International Journal of Advance Research in Science and Engineering
Vol. No.6, Issue No. 01 , January 2017
www.ijarse.com
IJARSE
ISSN (O) 2319 - 8354
ISSN (P) 2319 - 8346

MODULATIONAL INSTABILITY OF ION-ACOUSTIC WAVE IN PLASMAS WITH TWO ELECTRON TEMPERATURE DISTRIBUTION

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ABSTRACT

The modulation instability of ion-acoustic waves has been theoretically investigated in an unmagnetized collisionless plasma with (hot and cold) electrons, positrons and ions. A nonlinear Schrödinger equation (NLSE) has been derived by using the KBM method. The positron concentration, temperature ratio of the ion to electron, cold electron concentration, temperature ratio of cold to hot electrons and positron temperature are shown to play significant role in the modulation instability of ion-acoustic waves.

Key words: ion acoustic wave, nonlinear Schrödinger equation, , KBM method, modulational instability.

I. INTRODUCTION

During the last few years electron-positron-ion (EPI) plasmas attracted attention due to their importance both in laboratory experiments and in space plasma observations [1-3]. Electron-positron plasmas are found in astrophysical plasmas such as magnetosphere of pulsars, in active galactic nuclei, in early universe, and in the regions of the accretion disks surrounding the central black holes [4-6]. Therefore, the study of electron-positron-ion (EPI) plasmas is important to understand the behavior of both astrophysical [1-3,7-9] and laboratory plasmas [10-12]. In the last two decades there has been a great deal of interest in the study of nonlinear wave phenomena in both unmagnetized and magnetized EPI plasmas [13-21].

Several authors have derived the nonlinear Schrödinger equation by either using the reductive perturbation method [22-23] or the Krylov Bogoliubov Mitropolsky (KBM) method [24] have studied the stability of ion-acoustic waves against modulational instability in a collisional less plasma consisting of cold ions and hot electrons. It has been shown [24] that the ion-acoustic waves are modulationally unstable for wave numbers greater than a normalized critical wave number k_c (= 1.47). The modutional instability of ion acoustic wave with warm ions have been studied using reductive perturbation method [27] and KBM method [25] in unmagnified electron ion plasmas. The modutional instability of ion acoustic wave with negative ions in

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ISSN (O) 2319 - 8354
ISSN (P) 2319 - 8346

plasmas have been investigated by Mishra et al. [26] The modutional instability of ion acoustic waves in plasmas with superthermal electrons have been studied by Gharaee et al. [28]

The modulation instability of electrostatic modes in both EPI as well as in pair plasmas has been a subject of great interest in the recent years [29-30]. The nonlinear amplitude modulation of low-frequency electrostatic ion waves propagating in collisionless magnetized EPI plasma are studied [31]. Zhang et al. [32] have investigated modulation instability of ion-acoustic waves in electron-positron-ion plasma with nonthermally distributed electrons and cold ions. Eslami et al. [33] have studied modulation instability of ion-acoustic waves in electron-positron-ion plasma with electrons and positrons following q-nonextensive distribution. The nonlinear amplitude modulation of ion-acoustic wave in the presence of warm ions in unmagnetized EPI plasmas [34]. However, in the course of their study, they have taken the same temperature for the electron and positron species. Therefore, their analysis cannot be used to study the modulational instability of ion-acoustic waves in EPI plasmas in which electron and positron species are at different temperatures. A nonlinear Schrödinger equation which describes the modulational instability of ion-acoustic soliton is derived by using the multiple scale method, the dispersive and nonlinear coefficients are obtained which is depend upon the temperature of the ions, concentration of the positrons, electrons and dust particles [35]. Chawla et al. [20] studied the modulational instability of ion-acoustic waves in EPI. Modulational instability of ion-acoustic waves has been theoretically investigated [36] in an unmagnitized collisionless plasma with nonthermal electrons, Boltzmann positrons, and warm positive ions.

The modulational instability of ion-acoustic waves in a two-electron temperature plasma has been studied by Sharma and Buti [37] for parallel modulation. They found that due to the presence of cold electron component, the critical wave number for modulational instability reduces, which increases the unstable region in k-space. It has also been shown by them that the unstable region (in k-space) significantly depends upon the relative densities and temperatures of two electron components. The modulational instability of obliquely modulated ion-acoustic waves in two-electron-temperature collisionless plasma has been investigated by Yashvir et al. [38]. Their study reveals that there exists a wide domain in the $(k-\phi)$ plane in which the large amplitude ion-acoustic waves would be modulationally unstable. Chhabra and Sharma [39] studied the nonlinear oblique modulation of ion-acoustic waves in a two warm ion plasma. Mishra et al. [40] studied the modulational instability of obliquely modulated ion-acoustic waves in a collisional plasma with one and two electron temperature distributions. The modulational instability of obliquely modulated ion-acoustic waves in a collisionaless plasma consisting of two-ion species with different masses, concentrations, and charge states have been studied by Mishra et al. [41]. In that analysis, the ion species were taken as cold. Nonlinear modulation of ion-acoustic waves in two-electron-temperature plasmas studied by Esfandyari-kalejahi et al. [42]. Existence and characteristics of ion-acoustic wave modulation are studies [43] in a plasma with two-temperature electron satisfying kappa distribution.

The paper has been organized as follows: In Section II, the normalized fluid equations for the system have been presented. The nonlinear Schrödinger equation has been derived in Sec. III and in Sec. IV, stability analysis has been discussed. The conclusions are summarized in Sec. V.

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ISSN (P) 2319 - 8346

II. BASIC EQUATIONS

We consider a plasma consisting of warm adiabatic ions and isothermal electrons, which are divided into two groups: a hot component with density n_h and temperature T_h and a cold component with density n_c and temperature T_c. The nonlinear behavior of ion-acoustic waves may be described by the following set of normalized fluid equations:

$$\frac{\partial n}{\partial t}+\frac{\partial}{\partial x}(nv)=0 \tag{1}$$

$$\frac{\partial v}{\partial t}+v\frac{\partial v}{\partial x}=E-\sigma n\nabla n \tag{2}$$

$$\nabla n_h=-\frac{\beta}{(\mu+\upsilon\beta)}n_h E \tag{3}$$

$$\nabla n_c=-\frac{1}{(\mu+\upsilon\beta)}n_c E \tag{4}$$

$$\nabla n_p=\gamma n_p E \tag{5}$$

$$\nabla\cdot E=(1-\alpha)n+\alpha n_p-n_h-n_c \tag{6}$$

where

$$\alpha=\frac{n_p^{(0)}}{n^{(0)}},\quad \mu=\frac{n_c^{(0)}}{n^{(0)}},\quad \upsilon=\frac{n_h^{(0)}}{n^{(0)}},\quad \beta=\frac{T_c}{T_h},\ \gamma=T_p/T_e,\ \text{and}\ \sigma=3T_i/T_e$$

In the above equations, n and v are the density and fluid velocity of the ion species, E is the electric field, n_h is the hot electron density, n_c is the cold electron density and n_p is the positron density. $\sigma=3T_i/T_e$, defines the temperature ratio of adiabatic warm ions to electrons of the plasma and $\gamma=T_p/T_e$, the ratio temperature of positron with electron fluid . We have normalized the quantities n, v, n_h, n_c, n_p, x, E and t with

$$n_0,\ C_s=(kT_e/e),\ \lambda_D=\left(\frac{\varepsilon_0 kT_e}{n_0 e^2}\right)^{1/2}\ \text{and}\ \omega_{pi}^{-1}\ \text{respectively.}$$

III. DERIVATION OF THE NONLINEAR SCHRƠ DINGER EQUATION

Using the KBM perturbation method for nonlinear wave modulational, we expand all the quantities around the equilibrium state as follows:

$$E=\varepsilon E_1+\varepsilon^2E_2+\varepsilon^3E_3+\ldots$$

$$v=\varepsilon v_1+\varepsilon^2v_2+\varepsilon^3v_3+\ldots$$

$$n=1+\varepsilon n_1+\varepsilon^2n_2+\varepsilon^3n_3+\ldots$$

International Journal of Advance Research in Science and Engineering
Vol. No.6, Issue No. 01 , January 2017
www.ijarse.com
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ISSN (O) 2319 - 8354
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$$n_h = \upsilon + \varepsilon n_{h1} + \varepsilon^2 n_{h2} + \varepsilon^3 n_{h3} + \ldots$$

$$n_c = \mu + \varepsilon n_{c1} + \varepsilon^2 n_{c2} + \varepsilon^3 n_{c3} + \ldots$$

$$n_p = 1 + \varepsilon n_{p1} + \varepsilon^2 n_{p2} + \varepsilon^3 n_{p3} + \ldots \qquad (7)$$

In order to consider the modulational instability of ion-acoustic waves in the system, we assume that the perturbed quantities of all orders depend on x and t through the complex amplitudes (a , $\bar{a}$) and phase factor (ψ). The phase factor is given by

$$\psi = kx - \omega t \qquad (8)$$

The complex amplitude a is a slowly varying function of x and t expressed as

$$\frac{\partial a}{\partial t} = \varepsilon A_1(a,\bar{a}) + \varepsilon^2 A_2(a,\bar{a}) + \varepsilon^3 A_3(a,\bar{a}) + \ldots \qquad (9a)$$

$$\frac{\partial a}{\partial x} = \varepsilon B_1(a,\bar{a}) + \varepsilon^2 B_2(a,\bar{a}) + \varepsilon^3 B_3(a,\bar{a}) + \ldots \qquad (9b)$$

together with the complex conjugate relations to Eq. (9). The unknown functions A_1, A_2,… and B_1, B_2,… are determined so as to eliminate all secular terms in the perturbation solution.

On substituting the expression (7) into the set of equations (1) - (6), using (9) and equating terms with the same power of ε, we obtain a set of equations for each order in ε. From the first - order equations, the first order solutions are given as

$$n_1 = a\exp(i\psi) + \bar{a}\exp(-i\psi)$$

$$E_1 = \frac{i}{k}\left[\left(\sigma k^2 - \omega^2\right)\left\{a\exp(i\psi) - \bar{a}\exp(-i\psi)\right\}\right]$$

$$v_1 = \frac{\omega}{k}\left[a\exp(i\psi) + \bar{a}\exp(-i\psi)\right]$$

$$n_{h1} = \left(\frac{\omega^2 - \sigma k^2}{k^2}\right)\frac{\beta\upsilon}{(\mu + \upsilon\beta)}\left[a\exp(i\psi) + \bar{a}\exp(-i\psi)\right]$$

$$n_{c1} = \left(\frac{\omega^2 - \sigma k^2}{k^2}\right)\frac{\mu}{(\mu + \upsilon\beta)}\left[a\exp(i\psi) + \bar{a}\exp(-i\psi)\right]$$

$$n_{p1} = \frac{\gamma}{k}\left[\left(\sigma k^2 - \omega^2\right)\left\{a\exp(i\psi) + \bar{a}\exp(i\psi)\right\}\right] \qquad (10)$$

The condition for these solutions to be non - trivial is obtained in the form of linear dispersion relation

$$\omega^2 = \frac{k^2(1-\alpha)}{\left(1 + k^2 + \alpha\gamma\right)} + \sigma k^2 \qquad (11)$$

In order to get the nonsecular solution up to third order in ε, we set the constant and the coefficient of the resonant secular terms equal to zero, which gives the nonlinear Schrodinger equation:

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$$i\frac{\partial a}{\partial \tau}+P\frac{\partial^2 a}{\partial \xi^2}+Q|a|^2 a=0 \quad (12)$$

$$where \;\; \xi=\varepsilon(x-v_g t),\;\; \tau=\varepsilon^2 t \quad (13)$$

$$v_g=\frac{\omega}{k}\frac{\left[2k^4\sigma+k^2(1-\alpha)+2\sigma k^2(\alpha\gamma+1)-\alpha\gamma k(\sigma k^2-\omega^2)-(\sigma k^2-\omega^2)+k^2(\sigma k^2-\omega^2)\right]}{\left[\sigma k^4+k^2\omega^2+k^2(1-\alpha)+(\alpha\gamma+1)(\sigma k^2+\omega^2)\right]} \quad (14)$$

$$P=\frac{1}{2}\frac{dv_g}{dk}$$

$$=\begin{bmatrix}[-\omega^2\{-3\sigma k^4+\sigma k^2(\alpha\gamma+1)-\alpha\gamma k(\sigma k^2-\omega^2)+(\omega^2-\sigma k^2)\} \\ -v_g\omega k\{k^2(\sigma k^2+\omega^2)+2\sigma k^4+k^2(1-\alpha)+2\sigma k^2(\alpha\gamma+1)-(\alpha\gamma+1)(\sigma k^2+\omega^2)\} \\ +v_g^2k^4\{\sigma k^2+(1-\alpha)+\sigma(\alpha\gamma+1)\}]/[\omega k^2\{\sigma k^4+k^2\omega^2+k^2(1-\alpha)+(\sigma k^2+\omega^2)(\alpha\gamma+1)\}]\end{bmatrix} \quad (15)$$

$$Q=-\begin{bmatrix}\left(\begin{matrix}\left\{\frac{\sigma k^4+k^2\omega^2+k^2(1-\alpha)+\omega^2(\alpha\gamma+1)+\sigma k^2(\alpha\gamma+1)}{k^2\omega}\right\}\{\alpha_1+\gamma_1'\} \\ +\left\{-i\frac{(\sigma k^2-\omega^2)}{k^4}(k\alpha\gamma^2-1)\right\}\{\alpha_2+\gamma_2'\}+\left\{\frac{2\sigma k^2+(1-\alpha)+2\sigma(\alpha\gamma+1)}{k}\right\}\{\alpha_3+\gamma_3'\} \\ +\left\{\frac{\alpha\gamma}{k^3}(\sigma k^2-\omega^2)\right\}\{-\alpha_4+\gamma_4'\}+\left\{\frac{(\sigma k^2-\omega^2)}{k^3}\right\}\{-\alpha_5+\gamma_5'\} \\ +\left\{\frac{(\sigma k^2-\omega^2)}{k^3}\right\}\{-\alpha_6+\gamma_6'\}\end{matrix}\right)\times \\ \frac{1}{\left[\frac{\omega}{k}+\frac{\sigma k}{\omega}+\frac{(1-\alpha)}{k\omega}+\frac{\omega(\alpha\gamma+1)}{k^3}+\frac{\sigma k(\alpha\gamma+1)}{k^2\omega}\right]}\end{bmatrix} \quad (16)$$

$$\alpha_1=\frac{\omega A}{6k(\omega^2-\sigma k^2)} \quad (17)$$

$$\alpha_2=i\left[2\alpha_1\frac{(\sigma k^2-\omega^2)}{\omega}+2\sigma k+\frac{(\sigma k^2+\omega^2)}{k}\right] \quad (18)$$

$$\alpha_3=\frac{(\alpha_1 k+\omega)}{\omega} \quad (19)$$

$$\alpha_4=-i\frac{\alpha_2\gamma}{2k}+\frac{\gamma^2(\sigma k^2-\omega^2)^2}{2k^3} \quad (20)$$

$$\alpha_5=i\frac{\beta\upsilon}{(\mu+\upsilon\beta)}\frac{\alpha_2}{2k}+\frac{\beta^2\upsilon}{(\mu+\upsilon\beta)^2}\frac{(\sigma k^2-\omega^2)^2}{2k^4} \quad (21)$$

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ISSN (O) 2319 - 8354
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$$\alpha_6 = i\frac{\mu}{(\mu+\upsilon\beta)}\frac{\alpha_2}{2k} + \frac{\mu}{(\mu+\upsilon\beta)^2}\frac{(\sigma k^2-\omega^2)^2}{2k^4} \tag{22}$$

$$b_2 = \left[i\frac{(\sigma k^2-\omega^2)}{\omega}b_1(a,\bar{a}) + \frac{(\sigma k^2+\omega^2)}{k\omega}A_1 + 2\sigma B_1\right] \tag{23}$$

$$b_3 = \left[\frac{k}{\omega}b_1(a,\bar{a}) - i\frac{A_1}{\omega} - i\frac{B_1}{k}\right] \tag{24}$$

$$b_4 = \left[-i\frac{\gamma}{k}b_2(a,\bar{a}) + i\frac{\gamma(\sigma k^2-\omega^2)}{k^2}B_1\right] \tag{25}$$

$$b_5 = \left[i\frac{\beta\upsilon}{(\mu+\upsilon\beta)}\frac{1}{k}b_2(a,\bar{a}) + i\frac{\beta\upsilon}{(\mu+\upsilon\beta)}\frac{B_1}{k^3}(\omega^2-\sigma k^2)\right] \tag{26}$$

$$b_6 = \left[i\frac{\mu}{(\mu+\upsilon\beta)}\frac{1}{k}b_2(a,\bar{a}) + i\frac{\mu}{(\mu+\upsilon\beta)}\frac{B_1}{k^3}(\omega^2-\sigma k^2)\right] \tag{27}$$

$$\gamma_1 = v_g\gamma_3 - 2\frac{\omega}{k}a\bar{a} + c_1 \tag{28}$$

$$\gamma_2(a,\bar{a}) = 0 \tag{29}$$

$$\gamma_3 = \frac{\left[\frac{(\sigma k^2-\omega^2)}{k^4}(k\alpha\gamma^2-1) + \left\{2v_g\frac{\omega}{k} + \frac{\omega^2}{k^2} + \sigma\right\}(\alpha\gamma+1)\right]}{\left[v_g^2(1+\alpha\gamma) - \sigma(1+\alpha\gamma) - (1-\alpha)\right]}a\bar{a} + c_3 \tag{30}$$

$$\gamma_4 = (-v_g^2+\sigma)\gamma\gamma_3 + \left[\frac{\gamma^2}{k^3}(\sigma k^2-\omega^2)^2 + \frac{\gamma\omega^2}{k^2} + \sigma\gamma + 2v_g\gamma\frac{\omega}{k}\right]a\bar{a} + c_4 \tag{31}$$

$$\gamma_5 = (v_g\gamma_1 - \sigma\gamma_3)\left(\frac{\beta\upsilon}{(\mu+\upsilon\beta)}\right) + \left[\begin{array}{l}\frac{\beta^2\upsilon}{(\mu+\upsilon\beta)^2}\frac{(\sigma k^2-\omega^2)^2}{k^4} \\ -\frac{\beta\upsilon}{(\mu+\upsilon\beta)}\frac{\omega^2}{k^2} - \sigma\frac{\beta\upsilon}{(\mu+\upsilon\beta)}\end{array}\right]a\bar{a} + c_5 \tag{32}$$

$$\gamma_6 = (v_g\gamma_1 - \sigma\gamma_3)\left(\frac{\mu}{(\mu+\upsilon\beta)}\right) + \left[\begin{array}{l}\frac{\mu}{(\mu+\upsilon\beta)^2}\frac{(\sigma k^2-\omega^2)^2}{k^4} \\ -\frac{\mu}{(\mu+\upsilon\beta)}\frac{\omega^2}{k^2} - \sigma\frac{\mu}{(\mu+\upsilon\beta)}\end{array}\right]a\bar{a} + c_6 \tag{33}$$

Here $\gamma_2, \gamma_3, \gamma_4$ and γ_5 are function of a and $\bar{a}$ only and are assumed to real. Where c_1, c_3, c_4, and c_5 are arbitrary constants independents of a, $\bar{a}$ and ψ can be determined by the initial conditions. The dispersion coefficients P and the nonlinear coefficient Q are given, respectively, by equations (15) and (16).

International Journal of Advance Research in Science and Engineering
Vol. No.6, Issue No. 01 , January 2017
www.ijarse.com
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ISSN (O) 2319 - 8354
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IV. STABILITY ANALYSIS AND DISCUSSION

It is well known that the modulation instability depends on the sign of the product of the dispersive and nonlinear coefficient, i.e., PQ. It is found that the presence of positron modifies the unstable region of the ion-acoustic waves which is defined by $PQ > 0$ are and the stable region of the ion-acoustic waves which is defined by $PQ < 0$. We have investigated that ion-acoustic waves are modulationally unstable in the range of wave numbers lying between $k_{\min} < k < k_{\max}$, where the values of $k_{\min}$ and $k_{\max}$ depends upon the cold electron concentration, temperature ratio of cold to hot electrons, ion temperature, positron concentration, and positron temperature of the plasma. For the case of cold ions and in the absence of positron, and cold electron concentration, we find the critical wave number $k_c = 1.47$.

Fig. 1, is a PQ versus wave number k plot for different values of temperature ratio of cold to hot electrons (β) keeping the values of ion temperature (T_i / T_e), positron concentration (α), cold electron concentration (μ), and positron temperature (γ) constant. It shows that as the temperature ratio of cold to hot electrons (β) increases, the value of $k_{\max}$ decreases.

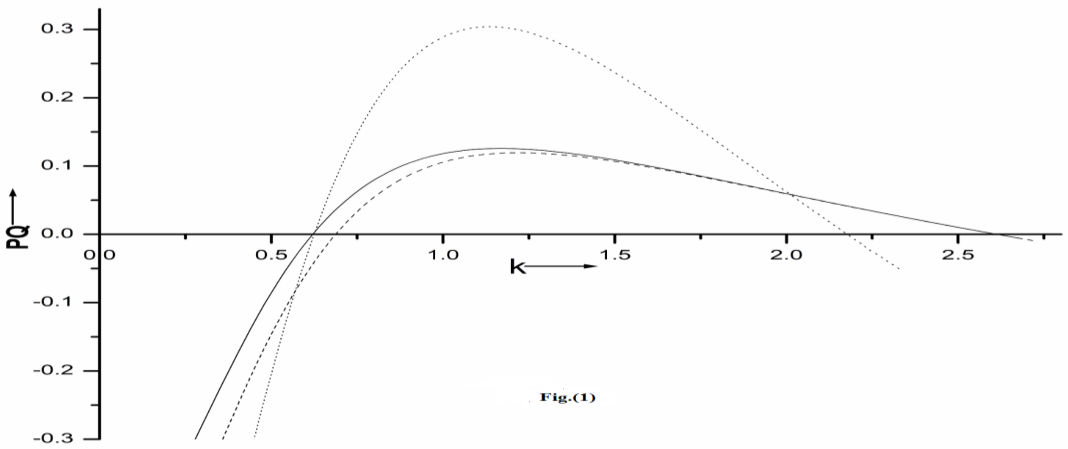

Fig. 1 Variation of the product PQ with wave number k with $\gamma = 0,\ T_i / T_e = 0.1,\ \mu = 0,$ and $\alpha = 0$ at different values of cold to hot electron temperature $(\beta) = 0.6$ (dotted line), 0.8 (dashed line) and 1 (solid line).

In Fig. 2, we have plotted the variation of PQ with respect to wave number k for different values of positron concentration (α), at ion temperature (T_i / T_e), cold electron concentration (μ), temperature ratio of cold to hot electrons (β), and positron temperature (γ). We also note from the figure that as the positron concentration (α) increases, the values of $k_{\max}$ and $k_{\min}$ increases.

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ISSN (O) 2319 - 8354
ISSN (P) 2319 - 8346

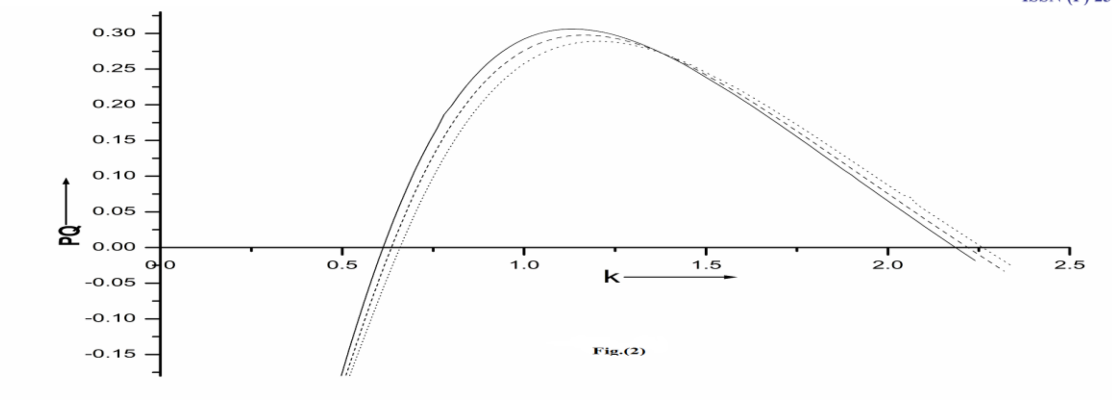

Fig. 2 Variation of the product PQ with wave number k with $\mu = 0.1,\ T_i/T_e = 0.1,\ \beta = 0.8,$ and $\gamma = 0.8$ at different values of positron concentration $(\alpha) = 0.01$ (solid line), 0.05 (dashed line) and 0.1 (dotted line).

In Fig. 3, PQ is plotted as function of k for different values of temperature ratio of cold to hot electrons (β), taking other plasma parameters such as cold electron concentration (μ), positron concentration (α), ion temperature (T_i/T_e), and positron temperature (γ) as constant. It is seen that as the temperature ratio of cold to hot electrons (β) increases, the value of k_{min} increases.

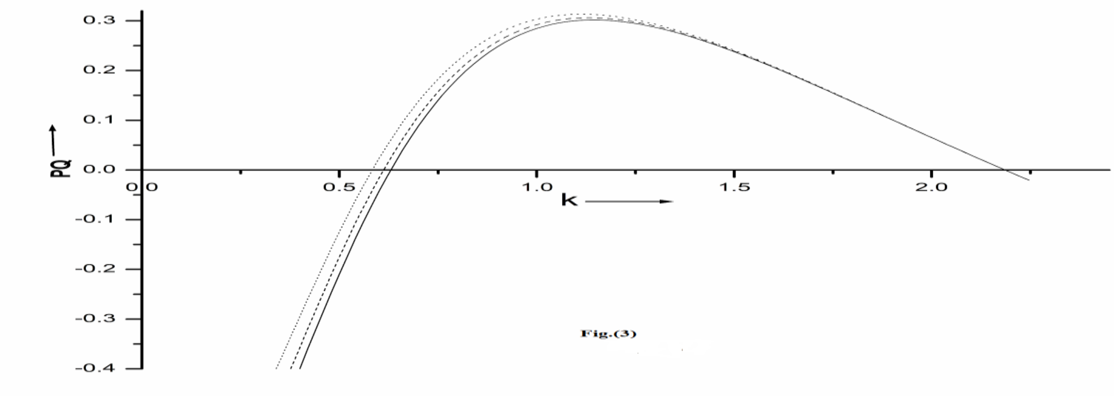

Fig. 3 Variation of the product PQ with wave number k with $T_i/T_e = 0.1,\ \gamma = 0.8,\ \mu = 0.1,$ and $\alpha = 0.01$ at different values of cold to hot electron temperature $(\beta) = 0.6$ (dotted line), 0.8 (dashed line) and 1 (solid line).

V. CONCLUSIONS

To conclude, we have studied the modulational instability of ion acoustic waves in unmagnetized electron-positron-ion plasmas with two electron temperature distributions by employing KBM perturbation method. It is found that as the ion temperature increases, the value of k_{max} and k_{min} decreases, at the same time the region of instability also decreases. The presence of positron concentration, positron temperature ratio, temperature ratio

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ISSN (O) 2319 - 8354
ISSN (P) 2319 - 8346

of cold to hot electrons and cold electron concentration, the value of k_{max} and k_{min} increases. For a given set of parameters values with temperature ratio of cold to hot electrons, cold electron concentration, ion temperature and positron concentration, by increasing the value of positron temperature ratio, the value of k_{max} and k_{min} increases. For a given set of parameters values with temperature ratio of cold to hot electrons, cold electron concentration, ion temperature and positron temperature ratio, by increasing the value of positron concentration, the value of k_{max} and k_{min} also increases.

In the absence of positron, temperature ratio of cold to hot electrons and increasing the value of the cold electron concentration, the value of k_{min} increases at warm ion case. In the presence of positron, temperature ratio of cold to hot electrons and increasing the value of the cold electron concentration, the value of k_{max} increases and k_{min} decreases in warm ion case.

In the absence of positron, cold electron concentration and increasing the value of the temperature ratio of cold to hot electrons, the value of k_{max} decreases at warm ion case. In the presence of positron, cold electron concentration and increasing the value of the temperature ratio of cold to hot electrons, the value of k_{min} increases at warm ion case.

Our findings are general and may be applicable to explain the stable and unstable modulational of ion acoustic wave in astrophysical plasma situations such as neutron stars or pulsars where unmagnetized electron-positron-ion plasma with warm ions may exist.

REFRENCES

[1] C.M. Surko, M. Leventhal and A. Passner, Phys. Rev. Lett. 62 (1989) 601.

[2] R.G. Greaves, M.D. Tinkle and C.M. Surko, Phys. Plasmas 1 (1994) 1439.

[3] E.P. Liang, S.C. Wilks and M. Tabak, Phys. Rev. Lett. 81 (1998) 4887.

[4] P. Goldreich and W.H. Julian, Astrophysics. J. 157 (1969) 869.

[5] H.R. Miller and P.J. Witta, Active Galectic Nuclei (Springer-Verlag, Berlin, 1978), p. 202.

[6] F.C. Michel, Rev. Mod. Phys. 54 (1982) 1.

[7] E. Tandberg-Hansen and A.G. Emslie, The Physics of Solar Flares (Cambridge University Press, Cambridge, England, 1988), p. 124.

[8] H. Boehmer, M. Admas and N. Rynn, Phys. Plasmas 2 (1995) 4369.

[9] T. Piran, Phys. Rep. 314 (1999) 575.

[10] C.M. Surko, M. Leventhal, W.S. Crane, A. Passner, F.J. Wyocki, T.J. Murphy, J. Strachan, and W.L. Rowan, Rev. Sci. Instrum. 57 (1986) 1862.

[11] M.D. Tinkle, R.G. Greaves, C.M. Surko, R.L. Spencer and G.W. Mason, Phys. Rev. Lett. 72 (1994) 352.

[12] R.G. Greaves and C.M. Surko, Phys. Rev. Lett. 75 (1995) 3846.

[13] F.B. Rizzato, Plasma Phys. Controlled Fusion 40 (1988) 289.

[14] V.I. Berezhiani, M.Y. El-Ashry and U.A. Mofiz, Phys. Rev. E 50 (1994) 448.

[15] H. Kakati and K.S.Goswami, Phys. Plasmas 7 (2000) 808.

[16] R.S. Tiwari, A. Kaushik and M.K. Mishra, Phys. Lett. A 365 (2007) 335.

[17] H. R. Pakzad, Astrophys. Space Sci. 323 (2009) 345.

IJARSE
ISSN (O) 2319 - 8354
ISSN (P) 2319 - 8346

[18] J. K. Chawla and M.K. Mishra, Phys. Plasmas 17 (2010) 102315.

[19] V.K. Valiulina and A.E. Dubinov, Astrophys. Space Sci. 337 (2012) 201.

[20] J. K. Chawla, M.K. Mishra and R.S. Tiwari, Astrophys Space Sci 347 (2013) 283.

[21] S.K. Jain and M.K. Mishra, J. Plasma Physics 661 (2013) 79.

[22] Y. H. Ichikawa, T. Imamura and T. Taniuti , J. Phys. Soc. Japan 33 (1972) 189.

[23] K. Shimizu and Y.H. Ichikawa, J. Phys. Soc. Japan 33 (1972) 789.

[24] T. Kakutani and N . Sugimoto, Phys. Fluids 17 (1974) 1617.

[25] I. R. Durrani, G. Murtaza, H.U. Rahman and I.A. Azhar, Phys. Fluids 22 (1979) 791.

[26] M. K. Mishra, R. S. Chhabra, and S. R. Sharm a, Phys. Rev. E 48 (1993) 6.

[27] N. X. Ju- Kui, W. Wen- Shan and L. He, Chin. Phys. 11 (2002) 1184.

[28] H. Gharaee, S. Afghah and H. Abbasi, Phys. Plasmas 18 (2011) 032116.

[29] M. Salahuddin, H. Saleem and M. Saddiq, Phys. Rev. E 66 (2002) 036407.

[30] I. Kourakis, A. Esfandyari-Kalejahi, M. Mehdipoor and P.K. Shukla, Phys. Plasmas 13 (2006) 052117.

[31] N. Jehan, M. Sala huddin, H. Saleem and A.M. Mieza, Phys. Plasmas 15 (2008) 092301.

[32] J. Zhang , Y. Wang and L. Wu , Phys. Plasmas 16 (2009) 062102.

[33] P. Eslami, M. Motta ghiza desh and H. R. Pakzad, Phys. Plasmas 18 (2011) 102313.

[34] S. Mahmood, S. Siddiqui, and N. Jehan, Phys. Plasmas 18 (2011) 052309.

[35] A.S. Bains, N.S. Saini and T.S. Gill, Astrophys Space Sci 343 (2013) 293.

[36] B. Ghosh and S. Banerjee, J. Astrophysics 2014 (2014) 785670.

[37] A.S. Sharma and B. Buti, Pramana 10 (1978) 629.

[38] Yashvir, T.N. Bhatnagar, S.R. Sharma, J. Plasma Phys. 33 (1985) 209.

[39] R. S. Chhabra and S.R. Sharma, J. Plasma Phys. 42 (1986) 379.

[40] M .K. Mishra, R.S. Chhabra and S.R. Sharma, J. Plasma Phys. 42 (1989) 379.

[41] M. K. Mishra, R.S. Chhabra and S.R. Sharma, Phys. Plasmas 1 (1994) 70.

[42] A. Esfandyari-kalejahi, I. Kourakis and M. Akbari-moghanjoughi, J. Plasma Phys. 76 (2010) 169.

[43] H. Alinejad, M. Mahadavi and M. Shahmansouri, Astrophysics 352 (2014) 571.