Effect of Radiating Partially Ionized Plasma and Wave Evolution in the Photosphere


Abstract— This paper investigate the effect of a radiating partially-ionized plasma and wave evolution. The presence of upstream and downstream magnetic field is studied with the influence of collision and interaction frequency in radiative flow field. A modified Chandrasekher, Dranzin and Ried method is used in solving the characteristics value problems with two-dimensional disturbances for the case of equilibrium free convection. Radiation present on the onset of partially ionized plasma and wave evolution is found to have periodicity steady state, unsteady with differential gradient on the ralight number. It effect on wave evolution is small on the radiation parameters of the order wave number $1 \times 10^{-5}$ concentration gradient. A steady state effect on the system graphs were pictorially displayed, evaluated and the results shows with remarkable good agreement on various figures on decrease points or decline points, steady state points, incline points and also their characteristic behaviour of the Rayleigh number and wave evolution in the region. The effect of collision on the onset of static cells diminishes for optical thin non-grey plasma-near periodic steady state. This is of relevant and very important in cosmic ray physics as the interaction between the ionized and neutral gas component represents a state which often exists in the Astrophysical space.

Index Terms— Rayleigh number, Ionized plasma, neutral, wave propagation, wave numbers.

I. INTRODUCTION

It is currently known that the characteristics behaviour of radiating ionized plasma and wave propagation in the photosphere interstellar medium and the involving hydro magnetic forces is of immense important in connection with meteorologists, space science, engineer, industrialist, environmentalist and in astrophysical phenomena, geophysical Scientist, ionized gas behaviour, and plasma jets. Also equipments in the area such as nuclear power plants, gas turbines and the various propulsion devices for air craft's, missiles satellite and Space vehicles (Sutton, 1959; Shil-Pai, 1965). Besides it has a variety of application in MHD Power generation and Hall accelerators Ram et.al; 1990, in re-entry problems (Bestman et.al; 1992), in geophysical fluid dynamics, meteorology and engineering. (Chamkha et. Al; 2001) studied the Radiation effects on the free convection flow past a semi-finite vertical plate with mass transfer.


The problem of studying the complex occurrence of neutral and ionized species of those particles accelerated at astrophysical sources and those particles produced in interaction and collisions with those on interstellar gas are relevant to Geophysics, Astrophysical flow, Solar power technology, space vehicle re-entry, also relevant to environmental scientist and engineers. Naturally occurrence and the existence of extraterrestrial and terrestrial atmosphere are cause by the variation in solar radiation amount-solar out put (Ayoade, 1993), variation in the absorption of solar radiation outside the earth atmosphere since atmosphere and weather are guided and governed by dynamics of fluid (William and John, 1999; Gaiser and Stanev, 2000). Analytical study of Galactic cosmic rays which are fully ionized; the accelerated mechanism fully strip the ions with antimeter component, as measured in the space shuttle, extra galactic origin transport in the cloudy interstellar medium containing randomly distributed giant molecular clouds have been considered in the works of Cowisik and Wilson, 1973; Dogiel et.al; 1987; Osborne et.al; 1987 and Ptuskin et.al; 1990. The latter two papers theory of diffusion in the cloudy medium which takes into account the cloud’s finite transparency for diffusion particles. Due to the high temperature involved, its application in space science Management, Astrophysics, Meteorites meteorology and in Agricultural industries cannot be overemphasised. Alabara et.al; (2008) Study the field structure and the heat transfer at the walls of two-component plasma. The flow is induced by two horizontal walls moving relative to each other along their common axis in the presence of a uniformly applied transverse magnetic field and the analysis made under the following assumptions

(i) The flow is viscous and incompressible (ii) The flow is fully developed (iii) The temperature varies linearly along the
Effect of Radiating Partially Ionized Plasma and Wave Evolution in the Photosphere

\[ \mathcal{B} = 4 \int_0^\infty \left( \alpha e \frac{\partial F}{\partial \epsilon} \right) d\epsilon \]

\( \mathcal{B} \) is the Planck's function, \( \mathcal{B} \) is the radiation absorption coefficient and \( \epsilon \) is the frequency of radiation, and \( \theta \) is the temperature. The equations expressing the continuity, momentum, heat and solute mass concentration acted on by a uniform vertical magnetic field \( H(0,0,H) \) and gravity \( g(0,0,\mathcal{B}) \) are

\[ \nabla \cdot \mathbb{V} = 0 \]
\[ \nabla \cdot \mathbb{H} = 0 \]
\[ \mathbb{V} = \nabla \times \mathbb{B} \]

(1)

\[ \begin{align*}
\frac{\partial \mathbb{V}}{\partial t} + \mathbb{V} \cdot \nabla \mathbb{V} &= - \nabla P + \nabla \left( \frac{\mu}{\rho} \right) \left( \nabla^2 \mathbb{V} \right) \\
\rho \frac{\partial \mathbb{V}}{\partial t} &= - \frac{\partial \mathbb{V}}{\partial t} + \nabla \times \mathbb{H} + \nabla \left( \frac{\mu}{\rho} \right) \left( \nabla^2 \mathbb{V} \right)
\end{align*} \]

(2)

\[ \frac{\partial \mathbb{H}}{\partial t} = - \nabla \times \mathbb{E} - \frac{1}{c} \nabla \times \left( \nabla \times \mathbb{H} \right) \]

(3)

\[ \frac{\partial \mathbb{V}}{\partial t} = \nabla \times \mathbb{E} - \frac{1}{c} \nabla \times \left( \nabla \times \mathbb{H} \right) \]

(4)

\[ \frac{\partial \mathbb{C}}{\partial t} + \mathbb{V} \cdot \nabla \mathbb{C} = \nabla \cdot \mathbb{D} \]

(5)

for ionized components

In consequence to the writing of equations 1, 2, 3, 4 and 5 above the Boussinesq approximation has been used. Similarly, for the neutral components we have

\[ \nabla \cdot \mathbb{V} = 0 \]
\[ \nabla \cdot \mathbb{H} = 0 \]
\[ \mathbb{V} = \nabla \times \mathbb{B} \]

(6)

(7)

II. MATHEMATICAL FORMULATION

In the analysis of exact consequence of radiative transfer in a fluid requires a formulation in terms of integro-differential equations. Solution of equations is complex(Spiegel, 1965; Opara and Bestman, 1988). Approximation theories have been developed that permit a formulation involving only differential equations. One such theory expresses radiation for optically thin non gas a differential approximation of variable space co-ordinate (Cogley, et al,1968). These theories where originally developed for astrophysical studies and where later employed in neuron transport theory. Although the usual formulation of the problem is well known, its modification for radiative terms is not. We therefore consider the flow of a two-component plasma model, using the subscripts \( \text{l} \) and \( \text{n} \) to designate ion and neutral particles. The problem as formulated by Sharma and Sunil (1992), is then modified by the radiative term thus.

\[ \nabla \cdot q = (\theta - \theta_\infty) \alpha^2 \]

(8)
and

\[
\frac{\partial \mathbf{E}}{\partial t} + \nabla \times \mathbf{H} = \frac{\mathbf{J}}{\mu} - \frac{\partial \mathbf{D}}{\partial t} + \nabla \frac{\partial \mathbf{P}}{\partial t}.
\]

(9)

\[
\rho = \rho_0 \left[ 1 - \beta (\partial \theta - \partial \phi) + \alpha' (\partial \phi - \partial \theta) \right],
\]

(10)

On the condition where the suffix zero refers to values at the reference level \( z = 0 \). The temperatures and solute concentration at the bottom surface \( z = 0 \) are \( \theta_0, C_0 \) and at the upper surface \( z = d \) are \( \theta, C \). We have also taken the Cartesian coordinates \( x, y, z \) with the origin on the lower boundary \( z = 0 \) and the \( z \)-axis perpendicular to it along the vertical \( z \)-axis. In the equation of motion for the neutral component, there will be an equal and opposite motion. (b) for the ionized component, the steady state solution is

\[
\nabla \times \mathbf{v}(x, y, z) = 0
\]

(11)

\[
\theta = \theta_0 - \beta z
\]

(11a)

\[
\nabla \times \mathbf{v}(x, y, z) = 0
\]

(12)

\[
\rho = \rho_0 \left[ 1 + \beta (\partial \theta - \partial \phi) - \beta' (\partial \phi - \partial \theta) \right]
\]

where \( \beta \) and \( \beta' \) are the adverse temperature and concentration gradient considering a small perturbation on the steady state. Under the argument of Chandrasekhar (1981); Drazin and Reid (2004); Pekene and Ekpe (2015); Bestman and Opara (1990) the liberalized perturbation equation become

\[
\frac{\partial \mathbf{E}}{\partial t} = \frac{\partial}{\partial t} \left[ \nabla \times \mathbf{H} \right] + \frac{\partial \mathbf{D}}{\partial t} - \frac{\partial \mathbf{P}}{\partial t}
\]

(13)

\[
\frac{\partial \mathbf{H}}{\partial t} = \frac{\partial \mathbf{E}}{\partial t} + \nabla \times \mathbf{J} + \frac{\partial \mathbf{P}}{\partial t}
\]

(14)

\[
\frac{\partial \mathbf{P}}{\partial t} = \mathbf{v} \cdot \nabla \mathbf{P} - \frac{1}{\kappa}
\]

(15)

where \( \mathbf{W}_z \) is the \( z \)-component of the velocity of ionized particles \( \mathbf{E}_z \) is the component of vorticity and \( \mathbf{E}_s \) is a factor representing the current density.

**III. DISPERSION RELATION**

Analyzing dispersion in terms of normal modes and assuming that the perturbation quantities are of the form

\[
W_t = W_t(z) e^{i(k_x x + k_y y + \omega t)}
\]

(16)

\[
\theta_t = \theta_t(z) e^{i(k_x x + k_y y + \omega t)}
\]

(17)

\[
\xi_t = \xi_t(z) e^{i(k_x x + k_y y + \omega t)}
\]

(18)

\[
\zeta_t = \zeta_t(z) e^{i(k_x x + k_y y + \omega t)}
\]

(19)

where

\[
\mathbf{E}_t = \frac{\partial \mathbf{V}}{\partial x} - \frac{\partial \mathbf{D}}{\partial y}
\]

(20)

\[
\mathbf{E}_s = \frac{\partial \mathbf{V}}{\partial y} + \frac{\partial \mathbf{D}}{\partial x}
\]

(21)

\[
\mathbf{E}_z = \frac{\partial \mathbf{V}}{\partial z}
\]

(22)

denote respectively the \( z \)-components of vorticity and current density; \( k_x \) and \( k_y \) are the wave number in the \( x \)-and \( y \)-directions, \( \kappa = \sqrt{k^2_x + k^2_y} \) is the resultant wave number and the growth rate. Expressing the coordinate \( x, y, z \) in the new unit length \( d \) and putting

\[
\alpha = \kappa d \quad \sigma = \frac{\kappa d \delta}{\nu} \quad \vartheta_1 = \frac{\nu}{\kappa d} \quad \vartheta_2 = \frac{d \kappa}{\mu} \quad \xi_t = \frac{f d \delta}{\nu} \quad R = \frac{\mu \beta}{\nu d}
\]

(23)

is the thermal Rayleigh number and the time constant \( \tau = \frac{\partial \mathbf{E}}{\partial t} \), where \( D = \frac{d}{\kappa d} \) while \( M \) is the non-dimensional magnetic number, Equations 12,13,14,15, and 16 under usual stability analysis Drazin and Reid (2004) and Chandrasekhar (1981) was modelled to be written.

\[
(D^2 - \alpha^2 - \alpha \vartheta - R_2 \alpha) \theta_t = -\frac{\kappa \delta}{\mu} \mathbf{W}_t
\]

(20)

\[
(D^2 - \alpha^2 - \alpha \vartheta - \vartheta_2 \vartheta - \vartheta_1 \vartheta) \mathbf{K}_t = -\frac{f d \delta}{\nu d} \mathbf{D} \mathbf{X}_t
\]

(21)
(22)

\[(D^2 - \alpha^2 - \sigma)X_i = -\left(\frac{\delta \alpha^2}{\nu}\right)DZ_i\]

\[\left(D^2 - \alpha^2 - X^2 - \sigma\right)Z_i - \left(\frac{\mu}{4\pi \varepsilon_0}H_i d\right)D X_i \times\]

\[(D^2 - \alpha^2)(D^2 - \alpha^2 - \xi^2 - \sigma)W_i + \]

\[\xi^2 (D^2 - \alpha^2)W_i\]

(23)

\[\left(\frac{H_i d^2}{\rho \nu}\right) D(D^2 - \alpha^2) \quad k_\perp = \left(\frac{\beta \alpha^2}{\nu}\right) \quad \alpha^2 \theta_i\]

(24)

for ionized components, and

\[(D^2 - \alpha^2 - \sigma)X_i = 0\]

(25)

\[(D^2 - \alpha^2) (D^2 - \alpha^2 - \pi^2 - \xi^2)W_i + \]

\[(D^2 - \alpha^2)W_i = \left(\beta \frac{\alpha^2}{\nu}\right) \alpha^2 \theta_i\]

(26)

\[\left(\frac{H_i d^2}{\rho \nu}\right) (D^2 - \alpha^2)W_i + \]

\[\frac{MD^2}{\xi^2} \quad (D^2 - \alpha^2)^2W_i\]

(27)

\[R \alpha^2 W_i = \left(D^2 - \alpha^2 - \alpha_1 \alpha\right)\left(D^2 - \alpha^2\right)\left(D^2 - \alpha^2 - \pi^2 - \xi^2\right)W_i\]

\[-MD^2\frac{\alpha^2}{\nu} + \frac{\xi^2}{\nu} \quad \alpha^2 \theta_i\]

(28)

\[R \alpha^2 W_i = \left(D^2 - \alpha^2 - \alpha_1 \alpha\right)\left(D^2 - \alpha^2\right)\left(D^2 - \alpha^2 - \pi^2 - \xi^2\right)W_i\]

\[\xi^2 (D^2 - \alpha^2)^2W_i\]

(29)

for neutral components.

If we eliminate \(\theta_i, k_\perp, X_i\) and \(Z_i\) between equations (20-23), assuming the time constant to be zero we get

\[R \alpha^2 W_i = \left(D^2 - \alpha^2 - \alpha_1 \alpha\right)\left(D^2 - \alpha^2\right)\left(D^2 - \alpha^2 - \pi^2 - \xi^2\right)W_i\]

\[-MD^2\frac{\alpha^2}{\nu} + \frac{\xi^2}{\nu} \quad \alpha^2 \theta_i\]

(30)

\[W = D^2 W = X = DZ = \theta = \xi = 0\]

and \(H_i, H_{i+1}, H_{i+2}\) are continuous.

The component of magnetic field strength depends only on moving charges and is independent of the medium also the tangential components is zero outside the fluid, we get

\[DK = 0\]

(31)

on the boundaries. With the boundary condition on equations (30) and (31) it can be shown that all the even-order derivative of \(W\) must vanish for \(Z = 0\) and \(Z = 1\).

Hence the proper solution of (28) and (29) characterised the lowest mode is

\[W = W_0 \sin \pi Z\]

(32)

where \(W_0\) is constant.

If we substitute equation (32) in to equation (28) and (29) and letting \(R_i \approx R_\infty \approx R\) for two species plasma we obtain the distribution/Dispersion relation.

\[\frac{\mu}{R} \beta \alpha^2 \left(\pi^2 + \alpha^2 + \alpha_1 \alpha\right) \left(\pi^2 + \alpha^2 + x^2 + \xi^2\right) \times\]

\[\times \left[R_\alpha^2 \left(\pi^2 + \alpha^2 + \alpha_1 \alpha\right) \left(\pi^2 + \alpha^2 + x^2 + \xi^2\right) \right] +\]

\[\left(\pi^2 + \alpha^2 + \alpha_1 \alpha\right) \pi^2 M - \xi^2 \left(\pi^2 + \alpha^2\right)\]

(33)

To evaluate the effects of radiative term wave number \(\alpha\) and coupling frequency \(\xi\), also we investigated the behaviour of the numerical solution (33) on the critical Rayleigh number dimensionless wave number at a given magnetic field as shown in the table. fig.1; table 2 fig. 2 and table 3 fig. 3.

Also evaluate the various benchmark of fig. 1, fig 2 and fig. 3 respectively.

**TABLE 1: Variation of dimensional wave number(a) with modified R at varying magnetic field M.**

<table>
<thead>
<tr>
<th>A</th>
<th>R at (M=0)</th>
<th>R at (M=25)</th>
<th>R at (M=75)</th>
<th>R at (M=100)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>X10^3</td>
<td>X10^3</td>
<td>X10^3</td>
<td>X10^3</td>
</tr>
<tr>
<td>0.20</td>
<td>4.126</td>
<td>12.127</td>
<td>29.605</td>
<td>88.223</td>
</tr>
<tr>
<td>0.30</td>
<td>1.506</td>
<td>5.477</td>
<td>12.044</td>
<td>49.236</td>
</tr>
<tr>
<td>0.40</td>
<td>1.445</td>
<td>2.354</td>
<td>4.937</td>
<td>26.128</td>
</tr>
</tbody>
</table>

21 www.ijerm.com
<table>
<thead>
<tr>
<th>B</th>
<th>R at (M=0) X10^0</th>
<th>R at(M=25) X10^0</th>
<th>R at(M=75) X10^0</th>
<th>R at(M=100) X10^0</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.20</td>
<td>3.377</td>
<td>11.45</td>
<td>28.87</td>
<td>71.26</td>
</tr>
<tr>
<td>0.30</td>
<td>0.907</td>
<td>5.148</td>
<td>11.124</td>
<td>46.838</td>
</tr>
<tr>
<td>0.40</td>
<td>1.264</td>
<td>1.707</td>
<td>3.469</td>
<td>24.291</td>
</tr>
<tr>
<td>0.50</td>
<td>1.317</td>
<td>0.909</td>
<td>4.584</td>
<td>3.652</td>
</tr>
<tr>
<td>0.60</td>
<td>1.377</td>
<td>1.661</td>
<td>1.342</td>
<td>6.832</td>
</tr>
<tr>
<td>0.70</td>
<td>1.496</td>
<td>1.578</td>
<td>0.77</td>
<td>2.423</td>
</tr>
<tr>
<td>0.80</td>
<td>1.842</td>
<td>1.685</td>
<td>1.434</td>
<td>1.963</td>
</tr>
<tr>
<td>0.90</td>
<td>0.457</td>
<td>1.521</td>
<td>-2.818</td>
<td>0.106</td>
</tr>
<tr>
<td>1.00</td>
<td>2.461</td>
<td>1.478</td>
<td>-4.873</td>
<td>1.617</td>
</tr>
</tbody>
</table>
TABLE 3: COMPARATIVE PLOT

<table>
<thead>
<tr>
<th>M</th>
<th>R at (M=0) X10⁶</th>
<th>R at (M=25) X10⁶</th>
<th>R at (M=75) X10⁶</th>
<th>R at (M=100) X10⁶</th>
<th>R at (M=0) X10⁶</th>
<th>R at (M=25) X10⁶</th>
<th>R at (M=75) X10⁶</th>
<th>R at (M=100) X10⁶</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.20</td>
<td>4.126</td>
<td>12.127</td>
<td>29.605</td>
<td>88.223</td>
<td>3.377</td>
<td>11.45</td>
<td>28.87</td>
<td>71.26</td>
</tr>
<tr>
<td>0.30</td>
<td>1.506</td>
<td>5.477</td>
<td>12.044</td>
<td>49.236</td>
<td>0.907</td>
<td>5.148</td>
<td>11.124</td>
<td>46.838</td>
</tr>
<tr>
<td>0.50</td>
<td>1.401</td>
<td>1.472</td>
<td>4.757</td>
<td>3.617</td>
<td>1.317</td>
<td>0.909</td>
<td>4.584</td>
<td>3.652</td>
</tr>
<tr>
<td>0.60</td>
<td>1.456</td>
<td>1.822</td>
<td>2.101</td>
<td>8.344</td>
<td>1.377</td>
<td>1.661</td>
<td>1.342</td>
<td>6.832</td>
</tr>
<tr>
<td>0.70</td>
<td>1.613</td>
<td>1.721</td>
<td>1.432</td>
<td>3.879</td>
<td>1.496</td>
<td>1.578</td>
<td>0.77</td>
<td>2.423</td>
</tr>
<tr>
<td>0.80</td>
<td>1.971</td>
<td>1.815</td>
<td>2.244</td>
<td>2.414</td>
<td>1.842</td>
<td>1.685</td>
<td>1.434</td>
<td>1.963</td>
</tr>
<tr>
<td>0.90</td>
<td>1.556</td>
<td>1.783</td>
<td>1.959</td>
<td>0.208</td>
<td>0.457</td>
<td>1.521</td>
<td>-2.818</td>
<td>0.106</td>
</tr>
<tr>
<td>1.00</td>
<td>2.783</td>
<td>1.881</td>
<td>1.846</td>
<td>1.811</td>
<td>2.461</td>
<td>1.478</td>
<td>-4.873</td>
<td>1.617</td>
</tr>
</tbody>
</table>
RESULT AND DISCUSSION

In the foregoing, the formulation and the numerical solution for the effect of radiative and coupling frequency of the problem of characteristics value with two dimensional evolution for the case of stable and natural convection were presented. By invoking, characteristic value were solved. To comprehend fully the effects of the dependent parameter, the flow state parameters use is made of the following in the numerical computation; on the above '{[Table 1 fig. 1(M=100, 75, 25 and 0)]; [Table 2 fig. 2 (M=100, 75, 25 and 0)]; [Table 3 fig. 3 comparative of fig. 1 and 2].

Graphs were plotted and pictorially displayed from fig.1 (M=100x10^3) Rayleigh number decrease at decline point value 39, 25, 23, 3, and 1 and incline point value 3.1 and 1 with increase in wave number assymotically to 0.8 with sharp decrease in gradient 0.9 and small increase shows unsteady respectively; (M=75x10^3) Rayleigh number at decline point value (20, 4 & 6) steady state value 6, 00, 00, 00 and incline value value 2; fig. 1 (M=25x10^3) Rayleigh number declining gradient decrease in gradient value 5 and 4, and steady state value 1 at some point 0.7 and become steady with increase in wave number were intercept at 0.8 along the wave line; fig.1(M=0x10^3) Rayleigh number decline point value 4, 1 and steady state value 1.

Also Table 2 and fig. 2 (M=100x10^3) Raleigh number decline point value (27,20,23,3,1, and 1; incline point 3,1); fig 2 (M=75 x10^3) Rayleigh number decline point 20.6 and 4, steady state space value 1, incline space value 1, increase negative -5 and -5; fig. 2 (M=25x10^3) Rayleigh number incline point value 10 and 3, steady space value 2; fig. 2 (M=0x10^3) Rayleigh number decline point 4,1; incline point space value 1; all terminate at 1.0.

Table 3 fig. 3(M=100x10^3) Rayleigh number declinepoint space value 40, 20, 25, 5, and 2; steady space 3 and incline space value 5; fig. 3(M=100x10^3) Rayleigh number decline 67, 5 and 3; steady space value 2, and incline space 2; fig. 3(M=75x10^3) Rayleigh number declinepoint value4, 2, 2 and incline space value 1; fig. 3(M= 25x10^3) Rayleigh number incline point space decline 4, 4, 2 and steady space value 2- and incline space 2; fig. 3(M=0x10^3) Rayleigh number decline space value 3, steady space value 2, 2 and 2; and increasing but negative space value -3, -5 on the double single line graphs (in all wave number increase steadily with 1x10^-3) where displayed Rayleigh number decrease, steady and incline in wave number increase with 1x10^-1 all terminate at 1.0. When a steady state set in as stationary convection \( \alpha = 0 \) the equation which expresses the modified Rayleigh number \( R \) as a function of dimensionless wave number (\( \alpha \)) may be shown analytically. But in this study, the numerical solution shows that for very small radiation parameter \( \alpha \) of order (10^-4) in the presence of magnetic field (M) unsteady State set, thus in Table 1 from the graph M=0 it shows more steady state effect than does M>0. Further more, when the coupling frequency \( \xi \) is 1.5 and 1.0 the critical value of the modified Rayleigh number (\( R_{c,\xi} \)) change substantially while the critical wave number (\( \alpha_{c,\xi} \)) is between 0.7, 0.8 and 0.8 to 0.9. Fig.1 is steady respectively as the magnetic field (M) varies. The coupling frequency therefore, has unsteady effect the thermo plasma in the photosphere. When comparing fig. 1 and 2, we observed that for \( \alpha \leq 0 \) there abouts unsteady state is notable as it is in the presence of radiation term but fig. 2 at M=75 and fig. 3 at M=0 are in similar occurrence. Table 3 and fig. 3 at M=100 shows 5 decrease point, 3 steady value, 5 incline point; fig. 3 at M=100 shows 3 decline points, 2 steady value and 2 incline value which shows that fig. 3(M=100) under fig. 1 has more interruption of particle at the down stream than fig. 3 (M=100) the results checkmate, examined the behaviour of Rayleigh number and wave number in ionized and neutral species in the photosphere medium.

NOMAACLATURE

\[ M = \text{magnetic field} \]

\[ \beta = \text{Thermal coefficient of expansion for temperature} \]

\[ \nu = \text{kinematic coefficient} \]

\[ \kappa = \text{thermal diffusivity} \]

\[ \eta = \text{electrical resistivity} \]

\[ \alpha' = \text{solute concentration} \]

\[ \delta = \text{radiation absorption coefficient} \]

\[ \mathcal{X}, \mathcal{Y}, \mathcal{Z} = \text{cartesian co-ordinate} \]

\[ g = \text{gravity}. \]
\[ u, v, w \] = velocity component.

\[ n = \text{ionized species} \]

\[ T_0 = \text{undisturbed temperature} \]

\[ f_i = \text{frequency of ionize species} \]

\[ f_{\text{ave}} = \text{average frequency} \]

\[ \alpha = \text{wave number} \]

\[ \varrho = \text{density variation} \]

\[ \alpha = \text{unit length} \]

\[ c = \text{velocity of light} \]

\[ R_{c} = \text{Modified critical Rayleigh number} \]

\[ \alpha = \text{Radiation} \]

\[ f_{\text{neu}} = \text{frequency of neutral species} \]

REFERENCES


ACKNOWLEDGEMENT

The author is so greatfull to Hon John I Pekene my brother, Mrs. Precious Doumokuma Pekene, Prof K.D Alagoa of Niger Delta University Department of physics Wilberforce Island Bayelsa state of Nigeria. My Menthors Alabrab'a M.A of RSUST Dept. of Physics Faculty of Science. RSUST Prof F.E Opara of Space Centre of Research University of Nigeria E.U Akpan of Niger Delta University Dept. of Mathematics Faculty of Science William Wilberforce Island Bayelsa State.Nigeria

About the Author Pekene D.BJ is a Lecturer in the Department of Physics, Cross River University of Technology Calabar Nigeria. He hold NCE, Physics education (University of Badan) B.Sc. Ed Physics (UNIPORT) M.Sc. Ed Physics (UNN) M.Sc. Theoretical Physics (RSUST) PH Ph.D in view (Theoretical Astrophysics), A Researcher and a Publisher. Also a Member of Physics Writer Series.