere-ionosphere coupling. Electric fields of the order of hundreds of millivolts per metre have been predieted in the high- latitude ionosphere, the auroral zone, magnetotail and the plasma sheet[29-34]. In a variety of situations in a particular at the time of substorm onset – the interplanetary magnetic field reverses its direction, and two oppositely directed inhomogeneous electric fields are reported in the plasma sheet and in the auroral zone[30-31].

The main advantage of this approach is to consider the energy transfer between wave and particles, along with the discussion of wave dispersion and the growth/damming rate of the wave. The method may be suitable to deal with the auroral electrodynamics where particle acceleration is also important along with wave emissions. The results obtained by this approach is the same as those derived using the kinetic approach. Effects of the kappa distribution function with the parallel electric field and ion have been widely studied by researchers concerning electrostatic waves, electromagnetic waves, drift waves, Alfven waves and kinetic Alfven waves and electrostatic ion cyclotron waves[35,36,22,]. the method of particle aspect analysis was used in references [37,38]. to the analysis of Alfven and kinetic Alfven wave for the parallel electric field ignoring the dusty plasma . Our purpose in this paper is to be investigate the effect of parallel electric field on kinetic Alfven wave with dusty plasma . The parallel electric field is assumed as developed by external source , not by the kinetic Alfven waves[39]. Using the particle aspect analysis the basic assumption are those of earlier work on the kinetic Alfven wave[37-41] in which the plasma has been considered to consist of resonant and non-resonant particles and the wave growth was discussed by the energy conservation method.

In the past, several observational and empirical models have been developed for the electric and magnetic field distribution in the ionosphere and the magnetosphere. Early reviews concerning the electric field distribution observed in the ionosphere include the work of various workers". Early satellites in polar orbits equipped with an electric double probe such as OGO-6 and INJUN-5 have established the concept of polar cap in terms of electric field patterns across which the dawn-to-dusk electric field exists permanently. The most prominent feature of the electric field data from polar orbiting satellites is the persistent occurrence of steep reversal in the field[42-50].

II. Basic trajectory: The kinetic Alfven wave is assumed to start at t=0 when the resonant particles are undisturbed. The main interest lies in the behaviour of kinetic Alfven waves, which satisfy the conditions.

$$V_{T\pi d}, V_{T\pi i} << \frac{\omega}{K_\pi} << V_{T\pi e};\ \omega << \Omega_i;\ \Omega_e, \Omega_d; K_\perp^2\rho_e^2 << K_\perp^2\rho_i^2; K_\perp^2\rho_d^2 < 1 \quad (1)$$

Where $V_{T\Pi i}$, $V_{T\Pi e}$ and $V_{T\Pi d}$ are the mean velocities of ions, electrons and dust particles along the magnetic field, $\Omega_{i,e,d}$ are gyration cyclotron frequencies of the respective species. $K_\perp$ and K_Π are the components of real wave vector k perpendicular and parallel to the magnetic field B_0. Consider the two particles representation of electric field a kinetic Alfven wave of the from (A K Dwivedi 2015)

$E_\perp = -\nabla_\perp \phi$ and $E_\Pi = -\nabla_\Pi \psi$

$$\overline{E} = \overline{E}_\perp + \overline{E}_\Pi$$

$$\phi = \phi_1 \cos(k_\perp x + k_\Pi z - \omega t)$$

$$\psi = \psi_1 \cos(k_\perp x + k_\Pi z - \omega t) \quad (2)$$

where ϕ_1 and ψ_1 are assumed to be a slowly varying function of time t, and ω is the wave frequency which is assumed as real.$u_x(\overline{r},t) u_y(\overline{r},t)$ and $u_z(\overline{r},t)$ of the changed particles presence of KAW.

$$u_x(\vec{r}.t) = -\frac{q}{m}\left[\phi_1 k_\perp - \frac{V_\Pi K_\Pi K_\perp}{\omega}(\phi_1 - \psi_1)\right]\sum_{-\infty}^{+\infty} J_n(\alpha)\sum_{-\infty}^{+\infty} J_l(\alpha)\left[\frac{\Lambda_n}{a_n^2}\cos\xi_{nl} - \frac{\delta}{2\Lambda_{n+1}}\cos(\xi_{nl} - \Lambda_{n+l}t) - \frac{\delta}{2\Lambda_{n-1}}\cos(\xi_{nl} - \Lambda_{n-l}t)\right]$$

$$u_y(\vec{r}.t) = -\frac{q}{m}\left[\phi_1 k_\perp - \frac{V_\Pi K_\Pi K_\perp}{\omega}(\phi_1 - \psi_1)\right]\sum_{-\infty}^{+\infty} J_n(\alpha)\sum_{-\infty}^{+\infty} J_l(\alpha)\left[\frac{\Omega}{a_n^2}\sin\xi_{nl} - \frac{\delta}{2\Lambda_{n+1}}\sin(\xi_{nl} - \Lambda_{n+l}t) - \frac{\delta}{2\Lambda_{n-1}}\sin(\xi_{nl} - \Lambda_{n-l}t)\right]$$

$$u_z(\vec{r}.t) = -\frac{q}{m}\left[\psi_1 k_\Pi - \frac{V_\perp K_\Pi K_\perp}{\omega}(\phi_1 - \psi_1)\frac{n}{\alpha}\right]\sum_{-\infty}^{+\infty} J_n(\alpha)\sum_{-\infty}^{+\infty} J_l(\alpha)\frac{1}{\Lambda_n}[\cos\xi_{nl} - \delta\cos(\xi_{nl} - \Lambda_n t)] \quad (3)$$

Where δ=0 for non-resonant particles and δ=1 for resonant particle and

$\Lambda_n = k_\Pi v_\Pi - \omega + n\Omega,\ a_n^2 = \Lambda_n^2 - \Omega^2$

$\alpha = \frac{k_\perp v_\perp}{\Omega}$,

$$\xi_{nl} = k_\perp x + k_\Pi z - \omega t + (l - n)(\theta - \Omega t) \quad (4)$$

θ is the initial phase of the velocity and $\Omega = qB_0/mc$, u_x and u_y are the perturbed and velocities in the x and y direction respectively. The slowly varying quantities ϕ_1 and ψ_1 are treated as a constant.

Integration of eq. (3) gives the perturbed coordinates of particles x,y,z which in addition of trajectories of free gyration

Exhibits the true path of the particles. In the view of the approximations introduced in the beginning, the dominant contribution comes from the term n=0. J_s are Bessel's functions which arise from the different periodical variation of charged particles trajectories. The term represented by Bessel's functions show the reduction of the field intensities due to finite gyro radius effect.

In order to find out the Density perturbation associated with the velocity perturbation, $\vec{u}(\vec{r},t,\vec{v})$, we consider the equation for non-resonant particles

$$n_1(\vec{r}t) = F(\vec{v})\sum_{-\infty}^{+\infty} J_n(\alpha)\sum_{-\infty}^{+\infty} J_1(\alpha)\frac{q}{m}\left[\left\{\phi_1\frac{v_\Pi k_\Pi}{\omega}(\phi_1 - \psi_1)\right\}\left\{\frac{k_\perp^2}{a_n^2} + \frac{\Omega^2 v_d k_\perp m}{\Lambda_n a_n^2 T_\perp}\right\} + \frac{k_\Pi^2}{\Lambda_n}\left\{\psi_1 - \frac{n}{\alpha}\frac{v_\perp k_\perp}{\omega}(\phi_1 - \psi_1)\right\}\right]\cos\xi_{nl} \quad (5)$$

The resonant particles we have.

$$n_1(\vec{r}t) = F(\vec{v})\sum_{-\infty}^{+\infty} J_n(\alpha)\sum_{-\infty}^{+\infty} J_1(\alpha)\frac{q}{m}\left[\left\{\phi_1\frac{v_\Pi k_\Pi}{\omega}(\phi_1 - \psi_1)\right\}\left\{\frac{k_\perp^2}{a_n^2} + \frac{\Omega^2 v_d k_\perp m}{\Lambda_n a_n^2 T_\perp}\right\}\cos\xi_{nl} + \frac{1}{2\Omega\Lambda_{n+1}}\cos(\xi_{nl} - \Lambda_{n+1}t)\left(k_\perp^2 - \frac{\Omega v_d k_\perp m}{T_\perp}\right)\frac{v_d k_\perp m}{\Lambda_n T_\perp}\cos(\xi_{nl} - \Lambda_n t) - \frac{1}{2\Omega\Lambda_{n+1}}\cos(\xi_{nl} - \Lambda_{n-1}t)\left(k_\perp^2 + \frac{\Omega v_d k_\perp m}{T_\perp}\right) + \frac{k_\Pi^2}{\Lambda_n^2}\left\{\psi_1 - \frac{n}{\alpha}\frac{v_\perp k_\perp}{\omega}(\phi_1\psi_1)\right\}\{\cos\xi_{nl} + \Lambda_n t\sin(\xi_{nl} - \Lambda_n t) - \cos(\xi_{nl} - \Lambda_n t)\}\right] \quad (6)$$

Where F(v) represent the kappa distribution function and V_d is the diamagnetic drift velocity which is defined by

$V_d = \frac{T_\perp}{m\Omega}\varepsilon_N;\ \varepsilon_n = \frac{1}{N}\frac{dN}{dy}$ inhomogeneous

To determine the dispersion relation and the growth rate, we use the by kappa distribution function with density perturbation.

3.Kappa distribution

$$N(y,v) = N_0\left[1-\varepsilon\left(y+\frac{V_x}{\Omega}\right)\right] f_\perp(v_\perp) f_\Pi(v_\Pi) \tag{7}$$

Where

$$f_\perp(v_\perp) = \left[\frac{mv_\perp^2}{2K_B}\right]\frac{2k_\perp}{k_\Pi - 1} \qquad f_\Pi(v_\Pi) = \left[\frac{mv_\Pi^2}{2K_B}\right]\frac{2k_\Pi}{2k_\Pi - 1}$$

$$T_{\Pi c} = T_\Pi\left(\frac{2\kappa}{2\kappa-1}\right)\left[1 + i\frac{e_1.E_0.\bar{K}}{K^2 V_{T\Pi}^2\left(\frac{2\kappa}{2\kappa-1}\right)}\right]$$

and $K = (k_\perp^2 + k_\Pi^2)^{1/2}$

And ε is a small parameter of the order of inverse of the density gradient scale length.

4.Dispersion relation

To evaluated the dispersion relation, we calculate the integrated perturbed density for non-resonant particles as

$$n_{i,c,d} = \int_0^\infty 2\pi V_\perp\, dV_\perp \int_{-\infty}^\infty dV_\parallel n_i(r,t) \tag{8}$$

With the help of eq.(5) and (7) use find the average densities for homogeneous plasma as

$$\bar{n}_i = \frac{\omega_{pi}^2}{4\pi e}\left[\frac{-K_\perp^2\phi}{\Omega_i^2} + \frac{K_\parallel^2}{\omega_i^2}\psi\right]\left(1-\frac{1}{2}k_\perp^2\rho_i^2\right)\left(\frac{2k-1}{2k}\right) \tag{9}$$

$$n_e = \frac{\omega_{pe}^2}{4\pi e V_{T\parallel e}^2}\psi \tag{10}$$

$$\bar{n}_d = \frac{\omega_{pd}^2}{4\pi Z_d e}\left[\frac{-k_\perp^2\phi}{\Omega_d^2} + \frac{k_\parallel^2\psi}{\omega^2}\right]\left(1-\frac{1}{2}k_\perp^2\rho_d^2\right)\left(\frac{2k-1}{2k}\right) \tag{11}$$

It is observed that essential feature of the kinetic Alfven wave is retained even in this ideal case. For maxwell's equation we use the quasi-neutrality condition,

$$\bar{n}_i = \bar{n}_e + Z_d\bar{n}_d$$

We get relation between ψ and ϕ as:

$$\phi = \frac{\Omega_d^2}{k_\perp^2}\left[\frac{\omega_{pc}^2}{\omega_{pd}^2 v_{T\parallel}^2 A_2} - \frac{k_\parallel^2}{\omega^2}\left(1+\frac{A_1B_1}{A_2}\right)B_2^{-1}\psi \tag{12}$$

Where

$$A_1 = 1 - \frac{1}{2}k_\perp^2\rho_i^2\left[\frac{2k_i-1}{2k_i}\right], \quad A_2 = 1-\frac{1}{2}k_\perp^2\rho_d^2\left[\frac{2k-1}{2k}\right]$$

$$B_1 = \frac{N_0}{N_{d0}}\frac{m_d}{m_i}\frac{1}{z_d^2}, \qquad B_2 = 1 - \frac{A_1B_1}{A_2}\frac{\Omega_d^2}{\Omega_i^2}$$

Using perturbed ion, electron and dust particle densities n_i, n_e and n_d and Ampere's law in the parallel direction, we obtained the equation:

$$\frac{\partial}{\partial z}\nabla_\perp^2(\phi-\psi) = \frac{4\pi}{c^2}\frac{\partial}{\partial t}J_z \tag{13}$$

where

$$J_z = c\int_0^\lambda ds\int_0^\infty 2\pi V_\perp dV_\perp\int_{-\infty}^{\infty} dV_\parallel\frac{m_j}{2}\left[(N+n_1)(V+u)^2 - NV^2\right]_j$$

J_z is the current density which is contributed by first-order perturbations of density and velocity.
we obtain the dispersion relation for the kinetic Alfven waves in homogeneous dusty plasma as:

$$\omega^4\left(\frac{\omega_{pe}^2 B_2}{k_\Pi^4\omega_{pd}^2 V_{T\Pi e}^4 V_A^2 A_2}\right) - \omega^2\left\{\begin{array}{c}\frac{k_\perp^2 B_2}{k_\Pi^2\Omega_d^2}\left(1+\frac{\omega_{pd}^2A_2}{c^2}\left(\frac{T_{\Pi cd}}{m_d}\right)\right) + \frac{\omega_{pi}^2A_1}{c^2k_\Pi^2\Omega_d}\left(1-\frac{\omega_{pi}^2}{\omega_{pd}^2V_{T\Pi e}^2\Omega_i^2A_2}\frac{T_{\Pi ci}}{m_i} - \frac{k_\perp^2}{\Omega_i^2}\frac{T_{\Pi ci}}{m_i}\right) + \\ \left(\frac{\omega_{pe}^2}{c^2\Omega_d^2V_{T\Pi e}^2k_\Pi^2}\frac{T_{\Pi cd}}{m_d}\right) + \left(\frac{B_2}{k_\Pi^2V_A^2} - \frac{\omega_{pe}^2}{k_\Pi^2\omega_{pd}^2V_{T\Pi e}^2A_2}\right)\end{array}\right\} - \frac{\omega_{pi}^2}{c^2\Omega_i}\frac{T_{\Pi ci}}{m_i}\left(1+\frac{A_1B_1}{A_2}\right) - \frac{\omega_{pd}^2A_2}{c^2\Omega_d^2}\frac{T_{\Pi cd}}{m_d} - \frac{A_1B_1}{A_2} + 1 = 0 \tag{14}$$

Where, $V_A^2 = \frac{c^2\Omega_i^2}{\omega_{pd}^2}$ is the square of Alfven's speed.

The oscillatory motion of non-resonant electrons carriers the major part of energy. The wave energy density per unit wave length W_w is the sum of pure field energy and the changes in energy of the non-resonant particles $W_{i,e,d}$. it is observed that the wave energy is contained in the from of the oscillatory motion of the non-resonant electrons.

5. Growth rate :

using the low of conservation of energy, calculate the growth rate of drift kinetic Alfven wave by

$$\frac{\mathrm{d}}{\mathrm{dt}}(W_w + W_r) = \tag{15}$$

With the help of we have found the growth rate of the drift kinetic Alfven wave with dusty plasma as:

$$\frac{\gamma}{\omega} = \frac{\pi^{1/2}\omega}{k_\parallel V_{T\parallel e}\left[1+\frac{\omega_{pi}^2 k_\parallel^2 T_\parallel}{\omega^2\omega_{pe}^2 m_e}\times(A_x+P_x)\right.}\frac{\Gamma(\kappa+1)}{\kappa^{\frac{3}{2}}\times\Gamma\left(\kappa-\frac{1}{2}\right)}\left(1+\frac{\omega^2}{k_\parallel^2 v_{T\parallel e}^2}\right)^{-(k+1)} \tag{16}$$

6.Growth length:

$$\gamma = \frac{\Gamma(\kappa+1)}{\kappa^{\frac{3}{2}}\times\Gamma\left(\kappa-\frac{1}{2}\right)}\times\left[\frac{\sqrt{\pi}\times\sqrt{\omega}}{K_\Pi.VT_{\Pi e}.\left[1+\frac{\omega_{pi}^2.VT_{\Pi e}^2}{\omega.\omega_{pe}^2}.(A_x+P_x)\right]}.\left[1+\frac{\omega}{K_\Pi^2.VT_{\Pi e}^2}\right]\right]^{-(\kappa+1)} \tag{17}$$

$$V_p = \left[\frac{B}{\omega_{pd}^2.VT_{\Pi e}^2.V_a^2.A_2} + \sqrt{B^2 + 4.\frac{\omega_{pe}^2.B_2}{\omega_{pd}^2.VT_{\Pi e}^2.V_a^2.A_2}.C.\frac{\omega_{pd}^2.VT_{\Pi e}^2.V_a^2.A_2}{\omega_{pe}^2.B_2}}\right]^{\frac{1}{2}} \tag{18}$$

$$L_g = \frac{\left[\frac{B}{\omega_{pd}^2.VT_{\Pi e}^2.V_a^2.A_2} + \sqrt{B^2+4.\frac{\omega_{pe}^2.B_2}{\omega_{pd}^2.VT_{\Pi e}^2.V_a^2.A_2}.C.\frac{\omega_{pd}^2.VT_{\Pi e}^2.V_a^2.A_2}{\omega_{pe}^2.B_2}}\right]^{\frac{1}{2}}}{\frac{\Gamma(\kappa+1)}{\kappa^{\frac{3}{2}}\times\Gamma\left(\kappa-\frac{1}{2}\right)}\times\left[\frac{\sqrt{\pi}\times\sqrt{\omega}}{K_\Pi.VT_{\Pi e}.\left[1+\frac{\omega_{pi}^2.VT_{\Pi e}^2}{\omega.\omega_{pe}^2}.(A_x+P_x)\right]}.\left[1+\frac{\omega}{K_\Pi^2.VT_{\Pi e}^2}\right]\right]^{-(\kappa+1)}} \tag{19}$$

Where B and C are define as, and L_g is Growth length,

$$B = \frac{k_\perp^2 B_2}{k_\Pi^2\Omega_d^2}\left(1+\frac{\omega_{pd}^2 A_2}{c^2}\left(\frac{T_{\Pi cd}}{m_d}\right)\right) + \frac{\omega_{pi}^2 A_1}{c^2 k_\Pi^2\Omega_d}\left(1-\frac{\omega_{pi}^2}{\omega_{pd}^2 V_{T\Pi e}^2\Omega_i^2 A_2}\frac{T_{\Pi ci}}{m_i} - \frac{k_\perp^2}{\Omega_i^2}\frac{T_{\Pi ci}}{m_i}\right) + \left(\frac{\omega_{pe}^2}{c^2\Omega_d^2 V_{T\Pi e}^2 k_\Pi^2}\frac{T_{\Pi cd}}{m_d}\right) + \left(\frac{B_2}{k_\Pi^2 V_A^2} - \frac{\omega_{pe}^2}{k_\Pi^2\omega_{pd}^2 V_{T\Pi e}^2 A_2}\right)$$

$$C = \frac{\omega_{pi}^2}{c^2\Omega_i}\frac{T_{\Pi ci}}{m_i}\left(1+\frac{A_1 B_1}{A_2}\right) - \frac{\omega_{pd}^2 A_2}{c^2\Omega_d^2}\frac{T_{\Pi cd}}{m_d} - \frac{A_1 B_1}{A_2} + 1$$

7. Results and discussion

In the numerical evaluation of the growth rate, growth length and dispersion relation for the kinetic Alfven waves in an dusty magnetized plasma, we have used the following dusty plasma parameters which may be suitable for auroral acceleration region[62-64,69].

$\Omega_i = 412\ s^{-1}$; $\Omega_d = 6.88\times10^{-10} Z_d$; $m_d = 10^{-12} g$; $VT_{\Pi e} = 4\times 10^6 m\ s^{-1}$
$\rho i = 1.68\times10^4$

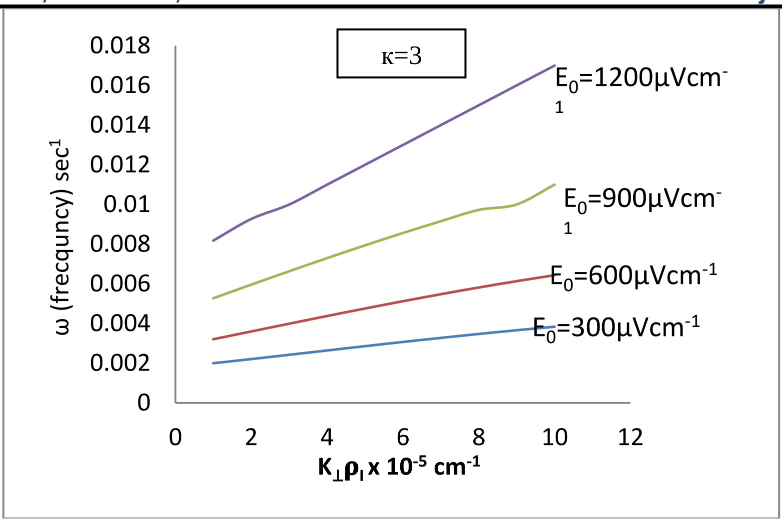

Figure 1. Frequency (ω) versus perpendicular wave number (K⊥ρ_i) for different E_0

shows the relation between wave frequency ω (rad/sec) versus perpendicular wave number $k_\perp$ for different values of parallel electric field E_0, at the fixed values of dust grain Z_d and kappa (κ). It is observed that the parallel electric field E_0, enhanced the frequency .it is clear that the wave frequency ω increases with increase of applied electric field. the increase of ω with increasing k⊥ρi.

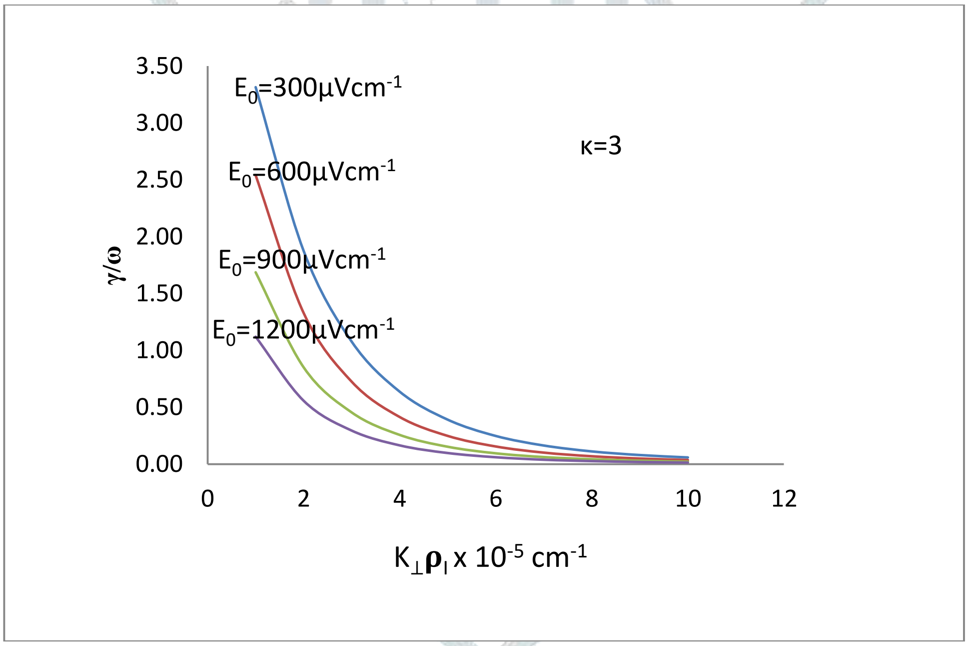

Figure 2. Growth rate (γ/ω) versus perpendicular wave number (k⊥ρi) for different E_0.

the variation of growth rate (γ/ω) with $k_\perp$ at different values of parallel electric field E_0 at fixed Z_d and kappa κ. Here it is noticed that the effect of electric field is to reduced the growth rate at higher values of electric field with. Thus, the parallel electric field controls the wave growth in the dusty magneto-plasma and transfers the energy to the particles by inverse Landau damping.

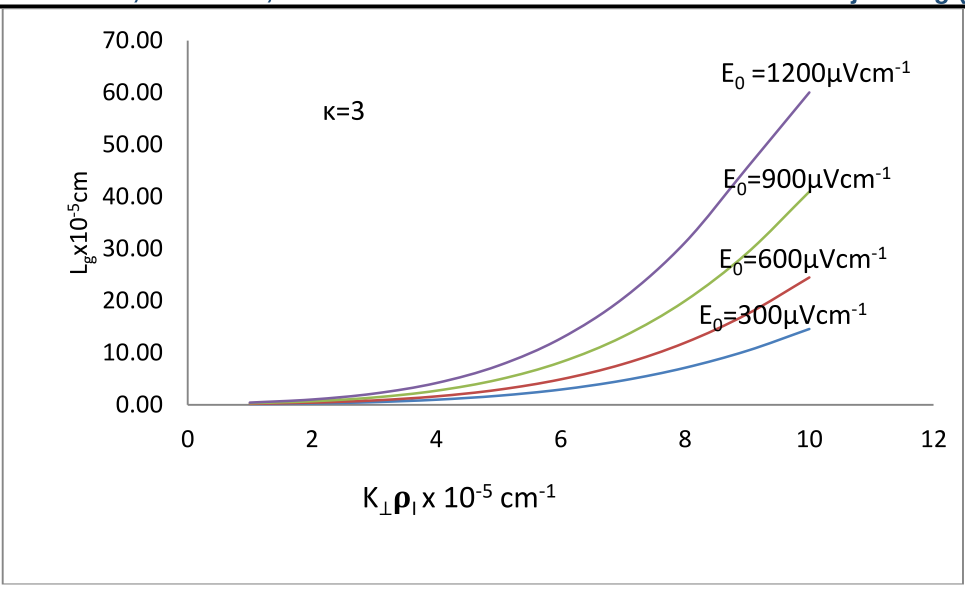

Figure 3. Growth length (L_g) versus perpendicular wave number ($k_\perp\rho i$) for different E_0.

the relation between Growth length (L_g) versus perpendicular wave number $k_\perp$ for different values of parallel electric field E_0, at the fixed values of dust grain Z_d and kappa (κ). It is observed that the parallel electric field E_0, enhanced the frequency .it is clear that the growth length(L_g) increases with increase of applied electric field. the increase of growth length(L_g) with increasing $k\perp\rho i$.

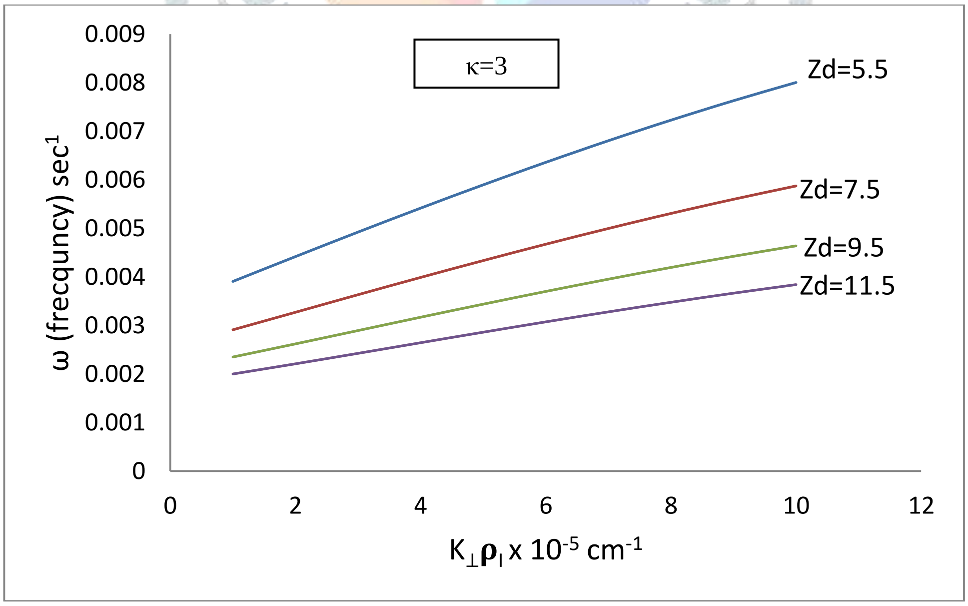

Figure 4. : frequency (ω) versus perpendicular wave number ($k_\perp\rho i$) for different Zd.

shows the relation between wave frequency ω versus perpendicular wave number $k_\perp$ for different values of dust grain Z_d, at the fixed values of electric field E_0 and kappa (κ). It is observed that the dust grain Z_d, enhanced the frequency .it is clear that the wave frequency ω increases with increase of applied dust grain Z_d. the increase of ω with increasing $k\perp\rho i$.

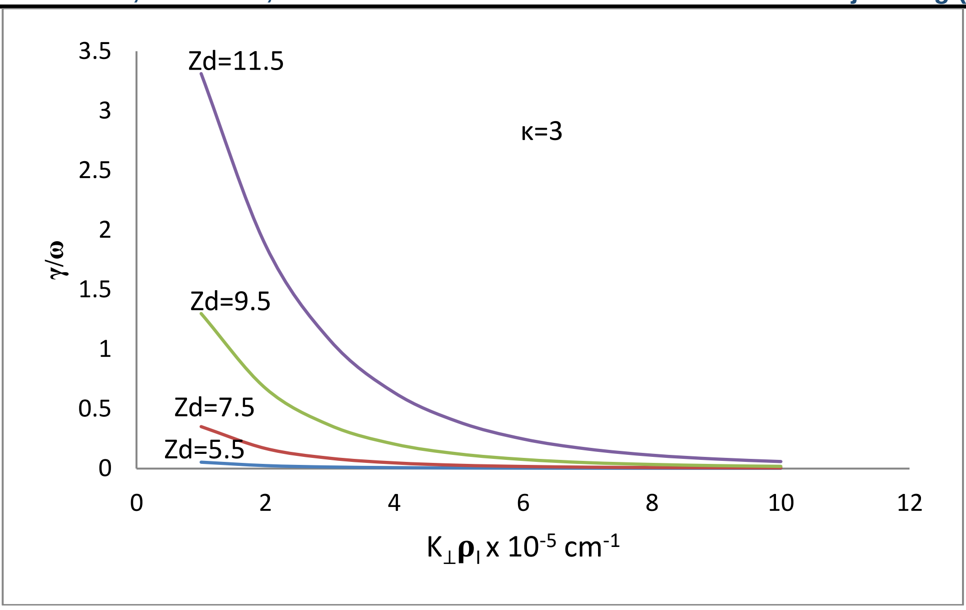

Figure 5. Growth rate (γ/ω) versus perpendicular wave number ($k_\perp\rho i$) for different Zd.

The variation of growth rate (γ/ω) with $k_\perp$ at different values of dust grain Z_d at fixed values parallel electric field E_0 and kappa κ. Here it is noticed that the effect of electric field is to reduced the growth rate at higher values of electric field with. Thus, the parallel electric field controls the wave growth in the dusty magneto-plasma and transfers the energy to the particles by inverse Landau damping.

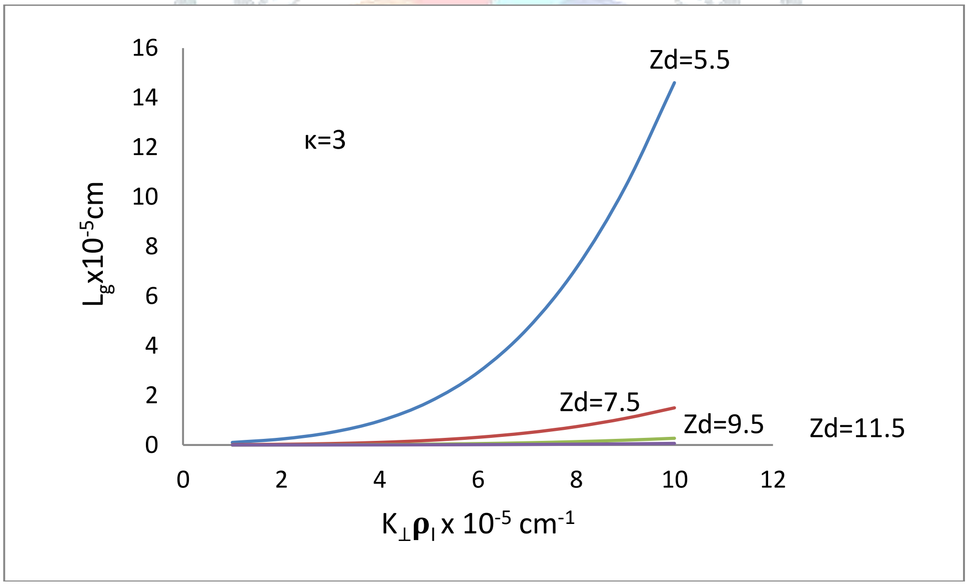

Figure 6. Growth length (L_g) versus perpendicular wave number ($k_\perp\rho i$) for different Zd.

the relation between Growth length (L_g) versus perpendicular wave number $k_\perp$ for different values of dust grain Z_d, at the fixed values of parallel electric field E_0 and kappa (κ =3). It is observed that the dust grain Z_0, enhanced the frequency .it is clear that the growth length(L_g) increases with increase of applied dust grain Z_d. the increase of growth length(L_g) with decreasing $k_\perp\rho i$.

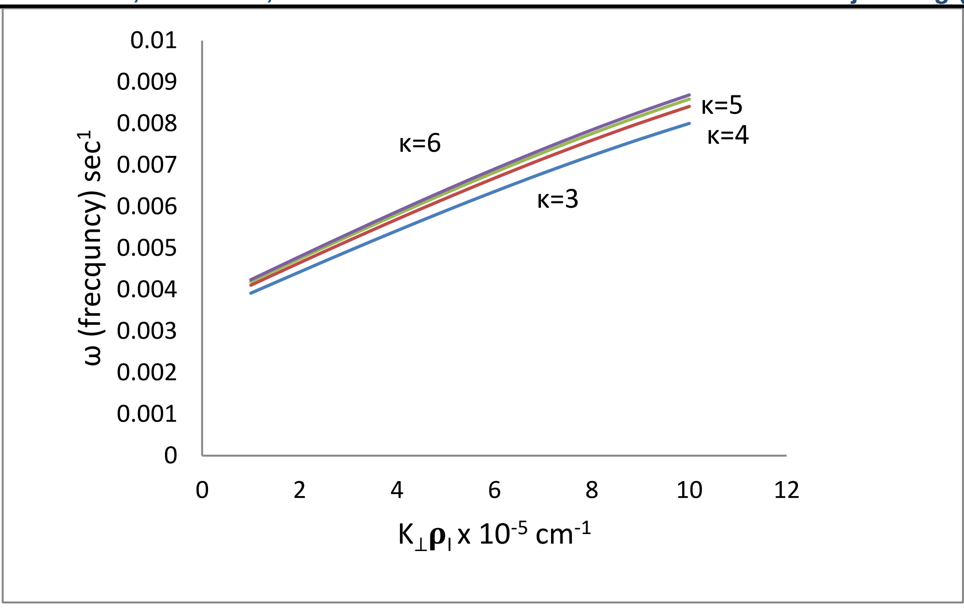

Figure 7. frequency (ω) versus perpendicular wave number (k⊥ρi) for different (κ).

shows the relation between wave frequency ω (rad/sec) versus perpendicular wave number $k_\perp$ for different values of kappa distribution function κ, at the fixed values of dust grain Z_d and parallel electric field E_0. It is observed that the kappa distribution function κ, enhanced the frequency .it is clear that the wave frequency ω increases with increase of applied kappa function κ. the increase of ω with increasing k⊥ρi.

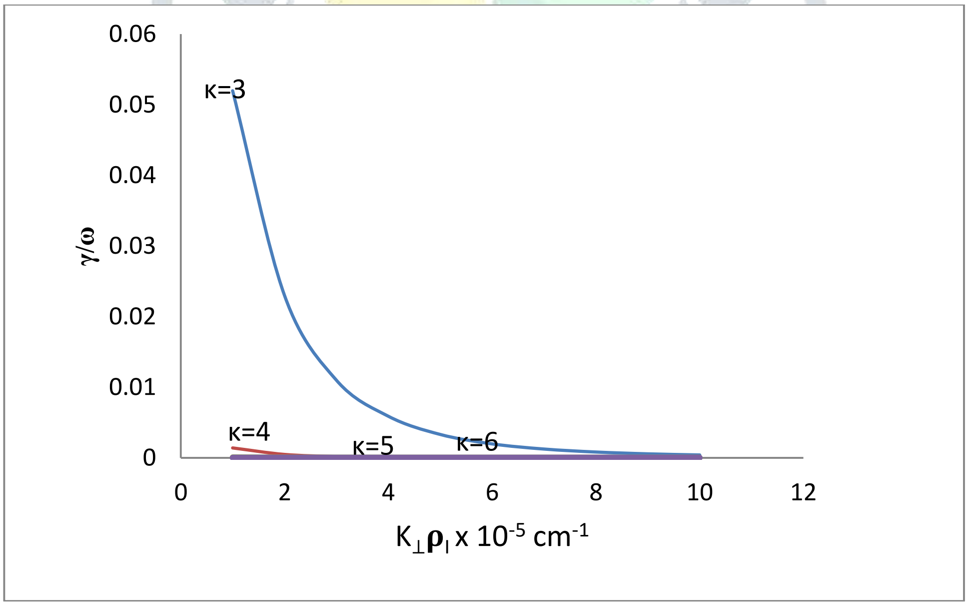

Figure 8. Growth rate (γ/ω) versus perpendicular wave number (k⊥ρi) for different (κ).

The variation of growth rate (γ/ω) with $k_\perp$ at different values of kappa distribution function κ at fixed values parallel electric field E_0 and dust grain Z_d. Here it is noticed that the effect of kappa function is to reduced the growth rate at higher values of kappa κ with. The growth rate slows down as we increase the value of the kappa.

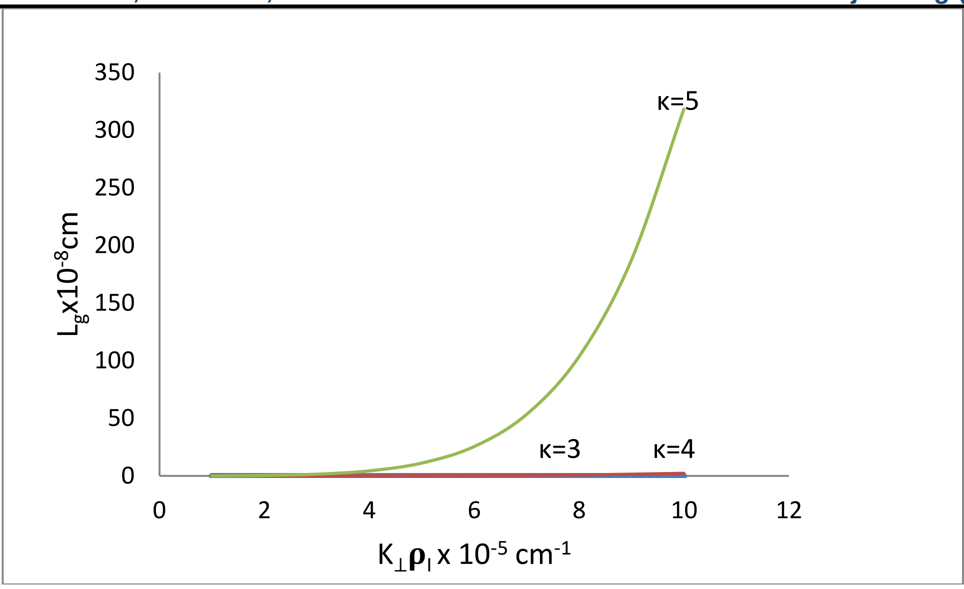

Figure 9. Growth length (L_g) versus perpendicular wave number ($k_\perp\rho i$) for different (κ).

the relation between Growth length (L_g) versus perpendicular wave number $k_\perp$ for different values of kappa function κ, at the fixed values of parallel electric field E_0 and dust grain Z_d. It is observed that the kappa function κ, enhanced the frequency .it is clear that the growth length(L_g) increases with increase of applied kappa function κ. the increase of growth length(L_g) with increasing $k_\perp\rho i$.

References:

1. Hasegawa, A 1977 Proc Indian Acad. Sci. 86A, 151
2. Goertz, C. K. and Boswell, R W 1979 J. Geophys. Res 84, 7239
3. Goertz, C. K 1984 Planet. Space Sci. 32, 1381
4. Moghaddam-Taaheri, E., Gocrtz, C. K. and Smith, R. A. 1989 J. Geophys. Res. 94, 10047.
5. Leonovich, A. S. and Mazur, V. A. 1989 Planet, Space. Sci. 37. 1095.
6.Leonovich, A. S. and Mazur, V. A. 1995 Planet. Space Sci. 43, 881.
7.Marchenko, A. V., Denton, R. E. and Hudson, M. K. 1996 Phys. Plasmas 3, 3861.
8. Klimushkin, D. Y. 1997 Planet. Spare Sci. 45, 269.
9. Huang, G. L and Wang, R. Y 1997 J. Plasma Phys. 58, 433.
10.Baronia,A and Tiwari, M.S. 2000 J. Plasma Phys. 311-328.
11. Mozer, F. S. and Cattell C., 1980 , Space Sci. Rev., 27 , 155.
12. Mozer, F. S. and Hull, A., 2001, J Geophys. Res., 106(A4) , 5763.
13. Mozer, F. S. and Kletzing, C. 1998, Geophys. Res. Lett., 25 , 1629.
14. Hull, A. J., and Mozer, F. S., 2000 a , Eos. Trans. AGV 8I(48) Fall Meet. Suppl., F1009.
15. Hull, A. J., and Bonnell, J. , 2003, J Geophys. Res. , 108(a6) , 1265.
16. Ergun, R. E.,and Andersson, A., 2002, Phys. Plasmas., 9 , 3695.
17. Johnston, A. D. and Winninghon, J. D.,1982, J Geophys. Res., 87 , 2321.
18 Jacob, G., and Versheet, F., 2000, CP537, American Institute of Physics , p. 53.
19. Barkan, A., and D'Angelo,N., 1998, CP446 , American Institute of Physics, p. 97.
20. Gelinas, L.J., and Kelley, M.C. 2000, CP537, American Institute of Physics, p. 48.
21. Mozer F. S. and Hull A., J Geophys Res 2000 2000JA90017.
22. Ahirwar G. and Varma P. Indian journal of pure & applied physics 2011, 385-393.
23. Goertz C K, Rev Geophys (USA), 27 (1989) 271.
24. Bliokh P, Sinitsin V & Yaroshenko V, Dusty and Self-Graviational Plasma in Space (Kluwer academic, Dordrecht) 1995.
25. Winter J. Plasma Phys (UK), 7 (2000) 3668.
26. Baronia A & Tiwari M S, J Plasma Phys, 63 (2000) 311.
27. Dwivedi A K, Varma P & Tiwari M S, Planet Space Sci. 49 (2001) 993.
28. Hasegawa A & Chen L, Phys Fluids 19 (1976) 1924.
29. Mozer, F. S. and Lucht, P. 1974 J. Geophys. Res. 79, 1001.
30. Lui, A. T. Y. and Akasofu, S. I. 1980 J. Geophys. Res. 7, 877.
31. Candidi, M. and Orsini, S. 1981 Geophys. Res. Lett. 8, 637
32. Cattell, C. A Kim, M Lin, R P and Mozer, F. S. 1982 Geophys. Res. Lett. 9, 539.
33. Mauk, B. H. and Zanetti, L. J. 1987 Ren. Geophys. 25. 541.
34. Providakes, J. F., Kelley, M. C. and Swartz. W. E. 1989 J. Geophys. Res, 94, 5350.
35. Dwivedi A K, Varma P & Tiwari M S, Planet Space Sci, 50 (2002) 93.
36. Mishra R & Tiwari M S, Planet Space Sci, 54 (2006) 188.

37. Dwivedi, A. K., Varma, P. and Tiwari, M. S., 2001, Planet. Space. Sci., 49 , 1003.
38.Dwivedi, A. K., Varma, P. and Tiwari, M. S., 2002, Planet. Space. Sci., 93 , 99.
39. Hull, A. J., Bonnell, J. W., Mozer, F. S., 2003, J Geophys. Res. , 108(a6) , 1265.
40. Shandilya, R. P., Varma, P. and Tiwari, M. S., 2003, Ind. J Phys., 77(B) , 553.
41. Shandilya, R. P., Varma, P. and Tiwari, M. S., 2004, Ind. J Radio & Space Phys., 33 , 13.
42. Mozer F S. Rev Geophys Space Phys (USA), 11 (1973) 755.
43. Pudovkin M I. Space Sci Rev (USA), 16 (1974) 727.
44. Kane R P, Space Sci Rev (USA), 18 (1976) 413,.
45. Gurevich A V. Krylou. A L. & Tsedilina E E Space Sci Rev (USA). 19 (1976) 50.
46. Stern D P. Space Sci Rev (USA), 24(1983) 317.
47. Pedersen A. Grand R. Gonfalone A & Fahleson V. Space Sci Rev (USA). 22 (1978) 333.
48. Volland H, Am Geophys Union, Washington DC (USA) 1979. p. 261.
49. Kamide Y & Akasofu S I, J Geophys Res (USA). 86 (1981) 3665.
50. Heppner J P. J Geophys Res (USA), 77(1972) 4877.