ISSN: 0976-3031

Available Online at http://www.recentscientific.com

CODEN: IJRSFP (USA)

International Journal of Recent Scientific Research
Vol. 9, Issue, 4(G), pp. 25997-26000, April, 2018

International Journal of Recent Scientific Research

DOI: 10.24327/IJRSR

Research Article

THE PROPAGATION OF CIRCULARLY POLARIZED WAVES IN THREE COMPONENTS OF PLASMA ELECTRON USING INSBMATERIAL IN QUANTUM PLASMA

Manisha Raghuvanshi and Sanjay Dixit

Department of Physics, Govt. M.V.M College Shivajinagar, Barkatullah University Bhopal, India

DOI: http://dx.doi.org/10.24327/ijrsr.2018.0904.1973

ARTICLE INFO

Article History:

Received 8th January, 2018
Received in revised form 21st February, 2018
Accepted 05th March, 2018
Published online 28th April, 2018

Key Words:

Quantum plasma, QHD model, dispersion relation, cold plasma

ABSTRACT

In this paper, we have investigated the quantum plasma effects on circular polarized wave in cold plasma. In this present paper, we have described the electron quantum plasma on the propagation of circular polarized waves. We also studied the dispersion equation of plasma propagating over the cold plasma covered the external magnetic field occupying on the QHD model. We obtained numerical and analytically dispersion relation of magnetized and unmagnetised quantum plasma. It is shown that the large amplitude of circular polarized wave in quantum plasma.

INTRODUCTION

Quantum plasma has been fascinating a considerable modernization in the field of quantum physics. The involvement of quantum terms of equation in plasma fluid, like as quantum diffraction effect, mutated equation of state, linear and nonlinear acoustic waves, parametric and modulation instability of quantum plasma, SRS and SBS instabilities of electromagnetic wave in ultra-cold plasma, the propagation waves and instabilities in quantum plasmas. S Chandra *et.al.* [1] are showed that the application of quantum effect such as quantum echo, instabilities of quantum plasma in Fermi gases, quantum landau damping. Traditionally plasma physics has mainly focused on regimes characteristics by high temperature and low density where quantum effects are no any impact. But in plasma density is so high and temperature is law. Thermal De Broglie wavelength of electron is comparing the antiparticle distance. Semiconductor, metal and laser plasma this consideration is strongly fulfilled.

A Mulley.*et al*. [2] studied on the various types of model in quantum plasma. These models are Wigner passion system, which involves integral-differential equations and other one is most popular quantum hydrodynamics model i.e. QHD, quantum hydrodynamics' model have been considered as an extension of usual fluid model in plasma. QHD model in semiconductor plasma have been new mathematical model or empirical modification to the fluid model of quantum plasma .
QHD model are invented to initiative work of G. Manfred *et.al*[3].QHD model imitative by catching the velocity space, moments of the Wigner equation in classical fluid model.QHD model has contained the well set equation interpret the transport of charge, momentum and energy of the charged particle collaborate over an ascetic invariable of electrostatic plasma potential. The fluid model of quantum plasma is generalized by QHD model with the involvement of quantum correction, the term is recognized as the Bohm potential term relevantly epitomizes the negative differential resistance. In quantum phenomena, Bohm potential are established on the resonant tunneling. Dense quantum plasma is the most important effect of quantum plasma.

Bahaa.F.*et.al*[4] investigated the quantum plasma effect the comparisons of De Broglie wavelength of the charge carrier and spatial scale of plasma system is the most important in dense quantum plasma. H.Ren *et.al*[5] highlighted the new dispersion relation with quantum effect correction for a bit types of linear and nonlinear waves in a uniform cold quantum plasma with non-zero external magnetic field and also investigate Kumar *et.al* [6] explained the cold quantum plasma and retrieved the dispersion relation for the propagation of linear polarized laser beam adopting perturbation techniques. In adding the surface plasma vacuum interface of a captivate

Corresponding author:* **Manisha Raghuvanshi
Department of Physics, Govt. M.V.M College Shivajinagar, Barkatullah University Bhopal, India

enough study seeing that the frequency spectra have species function in various field such as laser physics, plasma spectroscopy and plasma technology[7] .in dense quantum plasma of half space establish the dispersion relation for surface Plasmon's obtained by M. Laser *et.al* [8]. And also find out the dispersion relation of one, two stream and beam plasma instabilities in uniform magnetized plasma are obtained over the new dielectric tensor [9].

In present paper we have described three componenet of the electron quantum plasma of the quantum effects on the propagation of circularly polarized wave. We also studied the dispersion equation of propagate over the cold plasma covered the external magnetic field occupying on the QHD model.

Governing Equations

In consideration of a circularly polarized laser beam expressed By the electric field

$$E = E_o[cos(k_z z - \omega t)e_x + sin(k_z z - \omega t)e_y]$$

And the magnetic field

$$B = B_o[-sin(k_z z - \omega t)e_x + cos(k_z z - \omega t)e_y]$$

Propagating over the quantum plasma electron is mesmerized in an ambient static magnetic field$B_O = B_O e_z$. By the QHD model the dynamics of electrons are governed by the pursuing the equation of continuity and momentum.

$$\frac{\partial n_1}{\partial t} + \nabla(n_1 u_1) \quad (1)$$

$$\frac{\partial u_1}{\partial t} = -\frac{e_1}{m_1}(E_1 + u_1 \times B_1) - \frac{\nabla \mathrm{p}_1}{\mathrm{m}_1 \mathrm{n}_1} + \frac{\hbar^2}{2\mathrm{m}_1^2}\nabla\left(\frac{1}{\sqrt{\mathrm{n}_1}}\nabla^2\sqrt{\mathrm{n}_1}\right) \quad (2)$$

Where n is the number of density, m is mass of electron and ϑ velocity of electron and $\hbar$ is the Planck's constant divided by2π. Electrons are executing the pressure law and show the equation of state in one dimensional zero temperature Fermi gas.

$$P_1 = \frac{m_{1e} V_{1Fe}^2}{3n_0} n_1^3$$

Here $V_{1Fe} = \sqrt{\frac{2k_{1B}T_{1Fe}}{m}}$ is the Fermi thermal speed,k_{jB} is the Boltzmann's constant, n_0 is the equilibrium particle number density .we have to admitted the quantum statistical effects over Fermi temperature and quantum diffraction in $\hbar$ dependent.we will obtained classical hydrodynamics equations, we can set $\hbar$ equal the temperature of electron.

By the using of perturbation technique, we shall be estimate any physical quantity $\emptyset$ represent the following form

$$\emptyset = \emptyset_0 + \emptyset_1$$

Here $\emptyset_0$ is the unperturbed value and $\emptyset_1 \ll \emptyset_0$ is the small perturbation

$$\emptyset_1 \propto exp(-i\omega t + ik, r)$$

We get,

$$\frac{\partial n_0}{\partial t} + \nabla(n_0 u_1 + n_1 u_0) = 0 \quad (3)$$

$$\frac{\partial u_1}{\partial t} = -\frac{e_1}{m_1}(E_1 + u_0 \times B_1 + u_1 \times B_0) - \frac{V_{1Fe}^2}{n_0}\nabla \mathrm{n}_1 + \frac{\hbar^2}{4\mathrm{m}_1^2 n_0}\nabla(\nabla^2 \mathrm{n}_1) \quad (4)$$

Equation (4) are represented the Bohmpotential, has been perturbatively expanded using [10]. The basic set of linearized equations in homogeneous quantum magnetized cold plasma is

$$n_1 = \frac{k.u_1}{\omega - k.u_1} n_0 \quad (5)$$

$$-i\omega u_1 = -\frac{e}{m}(E_1 + u_0 \times B + u_1 \times B_0) - \frac{iR(k.u)}{\omega - k.u_0} k \quad (6)$$

$$Here\ , \qquad R = \left(V_{Fe}^2 + \frac{\hbar^2 k^2}{4m^2}\right)\frac{i}{\omega}$$

$$-i\omega u_1 = \frac{e}{m}E_1 + \frac{e}{m}u_0 B + \frac{e}{m}u_1 B_0 + (k.u)R\, k$$

Derive the expression of k from the equation (6)

$$-i\omega u_1 = \frac{e}{m}E_1 + \frac{e}{m}u_0 B + \frac{e}{m}u_1 B_0 - \frac{R}{Rk^2 + i\omega}\frac{e}{m}(k.E_1)\, k - \frac{R}{Rk^2 + i\omega}\frac{e}{m}u_{y1}k_x B_0 k \quad (7)$$

In 2012 B.F Mohamed and Rehab.A studied two components of the plasma electrons in the plane of circularized polarized laser beam we have extended that equation in threecomponents of plasma electron in circular polarized laser beam are showed in below

$$J_{x1} = -i\omega\frac{e}{m}E_{x1} + \frac{e}{m}\omega_c R\, E_{y1} + i\omega R' k_x(k.E_1) - R'\omega_c\frac{e}{m}k_x^2 E_{y1} \quad (8)$$

$$J_{y1} = i\omega\frac{e}{m}E_{y1} - \frac{e}{m}\omega_c E_{x1} + \frac{e}{m}R'\omega_c k_x(k.E_1) \quad (9)$$

$$J_{z1} = \frac{f}{i\omega}\frac{e}{m}E_{jz1} + \frac{h}{i\omega}\frac{e}{m}R' k_z(k.E_1)\frac{1}{i\omega}R'\omega_c k_x k_z \times \left(-i\omega\frac{e}{m}E_{y1} - \frac{e}{m}\omega_c E_{x1} + \frac{e}{m}R'\omega_c k_x(k.E_1)\right)(10)$$

Where,$f = \omega_c^2 - \omega^2 R'\omega_c k_x^2$, $R' = \frac{R}{Rk^2 + i\omega}$

And $\omega_c = \frac{eB_0}{m}$ $\quad is\ the\ electron\ larmor\ frequency$ .still at the similar time the current density and dielectric tensor ε are given by

$$J = \hat{\sigma}.E_1 \quad (11)$$

Here $\hat{\sigma}$ is the electrical conductivity and E is electric field. Commonly we approximate the current density assumes the current simply is proportional to the electric field

$$\hat{\varepsilon} = \hat{I} + \frac{i}{\epsilon_0 \omega}\widehat{\sigma} \quad (12)$$

We achieved by the equations of (8), (9) (11)

$$\hat{\varepsilon} = \hat{I} - \sum\frac{\omega_P^2}{\omega^2 f}\begin{pmatrix} -\omega^2(1 - R'k_x^2) & -i\omega\omega_c(1 - R'k_x^2) & \omega^2 R'k_x k_z \\ i\omega\omega_c(1 - R'k_x^2) & -\omega^2 & -i\omega\omega_c R'k_x k_z \\ \omega^2 R'k_x k_z & i\omega\omega_c R'k_x k_z & f(1 - R'k_z^2) - R'\omega_c^2 k_x^2 k_z^2 \end{pmatrix} \quad (13)$$

Where $\hat{I}$ $is\ the\ unit\ tensor\ and$ $\omega_{pe}^2 = \left[\frac{n_0 e^2}{m\epsilon_0}\right]$ is the plasma electron frequency?

Since the dispersion relation are follows

$$\varepsilon_3[(\varepsilon_1 - N^2) - \varepsilon_2^2] = 0 \quad (14)$$

Since, $\varepsilon_1 = 1 - \frac{\omega_{Pe}^2}{(\omega^2-\omega_c)}$,$\varepsilon_1 = -\frac{\omega_{Pe}^2\omega_c}{(\omega^2-\omega_c)}$,$\varepsilon_3 = 1 - \frac{\omega_{Pe}^2}{\omega^2}\left(1-\frac{R\,k^2}{Rk^2+i\omega}\right)$

$N^2 = \varepsilon_1 \pm \varepsilon_2$, $N = \frac{ck}{\omega}$

DISCUSSIONS

In case of unmagnetized plasma

We are concentrated to find out the dispersion relation in equation (13) numerically and analytically

In few cases for$u_0 = 0$

In first case, the absence of external magnetic field i.e. the propagation of linear polarized laser beam in unmagnetized quantum plasma ($\omega_C = 0$) and reduced the following equation

$$\left(\frac{ck}{\omega}\right)^2 - \left(1 - \frac{\omega_{Pe}^2}{(\omega^2-\omega_c)}\right) + \frac{\omega_{Pe}^2\omega_c}{(\omega^2-\omega_c)} = 0$$

Those are gives two dispersion relation and they are explain the propagate of laser beam in unmagnetized plasma. At this case the equations are obtained

$$\omega^2 = \omega_{pe}^2 + c^2k^2 \qquad (15)$$

$$\omega^4 - \omega^2\left(\omega_{pe}^2 + c^2k^2 + k_x^2R\right) + c^2k_x^2k_z^2R = 0 \qquad (16)$$

In case of magnetized plasma

In second case presence of external magnetic field i.e the propagation of linear polarized laser beam in magnetized plasma and this ignoring the quantum effect for the region of Bohm potential and Fermi temperature of quantum statistical effect the (R=0) equation (13) becomes

$$\left[1-\frac{\omega_{Pe}^2}{\omega^2}\left(1-\frac{\omega_{Pe}^2}{\omega^2}\right)\left[\frac{\omega_{Pe}^2}{(\omega^2-\omega_c)}-\frac{c^2k^2}{\omega^2}+\frac{\omega_{Pe}^2\omega_c}{(\omega^2-\omega_c)}\right]\right] = 0 \quad (18)$$

Equation (16) expressed the dispersion relation of linear polarized laser beam propagating in classical plasma showed in equation (14)

Taking some normalized

$W = {}^{\omega}/\omega_p$,$K = \frac{k_xV_{jFe}}{\omega_p}$, $\alpha = \frac{k_z}{k_x}$,$\gamma = \frac{c}{V_{jFe}}$,$\overline{\omega_c} = {}^{\omega_c}/\omega_p$,$\delta = {}^{1}/\omega$

And also the plasmonic coupling $\left(\mathrm{T} = \frac{\hbar\omega_p}{2mV_{Fe}^2}\right)$ those values are showed that the ratio between the plasmonic energy density to the electron Fermi energy density

By the following values modified and rewrite the equation (16)

$$W^4 - W^2\left(1+\gamma^2K^2+K^2\delta(1+K^2T^2)\right) + \alpha^2\gamma^2K^4\delta(1+K^2T^2) = 0 \qquad (19)$$

Numerical calculation

The parameters of piezoelectric material InSb at room temperature 77 k, m_0=9.11x 10^{-31}kg , n_0=10^{23}m^{-3}, C_s=4x 10^3ms^{-1} , ω_p =1.37x10^{16}s^{-3},V_{Fe}=1.4x10^8, $\hbar$ =6.6x10^{-34}Js, ω =5.15x 10^{11},N = 2.6x10^{15},In equation (19) plotted the different values T.

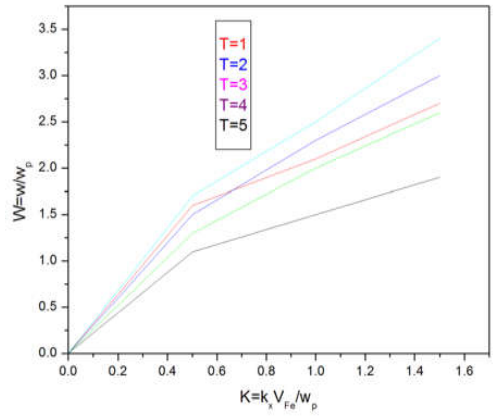

Figure 1 plot the all parameters Insb in equation (19), and display the dispersion curve for different values of T =1, 2,3,4,5.

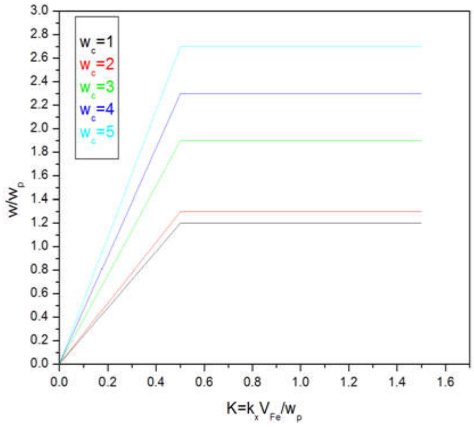

Figure 2 using equation (13) showed that the normalized frequency($W = {}^{\omega}/\omega_p$) and the normalized wave numbers ($K = \frac{k_xV_{Fe}}{\omega_p}$)for different values of$\omega_c = 1,2,3,4,5$.

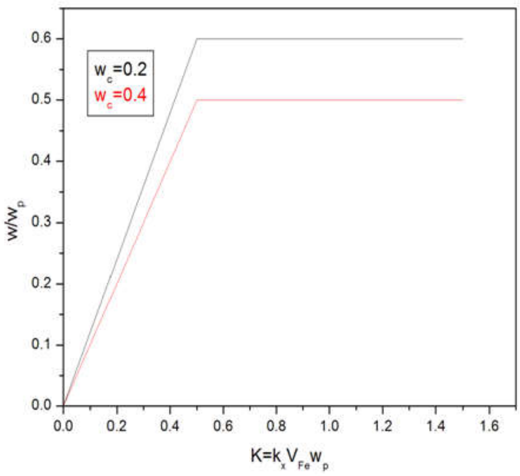

Figure 3 display a curve of dispersion relation of magnetized circular polarized wave in quantum plasma for parameters of (ω_c=0.2, 0.4) for increased wave number also increased its wave frequency.

CONCLUSION

In this paper we have explained that the dispersion relation of magnetised and unmagnetised quantum plasma through using QHD equation and Maxwell equations. Apply perturbation technique and obtained three component of plasma electron in circular polarized laser beam. We have studied that the large circular polarized wave in presence of electric and magnetic field. In this paper showed that the quantum effect on phase velocity and for increases the wave number, wave frequency are also increased applied with more magnetic field.

Acknowledgement

The authors are thankful to Dr. Sanjay Dixit, Assistant Professor (department of physics) Barkatullah University Bhopal, for useful discussions at the final stage of the manuscript

References

1. Swarniv Chandra, SailendraNath Paul And Basudev Ghosh "Linear And Non-Linear Propagation Of Electron Plasma Waves In Quantum Plasma" Department Of Physics, Jadavpur University, Kolkata 700 032, India, Indian Journal Of Pure & Applied Physics, Vol. 50, May 2012, Pp. 314-319
2. ApurvaMuley* And S. Ghosh "Effect Of Quantum Parameter–H On Longitudinal Electrokinetic Wave Characteristics In Magnetised Semiconductor" Scientific Journal 4(2): Feb, 2015 2277-9655
3. G. Manfredi and F. Haas, "Self-Consistent Fluid Model for A Quantum Electron Gas," *Physical Review B*, Vol. 64, No. 7, 2001, 7 P.
4. Bahaa F. Mohamed,RehabAlbrulosy "The Propagation Of Circularly Polarized Waves In Quantum Plasma"Banha University, Banha, Egypt , *Journal Of Modern Physics*, 2013, 4, 236-239.
5. H. Ren, A. Wu And P. Chu, "Dispersion Of Linear Waves In Quantum Plasmas," *Physics Of Plasma*, Vol. 14, No. 6, 2007, 6 P .
6. P. Kumar And C. Tiwari, "High Frequency Oscillations In Quantum Plasma," *Journal Of Physics*: *Conference Series*, Vol. 208, No. 1, 2010, Article ID: 012051
7. A. F. Alexandrov, L. S. Bogdankevich And A. A. Rukho- Dze, "Principles Of Plasma Electrodynamics," Springer, Berlin, 1984
8. M. Lazar, P. K. Shukla And A. Smolyakov, "Surface Waves On A Quantum Plasma Half-Space," *Physics Of Plasma*, Vol. 14, No. 12, 2007, Article ID: 124501.
9. P. A. Markowich, C. A. RinghoferAnd C. Schmeiser, "Semiconductor Equations," Springer-Verlag, New York, 1990
10. Stenflo, L. "Influence of A Circularly Polarized Electromagnetic Wave on A Magnetized Plasma" 1976, Phys. Scripta,14, 320.
11. H. Ren, Z. Wu, J. Cao And P. K. Chu "Dispersion Of Multi-Stream Instability In Quantum Magnetized Hot Plasmas," *Physics Letters A*, Vol. 372, No. 15, 2008, 2676- 2683

How to cite this article:

Manisha Raghuvanshi and Sanjay Dixit.2018, The Propagation of Circularly Polarized Waves In Three Components of Plasma Electron Using Insbmaterial In Quantum Plasma. *Int J Recent Sci Res.* 9(4), pp. 25997-26000.
DOI: http://dx.doi.org/10.24327/ijrsr.2018.0904.1973

****