ISSN (Print 0974-2115) (Online 2349-8552)
www.jchps.com Journal of Chemical and Pharmaceutical Sciences

Study of effect of ion temperature on Magnetoacoustic Shock waves in plasma

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ABSTRACT

In this search, it has been studied the properties of the magneto acoustic shock waves in ultra-dense quantum plasma and its including ions and electrons and positrons after taking effect of ion temperature on phase velocity of the magneto sonic wave and , this is by the ion pressure into momentum equation of ion fluid.

Moreover, it has been studied that waves by using reductive perturbation method. The results have been compared to the shock waves ones with what others have reached in related references.

KEY WORDS: Ultra-dense plasma, Shock waves, Ion temperature.

1. INTRODUCTION

Nonlinear structures arise when the plasma is in a disturbed state. This condition is automatically obtained in cosmic plasma or laboratory plasma due to internal or external self-disturbances. This can be experimentally guided by a laser beam on laboratory plasma under controlled conditions. Nonlinearity can't be ignored when waves are large. Nonlinearity can be obtained from the generation of harmonic generation (Antoine, 1996) harmonies involving fluid advection and nonlinear Lorentz force (Smolyakov, 2002) and limiting the molecules in the Wave potential and the Ponder motive force. Nonlinearity in plasma contributes to the localization of waves, leading to the emergence of different types of coherent small volume waves. This method maintains a balance between waves steepening resulting from non-linearity and spreading resulting in dispersion and it can reduce a range of nonlinear equations and obtain a single one. Using Schrödinger's nonlinear equation, KDV equation, the modified KDV equation, and other nonlinear structures, these include(solitary waves, shock waves, double layers), Which is composed of contiguous layers for which two adjacent layers are charged with two opposite charges, leading to the emergence of an electric field that accelerates, delays or reverses charged particles. "Nonlinear waves are called solitons when dispersion is equated with nonlinearity".

There are some plasma types where the effects of dissipative energy are similar or greater than the dispersive effects. In this case, nonlinear plasma waves appear as shock structures rather than soliton structures. A study of plasma shocks began in 1950 with attention to molten plasma and shocks from explosions in the upper atmosphere. Astronomical environments contain several different types of shock waves. Such as supernovae, explosion waves traveling through interstellar environments, and arc shock caused by the collision of solar wind with the magnetosphere and shock waves caused by the collisions of galaxies (Paschmann, 1980).

The reductive perturbation method (Dimiray, 2008) can be used in the case of equations can also be used .Plasma (e-p-i) is widely found in nature, where it can arise in the interior of the accretion discs "the growth of the astrocytic material in the form of disks" and in the vicinity of black holes, the magnetic wrappers of neutron stars And in the nuclei of active galaxies and even in solar flare plasma. Many facts indicate that our world was a warm plasma (epi) during the first minutes of its existence, and this plasma can be produced by a very short and intense laser pulse in the material and by the photo production of the pairs by dispersing the photons on the nuclei, These plasma are also formed in the tachymac and other magnetic constituents of plasma.

Roy (2009), studied the effect of ionic temperature on large-volume ionic acoustic solitons in electron-ion plasma, they used fake potential method. Das in 2014, studied the effect of ionic temperature on dust – ionic- acoustic waves in non-magnetized and hot plasma, using in this study the method of reduced disturbance to obtain the KDV equation with soliton solutions.

The importance of this research is to study the effect of ionic temperature on the Spread of quantum magnetic acoustic shock waves in a magnetized and ultra-dense plasma(e-p-i), where plasma is treated here as a carrier fluid consisting of positive and negative charges and which is submitted to a magnetic field using (QMHD). The aim of this study is to study the speed of these waves, based on the equations used in the reference (Hussain, 2013), to obtain the KDVB equation, which has conclusive solutions that take the form of a shock wave and comparing these solutions with what it was recently reached.

2. METHODS AND MATERIALS

- Using (QMHD) that control the movement of electrons, positrons and ions in quantum magnetized plasma.
- Studying the previous equations in the plane coordinates.
- Using the reductive perturbation Method to obtain the equation of KDVB.

In this work, we used QMHD equations used by Hussain (2013). They used the reductive perturbation method to reduce the set of QMHD equations to a nonlinear differential equation of KDVB, This method is used in the case of small-capacity shock waves, but they neglected in their study the effect of ionic temperature. In this work we take the ionic temperature into consideration and we will study its effect on the magnetic acoustic shock waves at the plane coordinates by inserting the ion pressure limit to the right side of the ion movement equation. The effects of ionic pressure resulting from Fermi ionic temperature can be neglected.

The continuity equation of the studied ions is given in the following relation:

$$\text{Ions } \frac{\partial n_\mathrm{i}}{\partial t} + \nabla(n_\mathrm{i}\vec{v_i}) = 0 \qquad (1)$$

Ions intensity: n_i, ion speed: $\vec{v_i}$

The equation of the movement is expressed as following:

$$\frac{\partial v_i}{\partial t} + \vec{v_i}\vec{\nabla}\vec{v_i} = \frac{\mathrm{e}}{m_\mathrm{i}}\left[\vec{\mathrm{E}} + \vec{v_i} \times \vec{\mathrm{B}}\right] - \frac{1}{m_\mathrm{i} n_\mathrm{i}}\nabla \mathrm{P}_i + \nu\nabla^2\vec{v_i} \qquad (2)$$

e ion charge: m_i :ion mass $\vec{\mathrm{E}}$:electric field $\vec{\mathrm{B}}$:Magnetic field

Refers to the kinetic viscosity of ions, dynamic viscosity: $\nu = \frac{\mu}{m_i n_i}$

The continuity equation for the quantum liquid consisting of decomposed electrons is as following

$$\frac{\partial n_e}{\partial t} + \nabla(n_e\vec{v_e}) = 0 \qquad (3)$$

The equation of the motion of the electron is expressed after adding the quantum limit

$$\left[\frac{\hbar^2}{2{m_\mathrm{e}}^2}\vec{\nabla}\left(\frac{1}{\sqrt{n_\mathrm{e}}}\nabla^2\sqrt{n_\mathrm{e}}\right)\right]$$

Associated with the Boom voltage as following:

$$0 = -e\left[\vec{\mathrm{E}} + \vec{v_e} \times \vec{\mathrm{B}}\right] - \frac{1}{n_e}\nabla \mathrm{P}_{Fe} + \frac{\hbar^2}{2m_e}\nabla\left(\frac{1}{\sqrt{n_\mathrm{e}}}\nabla^2\sqrt{n_\mathrm{e}}\right) \qquad (4)$$

Fermi pressure of the electronic liquid: P_{Fe}

Two equations of to the continuity and movement of the quantum fluid consisting of decomposed positrons can also be expressed as following:

$$\frac{\partial n_p}{\partial t} + \nabla\left(n_p\vec{v_p}\right) = 0 \qquad (5)$$

n_p: intensity of positrons, $\vec{\vartheta}_p$:Positron Speed

$$0 = e\left[\vec{\mathrm{E}} + \vec{v_p} \times \vec{\mathrm{B}}\right] - \frac{1}{n_p}\nabla \mathrm{P}_{Fp} + \frac{\hbar^2}{2m_p}\nabla\left(\frac{1}{\sqrt{n_\mathrm{p}}}\nabla^2\sqrt{n_\mathrm{p}}\right) \qquad (6)$$

m_p:positron mass, P_{Fp}: Fermi pressure of positrons

We add the equations above to the following Maxwell equations:

$$\vec{\nabla} \times \vec{\mathrm{E}} = -\frac{1}{\mathrm{c}}\frac{\partial\vec{\mathrm{B}}}{\partial t} \qquad (7)$$

$$\vec{\nabla} \times \vec{\mathrm{B}} = \frac{4\pi}{\mathrm{c}}\vec{\mathrm{j}} + \frac{1}{\mathrm{c}}\frac{\partial\vec{\mathrm{E}}}{\partial \mathrm{t}} \qquad (8)$$

We use the idiom of the Fermi decomposition P_{Fs} , which is expressed as following:

$$\mathrm{P}_{Fs} = \frac{\hbar^2(3\pi^2)^{2/3}}{5\mathrm{m_s}}n_\mathrm{s}^{5/3} \qquad (9)$$

$$\mathrm{S} = (e, p)$$

$$n_\mathrm{i}\ ,n_e,\ ,\vec{v_i}\ \vec{v_e},\ ,\vec{\mathrm{E}}\ \vec{\mathrm{B}}$$

Refer to intensity of ions, electrons, speed of ionic and electronic liquids, and electric and magnetic fields in order and can be organized according to time and position as following:

$$\vec{\mathrm{B}} \to \frac{\vec{\mathrm{B}}}{\mathrm{B}_0}, r \to \frac{\mathrm{r}\omega_i}{V_{Ai}}\ , t \to t\omega_i, \vec{\mathrm{E}} \to \frac{\mathrm{e}\vec{\mathrm{E}}}{mV_{Ai}\omega_i}, n_\mathrm{j} \to \frac{n_\mathrm{j}}{n_0}, \vec{v_\mathrm{j}} \to \frac{\vec{v_\mathrm{j}}}{\mathrm{V_s}}$$

$\mathrm{j} = e, i, p$, $\boldsymbol{n_0}$: The intensity of the plasma components in the state of equilibrium before being exposed to external influences “undisturbed state”.

$\omega_i = \frac{e\mathrm{B}_0}{m_i}$: The plasmatic frequency because of the vibration of ions around their equilibrium state. These vibrations result from the instantaneous plasma disorder away from the equilibrium, in the form of $\boldsymbol{\omega_i} = \frac{\boldsymbol{e}\mathbf{B_0}}{\boldsymbol{m_i}}$:

The plasmatic frequency because of the vibration of ions around their equilibrium state. These vibrations result from the instantaneous plasma disorder away from the equilibrium, in the form of a displacement in negative or positive charges and an electric field is resulted in the direction corresponding to the rebalance of plasma.

B_0 Is the internal magnetic field resulting from the constant movement of positive and negative charges in the plasma.

$V_{Ai}=\frac{\mathrm{B}_0}{\sqrt{4\pi m_{\mathrm{i}}n_{\mathrm{i}0}}}$: Alven speed a low frequency ionic wave is formed in the plasmatic environment under the influence of the magnetic field.

n_{i0} : Intensity of ions in the balance state of the plasma.

$V_S=\sqrt{\frac{K_B T_{Fe}}{m_i}}$: The velocity of the ionic sound, is a longitudinal wave resulted from the compressions and rarefaction that affect the ions in the studied environment.

Boltzmann constant: K_B

T_{Fe}: Fermi temperature of the electron.

Equations from 1 to 8 take the following form:

$$\frac{\partial n_{\mathrm{i}}}{\partial t}+\nabla(n_{\mathrm{i}}\vec{v_i})=0 \quad (10)$$

$$\frac{\partial \vec{v_i}}{\partial t}+\vec{v_i}\nabla\vec{v_i}=\left[\vec{\mathrm{E}}+\vec{v_i}\times\vec{\mathrm{B}}\right]-\frac{2\beta}{5}\sigma_1\frac{\nabla n_i^{\frac{5}{3}}}{n_i}+\eta\frac{\partial^2 v_i}{\partial x^2} \quad (11)$$

$$\frac{\partial n_e}{\partial t}+\nabla(n_e\vec{v_e})=0 \quad (12)$$

$$0=-\left[\vec{\mathrm{E}}+\vec{v_e}\times\vec{\mathrm{B}}\right]-\frac{2\beta}{5}\frac{\nabla n_{\mathrm{e}}^{\frac{5}{3}}}{n_e}+\frac{{\mathrm{H}_{\mathrm{e}}}^2}{2}\nabla\left(\frac{1}{\sqrt{n_{\mathrm{e}}}}\nabla^2\sqrt{n_{\mathrm{e}}}\right) \quad (13)$$

$$\frac{\partial n_p}{\partial t}+\nabla\left(n_p\vec{v_p}\right)=0 \quad (14)$$

$$0=\left[\vec{\mathrm{E}}+\vec{v_p}\times\vec{\mathrm{B}}\right]-\frac{2\beta}{5}\sigma\frac{\nabla n_{\mathrm{p}}^{\frac{5}{3}}}{n_p}+\frac{{\mathrm{H}_{\mathrm{p}}}^2}{2}\nabla\left(\frac{1}{\sqrt{n_{\mathrm{p}}}}\nabla^2\sqrt{n_{\mathrm{p}}}\right) \quad (15)$$

$$\vec{\nabla}\times\vec{\mathrm{E}}=-\frac{\partial\vec{\mathrm{B}}}{\partial t} \quad (16)$$

$$\vec{\nabla}\times\vec{\mathrm{B}}=n_{\mathrm{i}}\vec{v_i}+\frac{p}{1-p}n_p\vec{v_p}-\frac{1}{1-p}n_e\vec{v_e}+\delta\frac{\partial\vec{\mathrm{E}}}{\partial t} \quad (17)$$

$\beta={\mathrm{V}_{\mathrm{s}}}^2/{V_{Ai}}^2$: Called Plasma beta , this proportion is a result of the distribution of plasma when it exposed to magnetic fields.

Quantitative parameter: $\mathrm{H}=\frac{\hbar\omega_{\mathrm{i}}}{(\mathrm{m_e m_i})^{1/2}{\mathrm{V}_{\mathrm{Ai}}}^2}$

$$\sigma=\frac{\mathrm{T_{Fp}}}{\mathrm{T_{Fe}}},\mathrm{p}=\frac{\mathrm{n_{po}}}{\mathrm{ne0}},\delta=\frac{{\mathrm{V}_{\mathrm{Ai}}}^2}{\mathrm{c}^2},\ \sigma_1=\frac{\mathrm{T_i}}{\mathrm{T_{Fe}}}$$

$\mathrm{T_{FP}}$: Fermi temperature of positron

$\mathrm{T_{Fe}}$: electron Fermi temperature of

Normalized ion kinematic viscosity : $\eta=\frac{\nu\omega_i}{{V_{Ai}}^2}$

Assuming that the electric field is located in (x, y) and magnetic field on the z-axis applicable, magnetic field can be expressed like: $\vec{\mathrm{B}}=[B_0+B(z,t)]\hat{z}$.

B_0 : The internal magnetic field resulting from the constant movement of positive and negative charges in the plasma.

B (z, t): The external magnetic field that affect the environment of plasma.

We assume that it affects according to z^-, vector $\vec{\mathrm{k}}$ It applies to the axis x^- which means $\vec{\nabla}(\partial_{\mathrm{x}},0,0)$. Using Cartesian coordinates , from equations (10-17) we can have these following equations:

$$\frac{\partial n_{\mathrm{i}}}{\partial t}+\frac{\partial}{\partial x}(n_{\mathrm{i}}v_{ix})=0 \quad (18)$$

$$\frac{\partial v_{ix}}{\partial t}+v_{ix}\frac{\partial v_{ix}}{\partial x}=\mathrm{E}_x+v_{iy}\mathrm{B_z}-\frac{2\beta}{5n_i}\sigma_1\frac{\nabla n_i^{\frac{5}{3}}}{n_i}+\eta\frac{\partial^2 v_{ix}}{\partial x^2} \quad (19)$$

$$\frac{\partial v_{iy}}{\partial t}+v_{iy}\frac{\partial v_{iy}}{\partial x}=\mathrm{E}_y-v_{ix}\mathrm{B_z}+\eta\frac{\partial^2 v_{iy}}{\partial x^2} \quad (20)$$

$$\frac{\partial n_e}{\partial t}+\frac{\partial}{\partial x}(n_e v_{ex})=0 \quad (21)$$

$$0=-\mathrm{E}_x-v_{ey}\mathrm{B}_z-\frac{2\beta}{5}\frac{\nabla n_e^{\frac{5}{3}}}{n_e}+\frac{\mathrm{H_e}^2}{2}\frac{\partial}{\partial x}\left(\frac{1}{\sqrt{n_e}}\frac{\partial^2}{\partial x^2}\sqrt{n_e}\right) \quad (22)$$

$$0=-\mathrm{E}_y+v_{ex}\mathrm{B}_z \quad (23)$$

$$\frac{\partial n_p}{\partial t}+\frac{\partial}{\partial x}(n_p v_{px})=0 \quad (24)$$

$$0=\mathrm{E}_x+v_{py}\mathrm{B}_z-\frac{2\beta}{5}\frac{\nabla n_p^{\frac{5}{3}}}{n_p}+\frac{\mathrm{H_p}^2}{2}\frac{\partial}{\partial x}\left(\frac{1}{\sqrt{n_p}}\frac{\partial^2}{\partial x^2}\sqrt{n_p}\right) \quad (25)$$

$$0=\mathrm{E}_y-v_{px}\mathrm{B}_z \quad (26)$$

$$\frac{\partial \mathrm{B_z}}{\partial t}+\frac{\partial \mathrm{E}_y}{\partial x}=0 \quad (27)$$

$$-\frac{\partial \mathrm{B_z}}{\partial x}=n_i v_{iy}+\frac{p}{1-p}n_p v_{py}-\frac{1}{1-p}n_e v_{ey}+\delta\frac{\partial \mathrm{E}_y}{\partial t} \quad (28)$$

$$0=n_i v_{ix}+\frac{p}{1-p}n_p v_{px}-\frac{1}{1-p}n_e v_{ex}+\delta\frac{\partial \mathrm{E}_x}{\partial t} \quad (29)$$

KDVB equation: To study the magnetized plasma spread of the magneto acoustic disorders in high – intensity magnetic plasma, these two independent variables (t), (x) can be replaced with functional variables that Ensure the movement to referential frame moves at u speed to a constant frame (13) which is expressed as following:

$$\left.\begin{aligned}\boldsymbol{\xi}=\boldsymbol{\epsilon}^{\frac{1}{2}}(\boldsymbol{x}-\boldsymbol{\vartheta_m t}),\boldsymbol{\tau}=\boldsymbol{\epsilon}^{\frac{3}{2}}\boldsymbol{t}\\ \frac{\partial}{\partial \boldsymbol{x}}=\boldsymbol{\epsilon}^{\frac{1}{2}}\frac{\partial}{\partial\boldsymbol{\xi}},\frac{\partial}{\partial \boldsymbol{t}}=-\boldsymbol{\vartheta_m}\boldsymbol{\epsilon}^{\frac{1}{2}}\frac{\partial}{\partial\boldsymbol{\xi}}+\boldsymbol{\epsilon}^{\frac{3}{2}}\frac{\partial}{\partial\boldsymbol{\tau}}\end{aligned}\right\} \quad (30)$$

t: time , ϵ : minimal parameter , It enters as a multiplication factor of different grades of $n_{i.}$, n_e , , ϑ_{ix} ϑ_{ex} ϑ_{iy} , ϑ_{ey} , , E_x , E_y , B_z physical quantities

v_m : Speed of shock wave phase. We can have the following equations by the compensation of equation (30) in (18 to 29):

$$-v_m\epsilon^{\frac{1}{2}}\frac{\partial n_i}{\partial\xi}+\epsilon^{\frac{3}{2}}\frac{\partial n_i}{\partial\tau}+\epsilon^{\frac{1}{2}}\frac{\partial}{\partial\xi}(n_i v_{ix})=0 \quad (31)$$

$$-v_m\epsilon^{\frac{1}{2}}\frac{\partial v_{ix}}{\partial\xi}+\epsilon^{\frac{3}{2}}\frac{\partial v_{ix}}{\partial\tau}+\epsilon^{\frac{1}{2}}v_{ix}\frac{\partial v_{ix}}{\partial\xi}=\mathrm{E}_x+v_{iy}\mathrm{B}_z-\epsilon^{\frac{1}{2}}\frac{2\beta}{5n_i}\sigma_1\frac{\partial n_i^{\frac{5}{3}}}{\partial\xi}+\eta_0\,\epsilon^{\frac{3}{2}}\frac{\partial^2 v_{ix}}{\partial\xi^2} \quad (32)$$

$$-v_m\epsilon^{\frac{1}{2}}\frac{\partial v_{iy}}{\partial\xi}+\epsilon^{\frac{3}{2}}\frac{\partial v_{iy}}{\partial\tau}+\epsilon^{\frac{1}{2}}v_{iy}\frac{\partial v_{iy}}{\partial\xi}=\mathrm{E}_y-v_{ix}\mathrm{B}_z+\eta_0\,\epsilon^{\frac{3}{2}} \quad (33)$$

$$-v_m\epsilon^{\frac{1}{2}}\frac{\partial n_e}{\partial\xi}+\epsilon^{\frac{3}{2}}\frac{\partial n_e}{\partial\tau}+\epsilon^{\frac{1}{2}}\frac{\partial}{\partial\xi}(n_e v_{ex})=0 \quad (34)$$

$$0=-\mathrm{E}_x-v_{ey}\mathrm{B}_z-\epsilon^{\frac{1}{2}}\frac{2\beta}{5}\frac{\frac{\partial n_e^{\frac{5}{3}}}{\partial\xi}}{n_e}+\frac{\mathrm{H_e}^2}{2}\epsilon^{\frac{1}{2}}\frac{\partial}{\partial\xi}\left(\frac{1}{\sqrt{n_e}}\epsilon\frac{\partial^2}{\partial\xi^2}\sqrt{n_e}\right) \quad (35)$$

$$0=-\mathrm{E}_y+v_{ex}\mathrm{B}_z \quad (36)$$

$$-v_m\epsilon^{\frac{1}{2}}\frac{\partial n_p}{\partial\xi}+\epsilon^{\frac{3}{2}}\frac{\partial n_p}{\partial\tau}+\epsilon^{\frac{1}{2}}\frac{\partial}{\partial\xi}(n_p v_{px})=0 \quad (37)$$

$$0=\mathrm{E}_x+v_{py}\mathrm{B}_z-\epsilon^{\frac{1}{2}}\frac{2\beta}{5}\frac{\frac{\partial n_p^{\frac{5}{3}}}{\partial\xi}}{n_p}+\frac{\mathrm{H_p}^2}{2}\epsilon^{\frac{1}{2}}\frac{\partial}{\partial\xi}\left(\frac{1}{\sqrt{n_p}}\epsilon\frac{\partial^2}{\partial\xi^2}\sqrt{n_p}\right) \quad (38)$$

$$0=\mathrm{E}_y-v_{px}\mathrm{B}_z \quad (39)$$

$$-v_m\epsilon^{\frac{1}{2}}\frac{\partial \mathrm{B_z}}{\partial\xi}+\epsilon^{\frac{3}{2}}\frac{\partial \mathrm{B_z}}{\partial\tau}+\epsilon^{\frac{1}{2}}\frac{\partial \mathrm{E}_y}{\partial\xi}=0 \quad (40)$$

$$-\epsilon^{\frac{1}{2}}\frac{\partial \mathrm{B_z}}{\partial\xi}=n_i v_{iy}+\frac{p}{1-p}n_p v_{py}-\frac{1}{1-p}n_e v_{ey}-v_m\delta\epsilon^{\frac{1}{2}}\frac{\partial \mathrm{E}_y}{\partial\xi}+\epsilon^{\frac{3}{2}}\delta\frac{\partial \mathrm{E}_y}{\partial\tau} \quad (41)$$

$$0 = n_i v_{ix} + \frac{p}{1-p} n_p v_{px} - \frac{1}{1-p} n_e v_{ex} - v_m \delta \epsilon^{\frac{1}{2}} \frac{\partial E_x}{\partial \xi} + \epsilon^{\frac{3}{2}} \delta \frac{\partial E_x}{\partial \tau} \quad (42)$$

Values change because of external factors which affect the environment of plasma, Such as exposure to electromagnetic waves with high frequencies (microwave waves, laser beams and other influences) which lead in turn to not linear forces such as the slow down – push force, Which in turn leads to an electric field with low intensity added to the original electric field, Which in turn is reflected in other physical quantities and their values change.

Corrective limits from different grades in condition of that they must be less than 1 are entered to identify these variables, by multiplying the physical value of parameter ϵ as a multiplication factor of different grades.

$n_i, n_e, \vartheta_{ix}, \vartheta_{ex}, \vartheta_{iy}, \vartheta_{ey}, E_x, E_y, B_z$ are spread in the chains of forces according to ϵ as following:

$$n_j = 1 + \epsilon n_j^{(1)} + \epsilon^2 n_j^{(2)} + \cdots$$
$$v_{jx} = 0 + \epsilon v_{jx}^{(1)} + \epsilon^2 v_{jx}^{(2)} + \cdots$$
$$v_{jy} = \epsilon^{3/2} v_{jy}^{(1)} + \epsilon^{5/2} v_{jy}^{(2)} + \cdots \quad (43)$$
$$B_z = 1 + \epsilon B_z^{(1)} + \epsilon^2 B_z^{(2)} + \cdots$$
$$E_x = \epsilon^{3/2} E_x^{(1)} + \epsilon^{5/2} E_x^{(2)} + \cdots$$
$$E_y = \epsilon E_y^{(1)} + \epsilon^2 E_y^{(2)} + \cdots$$

j = e, I, p we can have the following equations by the compensation of equation (41) in (29 to 40) and comparing of quantities between ϵ and $\epsilon^{3/2}$

$$v_{ix}^{(1)} = v_{ex}^{(1)} = E_y^{(1)} = v_{px}^{(1)} \quad (44)$$

$$n_i^{(1)} = n_e^{(1)} = n_p^{(1)} = B_z^{(1)} = \frac{v_{px}^{(1)}}{v_m} \quad (45)$$

$$E_x^{(1)} = \left[\frac{\frac{2\beta}{3v_m}\sigma_1 - v_m}{(1+\delta)}\right] \frac{\partial v_{px}^{(1)}}{\partial \xi} \quad (46)$$

$$v_{iy}^{(1)} = \left[\frac{\delta(\frac{2\beta}{3v_m}\sigma_1 - v_m)}{(1+\delta)}\right] \frac{\partial v_{px}^{(1)}}{\partial \xi} \quad (47)$$

$$v_{ey}^{(1)} = \left[\frac{(v_m - \frac{2\beta}{3v_m}\sigma_1)}{(1+\delta)} - \frac{2\beta}{3v_m}\right] \frac{\partial v_{px}^{(1)}}{\partial \xi} \quad (48)$$

$$v_{py}^{(1)} = \left[\frac{(v_m - \frac{2\beta}{3v_m}\sigma_1)}{(1+\delta)} - \frac{2\beta\sigma}{3v_m}\right] \frac{\partial v_{px}^{(1)}}{\partial \xi} \quad (49)$$

The velocity of the phase of the magneto acoustic wave was obtained as following:

$$v_m = \sqrt{\frac{1 + \frac{2}{3}(\frac{1}{1-p} + \frac{p\sigma}{1-p} + \sigma_1)\beta}{(1+\delta)}} \quad (50)$$

It can be noticed from this equation that the velocity of the phase of the shock wave is related to:

$$p = \frac{n_{po}}{n_{e0}}, \sigma = \frac{T_{Fp}}{T_{Fe}}, \beta = V_s^2/V_{Ai}^2 \ \delta = \frac{{V_{Ai}}^2}{c^2}, \sigma_1 = \frac{T_i}{T_{Fe}},$$

Which means that these quantities have an important role in changing the velocity ϑ_m especially $p = \frac{n_{po}}{n_{eo}}$

By comparing of quantities between $\epsilon^{5/2}$, ϵ using the same technique we used above and which leads to following equations:

$$-v_m \frac{\partial n_i^{(2)}}{\partial \xi} + \frac{\partial n_i^{(1)}}{\partial \tau} + \frac{\partial v_{ix}^{(2)}}{\partial \xi} + \frac{\partial}{\partial \xi}(n_i^{(1)} v_{ix}^{(1)}) = 0 \quad (51)$$

$$\frac{\partial v_{ix}^{(1)}}{\partial \tau} - v_m \frac{\partial v_{ix}^{(2)}}{\partial \xi} + v_{ix}^{(1)} \frac{\partial v_{ix}^{(1)}}{\partial \xi} = E_x^{(2)} + v_{iy}^{(2)} + v_{iy}^{(1)} B_z^{(1)} - \frac{2\beta}{3}\sigma_1 \frac{\partial n_i^{(2)}}{\partial \xi} + \eta_0 \frac{\partial^2 {v_{ix}}^{(1)}}{\partial \xi^2} \quad (52)$$

$$-v_m \frac{\partial v_{iy}^{(1)}}{\partial \xi} = \mathrm{E}_y^{(2)} - v_{ix}^{(2)} - v_{ix}^{(1)} B_z^{(1)} \quad (53)$$

$$-v_m \frac{\partial n_e^{(2)}}{\partial \xi} + \frac{\partial n_e^{(1)}}{\partial \tau} + \frac{\partial v_{ex}^{(2)}}{\partial \xi} + \frac{\partial}{\partial \xi}(n_e^{(1)} v_{ex}^{(1)}) = 0 \quad (54)$$

$$0 = -\mathrm{E}_x^{(2)} - v_{ey}^{(2)} - v_{ey}^{(1)} B_z^{(1)} - \frac{2}{3}\beta \frac{\partial n_e^{(2)}}{\partial \xi} + \frac{{H_e}^2}{4} \frac{\partial^3 n_e^{(1)}}{\partial \xi^3} \quad (55)$$

$$0 = -\mathrm{E}_y^{(2)} + v_{ex}^{(2)} + v_{ex}^{(1)} B_z^{(1)} \quad (56)$$

$$-v_m \frac{\partial n_p^{(2)}}{\partial \xi} + \frac{\partial n_p^{(1)}}{\partial \tau} + \frac{\partial v_{px}^{(2)}}{\partial \xi} + \frac{\partial}{\partial \xi}(n_p^{(1)} v_{px}^{(1)}) = 0 \quad (57)$$

$$0 = \mathrm{E}_x^{(2)} + v_{py}^{(2)} + v_{py}^{(1)} B_z^{(1)} - \frac{2}{3}\beta\sigma \frac{\partial n_p^{(2)}}{\partial \xi} + \frac{{H_p}^2}{4} \frac{\partial^3 n_p^{(1)}}{\partial \xi^3} \quad (58)$$

$$0 = \mathrm{E}_y^{(2)} - v_{px}^{(2)} - v_{px}^{(1)} B_z^{(1)} \quad (59)$$

$$-v_m \frac{\partial B_z^{(2)}}{\partial \xi} + \frac{\partial B_z^{(1)}}{\partial \tau} + \frac{\partial \mathrm{E}_y^{(2)}}{\partial \xi} = 0 \quad (60)$$

$$v_{ix}^{(2)} + n_i^{(1)} v_{ix}^{(1)} - \frac{1}{1-p} v_{ex}^{(2)} - \frac{1}{1-p} n_e^{(1)} v_{ex}^{(1)} + \frac{p}{1-p} v_{px}^{(2)} + \frac{p}{1-p} n_p^{(1)} v_{px}^{(1)} - v_m \delta \frac{\partial \mathrm{E}_x^{(1)}}{\partial \xi} = 0 \quad (61)$$

$$-\frac{\partial B_z^{(2)}}{\partial \xi} = v_{iy}^{(2)} + n_i^{(1)} v_{iy}^{(1)} - \frac{1}{1-p} v_{ey}^{(2)} - \frac{1}{1-p} n_e^{(1)} v_{ey}^{(1)} + \frac{p}{1-p} v_{py}^{(2)} + \frac{p}{1-p} n_p^{(1)} v_{py}^{(1)} + \delta \frac{\partial \mathrm{E}_y^{(1)}}{\partial \tau} - v_m \delta \frac{\partial \mathrm{E}_y^{(2)}}{\partial \xi} \quad (62)$$

The Common mathematical solution of (50) – (61) leads to KDVB in plane coordinates

$$\frac{\partial v_{px}^{(1)}}{\partial \tau} + A v_{px}^{(1)} \frac{\partial v_{px}^{(1)}}{\partial \xi} + B \frac{\partial^3 v_{px}^{(1)}}{\partial \xi^3} + C \frac{\partial^2 v_{px}^{(1)}}{\partial \xi^2} = 0 \quad (63)$$

$$A = \left[3 + \frac{2\delta(\frac{2\beta}{3v_m}\sigma_1 - v_m)}{(1+\delta)} + \frac{8p\beta\sigma}{3(1-p)v_m^2} \right] \left[\frac{6 + 2\sigma_1 + 4\left(\frac{1}{1-p} + \frac{p\sigma}{1-p}\right)\beta}{3v_m^2} \right]^{-1} \quad (64)$$

$$B = \left[\frac{\delta v_m \left(\frac{2\beta}{3v_m}\sigma_1 - v_m\right)^2}{(1+\delta)} - \frac{1+p}{1-p} \frac{H^2}{4v_m} \right] \quad (65)$$

$$C = -\eta_0 \left[\frac{6 + 2\sigma_1 + 4\left(\frac{1}{1-p} + \frac{p\sigma}{1-p}\right)\beta}{3v_m^2} \right]^{-1} \quad (66)$$

By using (Tanh) method (9) we can have the KDVB solution which represents the shock wave:

$$v_{px}^{(1)}(\xi) = \frac{3C^2}{25AB} sech^2 \left[\frac{C}{10B}(\xi - u\tau) \right] + \frac{6C^2}{25AB} [1 - \tanh[\frac{C}{10B}(\xi - u\tau)]] \quad (67)$$

3. RESULTS AND DISCUSSION

In this research, we obtained the (KDVB) from (QMHD) equations using reductive perturbation method after taking the ionic temperature in consider where it was disregard in reference (8) by adding the limit which represents the ionic pressure to the ionic movement equation

It was noticed that the temperature has an effect on the phase velocity of the magneto acoustic shock wave when this proportion was found $\sigma_1 = \frac{T_i}{T_{Fe}}$

In (50) and this correspond with the results that were found by S. Hussain, S .Mahmood and A. Mushtaq, as (31) in reference (8) shows : $v_m = \sqrt{\frac{1 + \frac{2}{3}(\frac{1}{1-p} + \frac{p\sigma}{1-p})\beta}{(1+\delta)}}$

It was found by comparing between (31) (original reference) and (50) (that we have found), that σ_1 has an effect on the velocity of shock wave by its existence in the numerator of (50) equation which increases the phase velocity of the wave.

It should be noticed that our study of the plane magnetic acoustic shocks in plasma (e-p-i) where the proportion was p in relation (50) which represents the intensity of positron n_{po} to the electron n_{eo} in the case of the balanced environment of plasma to determine the effect of σ_1 on the phase velocity of the magnetic acoustic wave

v_m in terms of $p = \frac{n_{po}}{n_{e0}}$ which has been found in reference (8), then the changes of the velocity of the phase of the magnetic acoustic wave which has been found in reference (8) after neglecting the ionic temperature in relation (31) of the reference (8) , and the relation of the velocity of the phase which found in this study in relation (50) in terms of $p = \frac{n_{po}}{n_{e0}}$ using (MATLAB) method as the graph (1) shows. Ultra - high – intensity plasma parameters have been taken in consideration, such as non-linear parameter A and diffusion parameter B Parameter of dispersion, the intensity of the magnetic field also take values into this account domain: $B_0 = 10^9 - 10^{11}$Gauss.

Positrons intensity: $n_{0p} = 0.4 \times 10^{28} cm^{-3}$
Ions intensity: $n_{0i} = 0.6 \times 10^{28} cm^{-3}$
Electrons intensity: $n_{0e} = 10^{28} cm^{-3}$
Temperature: $T = 8000 - 40.000\ K$
Fermi temperature of the electrons: $T_{\mathrm{F}e} = 9.1166 \times 10^6$K
Fermi temperature of the positrons: $T_{\mathrm{F}e} = 4.9493 \times 10^6$K
Fermi temperature of ions: $T_{\mathrm{F}i} = 3537$K
Figure.1, shows that curve $\vartheta_m(p)$

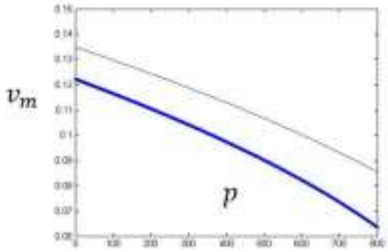
Moved after the ionic temperature was taken in consideration, it can be noticed that the speed decreases in both curves $\vartheta_m = \frac{\vartheta_{e,p}}{\mathrm{V}_{Ai}}$
Inversely with the increasing of $p = \frac{n_{po}}{n_{e0}}$ and the value of $\vartheta_m(P)$ also increases

As Δϑ m=0.01 when P=0, so this concludes that taking the ionic temperature in consideration increases the accuracy of relative velocity.

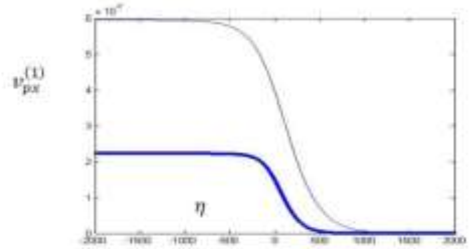
In addition, it has been shown that ionic temperature has a clear effect on the damping speed through the appearance of σ_1 in the energy loss coefficient. This proportion in the numerator of the relation (66) leads to the increasing of this coefficient and so the increasing of the damping speed, and the existence of σ_1 in different positions of both relations nonlinear coefficient (64) dissipation limit (65) affects the damping speed too. And to determine the effect of $\sigma_1 = \frac{T_i}{T_{Fe}}$ on the damping speed, we found a solution of shock wave which is in relation (52) in the original reference (8), the solution that we found in this research (67), and the curves in graph (2).

It can be noticed that the damping speed have increased clearly after the ionic temperature has been taken in consideration, the graph (2) showed the increasing of the kinematic viscosity as $\Delta\vartheta_{px} = 4 \times 10^{-7}$

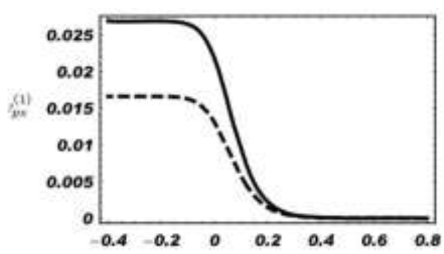
Also affects the damping speed which appears in the relation of dissipation limit C where it increases as $\Delta\vartheta_{px} = 0.011$when the increases from $\eta_0 = 0.001\ to\ \eta_0 = 0.0015$. As graph (3) in reference (8) shows :



Graph.1. The changes of the velocity of the phase of the magnetic acoustic shock wave v_m in terms of proportion p in two cases



Graph.2. Shows the effect of the damping speed (the fine line) comparing to the original reference (the thick line) (Hussain, 2013)



Graph.3. The increasing of damping speed of the magnetic acoustic shock due to the changing in kinematic viscosity of the ionic liquid from $\eta_0 = 0.001$ (the dotted line) to $\eta_0 = 0.0015$ (the continuous Line)

a- entering the ionic temperature into calculation (the fine line).
b-without entering the ionic temperature into calculation (the thick line).

4. CONCLUSION

Reductive perturbation method enables us to reduce the equations of the study of plasma by the approximation of (QMHD) to (KDVB) which has shock solutions and enables us to get the relation of the phase velocity of the shock, so it can be studied the properties of these waves such as their intensity, the impact of external disturbances such as magnetic fields, and parameters), the intensity of plasma, its components (electrons, ions, positrons, charged grains of the dust), the mass of these components, the temperature of plasma, Fermi temperature of the components of the plasma, as well as quantum effects such as quantum diffraction effects which appears by adding the limit of the force that associated with Bohm's potential to the kinematic equations of the electrons and positrons on the formation and spread of these waves.

It should be noted that the numerical study of these waves become easier with the use of computer programs. We used the program MATLAB in our research to find out the general form $p = \frac{n_{po}}{n_{e0}}$ of the change of velocity of the spread of the shock wave sequentially and the form of the change of the shock wave sequentially the standard variable$\eta = \xi - u\tau$ which associated with the position and time.

There are several methods for solving nonlinear partial differential equations that we did not mention, but some of them was mentioned in reference.

We propose to study the effect of ionic temperature on the formation and spread of soliton waves in ultra-intensity magnetic (electron-positron-ion) by neglecting the dissipation limit in equation (63). We get the (KDV) formula with soliton solutions.

REFERENCES

Antoine, Theory of high-order harmonic generation by an elliptically polarized laser light, Phys. Rev. A, 53, 1996, 1725-1745.

Das R, Effect of ion temperature on dust ion acoustic solitary waves in a warm unmagnetized plasma with electron inertia, India, 3, 2014, 8791- 8799.

Dimiray H, Modified Reductive Perturbation Method, Faculty of Arts and Sciences, 34980-Istanbul-Turkey, 2008, 11-20.

Hereman W, Malfiet W, The Tanh Method, A Tool to Solve Nonlinear Partial Differential Equations with Symbolic Software, U.S.A., 2004, 529-541.

Hussain S, Mahmood S, Musht AQ, Magnetoacoustic shocks in dense astrophysical plasmas, Astrophysics and Space Science, Italy, 2013, 2105–2110.

Kolebaje O, Oyewande O, Numerical Solution of the Korteweg De Vries Equation, International Journal of Basic and Applied Sciences, 2012, 321-335.

Morales G.J, Lee Y.C, Ponderomotive - Force Effects in plasma, Phys. Rev. Lett., 33, 1974, 1016.

Paschmann G, Sckppke N, Asbridge J.R, Bame S.J, Energization of Solar Wind Ions by Reflection From the Earth's Bow Shock, J. Geophys. Res., 85, 1980, 4689.

Roy K, Muniandy S.V, Yap S.L, Effect of ion temperature on arbitrary amplitude ion acoustic solitary waves in quantum electron-ion plasmas, American Institute of Physics, USA, 2009, 275-279.

Smolyakov V.A, Tyshetskiy Y.O, Nonlinear effects in plasma, University of Saskatchewan, Canada, 2002, 47-57.