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LONGITUDINAL ELECTRO-KINETIC WAVE IN ION-IMPLANTED QUANTUM SEMICONDUCTOR PLASMAS IN PRESENCE OF MAGNETIC FIELD

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ABSTRACT

Using quantum hydrodynamic model, the propagation characteristics of longitudinal electro-kinetic wave in multi-component quantum semiconductor plasma with transverse magnetic field has been studied. It is found that the quantum correction term modifies the propagation characteristics of slow and fast electro-kinetic branch. A new mode has been reported in the presence of transverse magnetic field under fast electro-kinetic branch. The presence of transverse magnetic field converts an existing aperiodic mode into periodic one.

KEYWORDS: Electrostatic waves, Quantum hydrodynamic model, Bohm potential

INTRODUCTION

A survey of available literature reveals that the investigations of the properties of charged colloids[1-8] in semiconductors have been hotly persuaded in past two decade. The dopants or implanted metal ions finally convert into negatively charged colloidal particles within the semiconductor medium. Therefore we have considered an ion-implanted semiconductor plasma system consists of electrons, holes and negatively charged colloids. One may safely assume that all the colloids are of uniform size. This size may be assumed to be smaller than the perturbation wavelength, inter-grain distance as well as electron Debye radius. On the basis of these assumptions, colloids can be treated as point masses of nano sized grains. These charged nano sized grains shall act as third species inside the plasma medium but expected to have significant effect on the behaviour of plasma. Hence now ion-implanted semiconductor plasma that contains electrons, holes and negatively charged colloids may be treated with multi-component plasma model.

The study of quantum plasma physics has been one of the most active fields in the resent years[9-13] because of its potentialities in modern electronic devices as well as in astral system under extreme conditions. It is known that the Madelung decomposition of the wave function always leads to one-body fluid theory. This model has been studied extensively[14, 15] for the study of quantum corrections to a host of collective motions, which include propagating mode solutions[16-18], dusty quantum plasma modes[19,20], quantum ion-acoustic waves[21] among others. There are some recent works on quantum effects on wave spectrum in semiconductor plasmas [22-25]. Using the quantum hydrodynamic model (QHD) Uzma et al.[22] has reported the effect of the Bohm potential on SBS and the consequent instability in a piezoelectric semiconductor through the pondermotive force. Ghosh et al.[23] has shown that the large parametric gain constant at lower pump electric field can easily be achievable in magnetized heavily doped n-Insb crystal subjected to a spatially uniform pump electric field. Zeba et al.[24] has investigated the electron- hole two stream instability in semiconductor plasmas including quantum recoil effects, as well as interactions of exchange and correlation effects and pressures of degenerated electron and hole fluids. The quantum effect on the steady-state as well as transient gain characteristics of the stimulated Brillouin scattered mode and the necessary threshold intensity in electrostrictive semiconductor plasmas has been studied by Ghosh et al.[25]. They have inferred that the Bohm potential in the electron dynamics enhances the steady state and transient Brillouin gain constants, whereas it reduces the threshold pump intensity for inciting SBS.

The properties of plasma subjected to a static magnetic field are significantly modified[26-28]. A magnetic field applied to a metallic system introduces a characteristic frequency, namely the cyclotron

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frequency of the carriers (function of effective mass) in the plane perpendicular to the field direction. In semiconductor plasmas, by changing the magnetic field the cyclotron frequency can be made comparable to all important frequencies of the system. It is well known fact that the application of magnetic field adds new dimensions to the field of waves and instabilities in solid state plasma.

The purpose of this paper is to report the analytical study of the quantum effect on wave propagation of longitudinal electro-kinetic wave (LEKW) in multi-component plasma through Bohm potential as well as effect of transverse magnetic field on it. In second section, we derive the requisite dispersion relations in ion-implanted semiconductor plasma in presence of transverse magnetic field using QHD model. The dispersion relation is solved under slow and fast electro-kinetic mode of propagation. In section 3, numerical estimates are made for IV group semiconductor at liquid nitrogen temperature.

THEORETICAL FORMULATION

We begin with an ion-implanted quantum semiconductor plasma system in which LEKW are propagating along x-axis in presence of a magnetostatic field $\vec{B}_0$ applied perpendicular to the wave propagation direction. The classical hydrodynamic model of homogeneous multi-component semiconductor plasma of infinite extent (i.e. $k\,l << 1$; k the wave number of the wave and l the mean free path of the carrier), consisting of non-drifting electrons, holes and stationary but participating negatively charged colloids, has been extended to included essential quantum corrections term. Now the basic equations regarding to the present problem is as follows.

(i) Momentum transfer equations

$$\frac{\partial \vartheta_{x1e}}{\partial t} = \frac{z_e q_e}{m_e}[\vec{E}_{x1} + \vec{\vartheta}_{1e} \times \vec{B}_0] - \nu_e \vartheta_{x1} - \frac{1}{m_e n_{0e}} \nabla P_e + \frac{1}{m_e n_{0e}}\left[\frac{\hbar^2 \nabla(\nabla^2 n_{1e})}{4 m_e}\right] \tag{1}$$

$$\frac{\partial \vartheta_{x1h}}{\partial t} = \frac{z_h q_h}{m_h}[\vec{E}_{x1} + \vec{\vartheta}_{1h} \times \vec{B}_0] - \nu_h \vartheta_{x1} - \frac{1}{m_h n_{0h}} \nabla P_h + \frac{1}{m_h n_{0h}}\left[\frac{\hbar^2 \nabla(\nabla^2 n_{1h})}{4 m_h}\right] \tag{2}$$

$$\frac{\partial \vartheta_{x1d}}{\partial t} = \frac{z_d q_d}{m_d}[\vec{E}_{x1} + \vec{\vartheta}_{1d} \times \vec{B}_0] \tag{3}$$

(ii) Continuity equations

$$\frac{\partial n_{1e}}{\partial t} + n_{0e}\nabla \vec{\vartheta}_{1e} = 0 \tag{4}$$

$$\frac{\partial n_{1h}}{\partial t} + n_{0h}\nabla \vec{\vartheta}_{1h} = 0 \tag{5}$$

$$\frac{\partial n_{1d}}{\partial t} + n_{0d}\nabla \vec{\vartheta}_{1d} = 0 \tag{6}$$

(iii) Wave equation

$$k \times k \times \vec{E}_1 = i\omega\mu_0 \vec{J}_1 - \frac{\omega^2}{c_L^2}\vec{E}_1 = 0 \tag{7}$$

In equations (1)-(7) $m_{e,h,d}$, $\vartheta_{1e,h,d}$, $\nu_{e,h}$ and $P_{e,h}$ are the masses, velocities, phenomenological collision frequencies and Fermi pressure of electrons (e), holes (h) and dust(d) respectively.

The above basic equations include two different quantum effects: (a) quantum statistics and (b) quantum diffraction. On the right hand side, the third term in momentum transfer equations (1) and (2) represent quantum statistical pressure due to high number density of electrons and holes, which is given by

$$P_{e,h} = m_{e,h}\vartheta_{Fe,h}^2 n^3 / 3 n_{0e,h}^2 \tag{8}$$

where $\vartheta_{Fe,h}^2 = 2k_B T_{Fe,h} / m_{e,h}$ stands for the Fermi velocities of electrons and holes, k_B is the Boltzmann constant and $T_{Fe,h}$ is Fermi temperature of electrons and holes. Quantum diffraction is taken into account by the forth term proportional to $\hbar^2$ in Equations (1) and (2) given by,

$$B_{pe,h} = (\hbar^2 / 4 m_{e,h})\{\nabla(\nabla^2 n_{1e,h})\} \tag{9}$$

where $\hbar$ is the Planck's constant divided by 2π. The contribution of this term may be interpreted alternatively as a quantum pressure term or as a quantum Bohm potential[29]. In other applications in semiconductor physics, the Bohm potential is responsible for tunneling and differential resistance effects[30].

The first order perturbations of wave may be assumed to vary as $exp\{i(\omega t - kx)\}$ in which (ω, k) are the angular frequency and wave number of the propagating wave, respectively. Using equations (1)-(7) and following the procedure adopted by Chen[31] and Steele and Vural[32], the modified dielectric response function of longitudinal electro-kinetic waves in ion-implanted semiconductor quantum plasma medium in presence of transverse magnetostatic field is obtained as:

$$\varepsilon(\omega, k) = 1 + \chi_e + \chi_h + \chi_d \tag{10}$$

where

$$\chi_e = \frac{\omega_{pe}^2(\omega - i\nu_e)}{[(\omega - i\nu_e)\{\omega^2 - i\omega\nu_e - k^2\vartheta_{Fe}^2(1+\Gamma_e)\} - \omega\omega_{ce}^2]}$$

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$$\chi_h = \frac{\omega_{ph}^2(\omega - i\nu_h)}{[(\omega - i\nu_h)\{\omega^2 - i\omega\nu_h - k^2\vartheta_{Fh}^2(1+\Gamma_h)\} - \omega\omega_{ch}^2]}$$

$$\chi_d = \frac{\omega_{pd}^2}{(\omega^2 - \omega_{cd}^2)}$$

The properties of the electrostatic waves are determined from Equation (10) in multi-component plasma including the quantum statistical pressure and the quantum diffraction effects of carriers. Here $\omega_{pe,h}^2 = \frac{(z_{e,h}e)^2 n_{0e,h}}{\varepsilon m_{e,h}}$, $\Gamma_{e,h} = \frac{\hbar^2 k^2}{8 m_{e,h} k_B T_{Fe,h}}$, $\omega_{ce,h}^2 = \frac{eB_0}{m_{e,h}}$, $\varepsilon = \varepsilon_0 \varepsilon_L$; ε_L being the lattice dielectric constant and χ_e, χ_h, χ_d, are the electron, hole and dust susceptibilities, respectively.

RESULTS AND DISCUSSION

In order to study the propagation characteristics of LEKW, we have applied the above analysis to the group IV- semiconductor (viz. Ge) at liquid nitrogen temperature. For numerical results we have considered the set of parameters used by chaudhary et al.[33]. At this temperature the present problem can be discuss under two different velocity regimes given as

(i) $(\omega << k\vartheta_{Fe}, k\vartheta_{Fh})$

(ii) $(k\vartheta_{Fh} << \omega << k\vartheta_{Fe})$

The growth in time ($\omega = \omega_{Re} - i\omega_{Im}$ for a real k) is designated as an absolute or non-convective instability. The wave is growing, if the imaginary part of wave frequency is negative, when the power is taken out from the medium. Here the variation of ω_{Re} and ω_{Im} with wave number k stand for the dispersion and absorption characteristics of the wave.

(i) $(\omega << k\vartheta_{Fe}, k\vartheta_{Fh})$

If the phase velocity of the wave is less than the Fermi velocities of electrons and holes both, the mode may be termed as slow electro-kinetic mode (SEKM). Therefore, for SEKM, under collision dominated or low frequency regime $(\omega << \nu_e, \nu_h)$, dispersion relation (10) reduces to

$$1 + \frac{i\nu_e\omega_{pe}^2}{[\omega(\nu_e^2 + \omega_{ce}^2) - ik^2\vartheta_{Fe}^2(1+\Gamma_e)\nu_e]} + \frac{i\nu_h\omega_{ph}^2}{[\omega(\nu_h^2 + \omega_{ch}^2) - ik^2\vartheta_{Fh}^2(1+\Gamma_h)\nu_h]} + \frac{\omega_{pd}^2}{(\omega^2 - \omega_{cd}^2)} = 0 \quad (11)$$

Equation (11) may be written in the form of polynomial in ' ω ' as,

$$A_4(\omega^4) + A_3(\omega^3) + A_2(\omega^2) + A_1(\omega) + A_0 = 0 \quad (12)$$

where,

$$A_4 = [(\nu_e^2 + \omega_{ce}^2)(\nu_h^2 + \omega_{ch}^2)]$$

$$A_3 = -i\begin{bmatrix} (\nu_e^2 + \omega_{ce}^2)\{k^2\lambda_{Fh}^2(1+\Gamma_h) - 1\}\omega_{ph}^2\nu_h \\ + (\nu_h^2 + \omega_{ch}^2)\{k^2\lambda_{Fe}^2(1+\Gamma_e) - 1\}\omega_{pe}^2\nu_e \end{bmatrix}$$

$$A_2 = \begin{bmatrix} (\nu_e^2 + \omega_{ce}^2)(\nu_h^2 + \omega_{ch}^2)(\omega_{pd}^2 - \omega_{cd}^2) \\ + k^2\{\lambda_{Fe}^2(1+\Gamma_e) + \lambda_{Fh}^2(1+\Gamma_h) - k^2\lambda_{Fe}^2(1+\Gamma_e)\lambda_{Fh}^2(1+\Gamma_h)\}\omega_{pe}^2\omega_{ph}^2\nu_e\nu_h \end{bmatrix}$$

$$A_1 = i\begin{bmatrix} \omega_{pe}^2\nu_e(\nu_h^2 + \omega_{ch}^2)[\{k^2\lambda_{Fe}^2(1+\Gamma_e) - 1\}\omega_{cd}^2 - k^2\lambda_{Fe}^2(1+\Gamma_e)\omega_{pd}^2] \\ + \omega_{ph}^2\nu_h(\nu_e^2 + \omega_{ce}^2)[\{k^2\lambda_{Fh}^2(1+\Gamma_h) - 1\}\omega_{cd}^2 - k^2\lambda_{Fh}^2(1+\Gamma_h)\omega_{pd}^2] \end{bmatrix}$$

$$A_0 = k^2\begin{bmatrix} k^2\lambda_{Fe}^2(1+\Gamma_e)\lambda_{Fh}^2(1+\Gamma_h)\omega_{pe}^2\omega_{ph}^2\nu_e\nu_h\left(\omega_{cd}^2 - \omega_{pd}^2\right) \\ - \omega_{pe}^2\omega_{ph}^2\nu_e\nu_h\omega_{cd}^2\{\lambda_{Fe}^2(1+\Gamma_e) + \lambda_{Fh}^2(1+\Gamma_h)\} \end{bmatrix}$$

Equation (12) being the fourth order polynomial can not be solved analytically. Hence this polynomial is solved numerically using Lagurre method. In the velocity regime $(\omega << k\vartheta_{Fe}, k\vartheta_{Fh})$ the variation of ω_{Im} and ω_{Re} with real positive value of k in presence and absence of quantum effect are depicted in following figures and table 1.

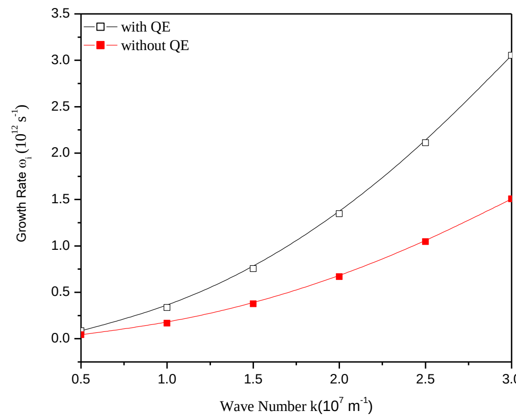

Figure 1. The gain coefficients of II- mode for SEKW in presence and absence of QE with wave number k having $n_{0e} = 10^{23}$, $n_{0h} = 5\times10^{23}$, $n_{0d} = 10^{14}$ ***at*** $B_0 = 0.8\ T$.

Out of four modes, the gain profiles of II-and III- modes in SEKW with and without quantum effect are illustrated in Figures 1and 2, remaining two modes (I and IV) are found to be non-propagating modes. Figures 1 and 2 displays the absorption profiles of II- and III- mode respectively, with wave number *k*. Figure 1shows the attenuation nature of the propagating wave whereas the Figure 2 shows the

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amplification nature of the propagating wave in presence and absence of quantum effect.

Table 1:

Variation of real part of the wave frequency (ω_{Re}) with wave number k for SEKW in presence and absence of quantum effect having $n_{0e} = 10^{23}$, $n_{0h} = 5\times10^{23}$, $n_{0d} = 10^{14}$ at $B_0 = 0.8\ T$.

k (10^7 m^{-1})	Real part of wave frequency ω_{Re} (s^{-1})							
	* I – Root (10^{10})		II – Root (10^1)		III – Root (10^{-2})		*IV – Root (10^{10})	
	$\gamma_{e,h}=0$	$\gamma_{e,h}\neq0$	$\gamma_{e,h}=0$	$\gamma_{e,h}\neq0$	$\gamma_{e,h}=0$	$\gamma_{e,h}\neq0$	$\gamma_{e,h}=0$	$\gamma_{e,h}\neq0$
1	-1.28	-1.28	-6.653	-3.34	-5.267	-5.302	1.28	1.28
1.5	-1.28	-1.28	-2.975	-1.484	-5.306	-5.325	1.28	1.28
2	-1.28	-1.28	-1.676	-0.834	-5.322	-5.35	1.28	1.28
2.5	-1.28	-1.28	-1.073	-0.532	-5.339	-5.381	1.28	1.28
3	-1.28	-1.28	-0.746	-0.369	-5.359	-5.418	1.28	1.28

* The modes I and IV are exactly equal and opposite in nature even in the presence of quantum effect

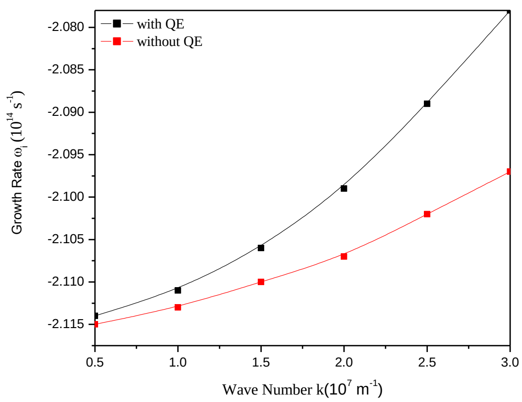

Figure 2. The gain coefficients of III- mode for SEKW in presence and absence of QE with wave number k having $n_{0e} = 10^{23}$, $n_{0h} = 5\times10^{23}$, $n_{0d} = 10^{14}$ at $B_0 = 0.8\ T$.

From Figures 1 and 2 it is clear that the attenuation coefficient of II-mode increases parabolicly with increment in k whereas the gain coefficient of III-mode decreases with increment in k. It is found that quantum correction term is responsible for enhancement in the attenuation coefficient of II-mode; while decrease the gain coefficient of III-mode, more rapidly as compared to without quantum effect. Hence the quantum effect modifies gain coefficients of both the modes (II and III).

Table 1 shows the variation of real frequency of all the possible four modes with wave number k, in presence ($\gamma_{e,h} \neq 0$) and absence ($\gamma_{e,h} = 0$) of quantum effect at $B_0 = 0.8$ T. From table it is clear that the phase velocities of I- and IV- modes are exactly equal and opposite to each other. Quantum effect cannot modify these modes.

The phase velocity of II- mode decreases with increment in k and presence of quantum effect decreases phase velocity to nearly half of the phase velocity in absence of quantum effect. On the other side the phase velocity of III-mode increases with increment in k and it is always higher in presence of quantum effect.

(ii) $\left(k\vartheta_{Fh} << \omega << k\vartheta_{Fe}\right)$

If the phase velocity of the mode is less than electron Fermi velocity but more than the hole Fermi velocity, the mode may be termed as fast electro-kinetic mode (FEKM). Thus for FEKM the dispersion relation (10) reduces to,

$$1+\frac{i\nu_e\omega_{pe}^2}{[\omega(\nu_e^2+\omega_{ce}^2)-ik^2\vartheta_{Fe}^2(1+\Gamma_e)\nu_e]}+\frac{i\nu_h\omega_{ph}^2}{[\omega(\nu_h^2+\omega_{ch}^2)-i\omega^2\nu_h]}+\frac{\omega_{pd}^2}{(\omega^2-\omega_{cd}^2)}=0 \quad (13)$$

Equation (13) may be rewritten in the term of polynomial in ‘ ω ’ as,

$$B_5(\omega^5)+B_4(\omega^4)+B_3(\omega^3)+B_2(\omega^2)+B_1(\omega)+B_0=0 \quad (14)$$

where,

$$B_5 = i[\nu_h(\nu_e^2+\omega_{ce}^2)]$$

$$B_4 = [(\nu_e^2+\omega_{ce}^2)(\nu_h^2+\omega_{ch}^2)+\{k^2\lambda_{Fe}^2(1+\Gamma_e)-1\}\omega_{pe}^2\nu_e\nu_h]$$

$$B_3 = -i\begin{bmatrix}(\nu_h^2+\omega_{ch}^2)\{k^2\lambda_{Fe}^2(1+\Gamma_e)-1\}\omega_{pe}^2\nu_e \\ +(\nu_e^2+\omega_{ce}^2)\{\omega_{cd}^2-\omega_{ph}^2-\omega_{pd}^2\}\nu_h\end{bmatrix}$$

$$B_2 = -\begin{bmatrix}(\nu_e^2+\omega_{ce}^2)(\nu_h^2+\omega_{ch}^2)(\omega_{cd}^2-\omega_{pd}^2) \\ +k^2\lambda_{Fe}^2(1+\Gamma_e)\omega_{pe}^2\nu_e\nu_h\{\omega_{cd}^2-\omega_{ph}^2-\omega_{pd}^2\} \\ -\omega_{pe}^2\omega_{cd}^2\nu_e\nu_h\end{bmatrix}$$

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$$B_1 = i\left[\begin{array}{l} k^2\lambda_{Fe}^2(1+\Gamma_e)\omega_{pe}^2\nu_e(\nu_h^2+\omega_{ch}^2)\{\omega_{cd}^2-\omega_{pd}^2\} \\ \qquad -\ \omega_{ph}^2\,\omega_{cd}^2\,\nu_h(\nu_e^2+\omega_{ce}^2)-\omega_{pe}^2\omega_{cd}^2\nu_e(\nu_h^2+\omega_{ch}^2) \end{array}\right]$$

$$B_0 = -k^2\lambda_{Fe}^2(1+\Gamma_e)\omega_{pe}^2\omega_{ph}^2\omega_{cd}^2\nu_e\nu_h$$

Equation (14) being the fifth order polynomial, has to be solved numerically. In the velocity regime $(k\vartheta_{Fh} \ll \omega \ll k\vartheta_{Fe})$ the variation of ω_{Im} and ω_{Re} with real positive value of k in presence and absence of quantum effect are depicted in following figures and table 2.

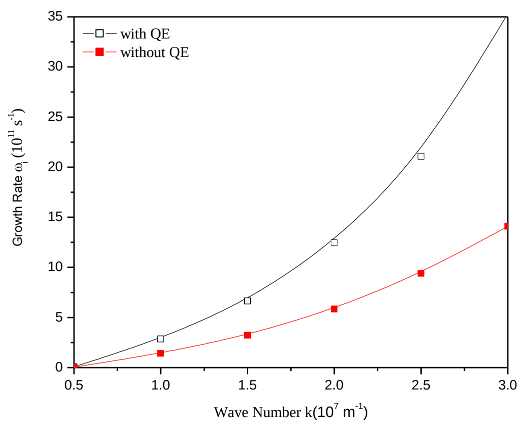

Figure 3. The gain coefficients of II- mode for FEKW in presence and absence of QE with wave number k at $B_0 = 0.8\ T$.

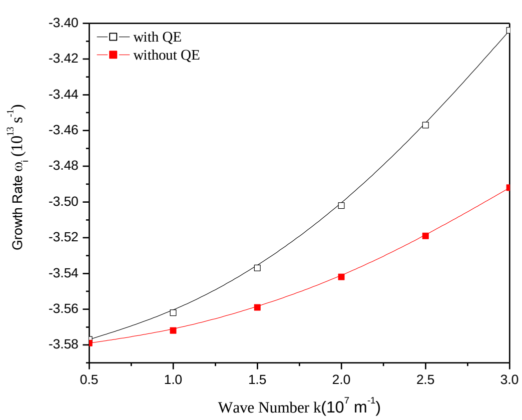

Figure 4. The gain coefficients of III- mode for FEKW in presence and absence of QE with wave number k at $B_0 = 0.8\ T$.

Figures 3 and 4 illustrate the absorption characteristics in the velocity regime $(k\vartheta_{Fh} \ll \omega \ll k\vartheta_{Fe})$ of II- and III- modes respectively in presence and absence of quantum effects with externally applied magnetic field ($B_0 = 0.8\ T$). Figure 3 shows attenuation characteristics of the II- mode, which illustrates that the decay rate increases with increasing the value of k for both the cases (with QE and without QE). Figure 4 displays the amplification characteristics of the III- mode with growth rate decreasing with increase in the value of k. The magnitudes of gain coefficients are identical for both the modes in presence and absence of quantum effect. In presence of quantum effect attenuation coefficient of II- mode increases and for III- mode growth rate decreases more rapidly. It is found quantum effects are responsible for the modifications of II- and III- modes in ion implanted magnetized quantum semiconductor plasma.

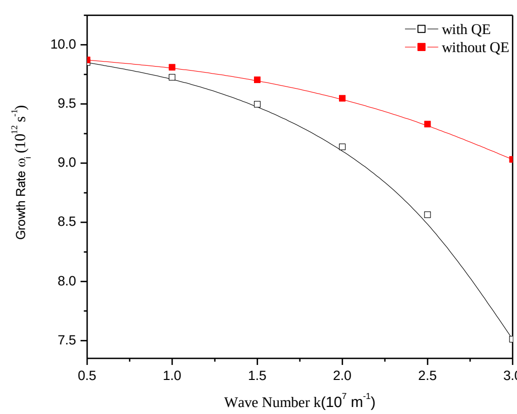

Figure 5. The gain coefficients of V- mode for FEKW in presence and absence of QE with wave number k at $B_0 = 0.8\ T$.

The gain profile for the new V- mode of FEKW with respect to k is illustrated in Figure 5. This mode is found to be decaying $(\omega_i > 0)$ in nature. The attenuation coefficient of V- mode decreases with increment in k for both the cases (in presence and absence of QE). The presence of QE increases the decay rate of attenuation coefficient. Quantum effect is responsible for decrease in attenuation rate more rapidly as compared to that when quantum effect is absent.

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Table 2:
Variation of real part of the wave frequency (ω_{Re}) with wave number k for FEKW in presence and absence of quantum effect having $n_{0e} = 10^{23}$, $n_{0h} = 5\times10^{23}$, $n_{0d} = 10^{14}$ at $B_0 = 0.8\ T$.

Real part of wave frequency ω_{Re} (s^{-1})										
k (10^7 m^{-1})	I – Root(10^{10})		II – Root(10^1)		III – Root(10^{-2})		IV – Root(10^{10})		*V – Root(10^{10})	
	$\gamma_{e,h}=0$	$\gamma_{e,h}\neq 0$	$\gamma_{e,h}=0$	$\gamma_{e,h}\neq 0$	$\gamma_{e,h}=0$	$\gamma_{e,h}\neq 0$	$\gamma_{e,h}=0$	$\gamma_{e,h}\neq 0$	$\gamma_{e,h}=0$	$\gamma_{e,h}\neq 0$
1	-1.28	-1.28	-9.073	-4.643	-7.604	-7.754	1.28	1.28	1.027	1.08
1.5	-1.28	-1.28	-4.148	-2.126	-7.767	-7.864	1.28	1.28	1.091	1.194
2	-1.28	-1.28	-2.385	-1.26	-7.843	-7.999	1.28	1.28	1.169	1.408
2.5	-1.28	-1.28	-1.575	-0.895	-7.93	-8.169	1.28	1.28	1.289	1.874
3	-1.28	-1.28	-1.148	-0.843	-8.034	-8.374	1.28	1.28	1.481	3.582

* New V^{th} mode

Table 2 illustrates the variation of real frequencies of FEKW with k in presence ($\gamma_{e,h} \neq 0$) and absence ($\gamma_{e,h} =0$) of quantum effects. It is seen that out of four existing mode only one (IV) mode is found to be growing mode in both the cases (with and without quantum effect). The phase velocities of I and IV-modes are again equal and opposite to each other in this velocity regime $\left(k\vartheta_{Fh} \ll \omega \ll k\vartheta_{Fe}\right)$ for both the cases (with and without QE). From above table 2, phase velocities of the II/ III-mode decreases/ increases with increasing value of wave vector k in presence and absence of QE. In presence of QE the phase velocity of II/ III-mode decreases/ increases more rapidly as compared to that when QE is not present.

If we set ($B_0 = 0$) the III-modes of FEKW are found to be aperiodic ($\omega_{Re} = 0$) mode in presence and absence of QE, hence it is clear that the presence of magnetic field converted the aperiodic (III) mode into periodic one. It is also seen that magnetic field introduced one new mode (V) in ion-implanted quantum semiconductor plasma which is a growing mode.

CONCLUSIONS

The analytical study of the quantum effect on wave propagation of LEKW in multi- component plasma through Bhom potential as well as effect of transverse magnetic field has been undertaken in this work. The following conclusions can be drawn from this study.

1. Presence of quantum correction has greatly modified the existing wave spectra of slow and fast EKW branch.
2. For FEKM, it is found that in presence of magnetic field one existing aperiodic mode is converted into periodic mode.
3. Magnetic field is also found to be responsible for the excitation and amplification of a new mode (reported as V-mode) under FEKW regime.

It is hoped that the present study will lead to a better understanding of the wave spectra of LEKW in ion-implanted quantum semiconductor plasma with a transverse magnetic field and can be put to use in various interesting applications.

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