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Scalar - Vector Potential and Lagrange Function of the Moving and Fixed Charge

By F. F. Mende

Abstract- In the article is introduced the concept of scalarvector potential and on its basis is written Lagrange's function for the moving charge. This procedure of the introduction to function of Lagrange the moving charge earlier is not described. This made possible to write down Lagrangian of fixed charge, which is found in the environment of the strange fixed and moving charges.

Keywords: equation of motion, charge, lagrangian, leastaction principle, kinetic energy, potential energy, the laws of induction, scalar-vector potential.

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Scalar-Vector Potential and Lagrange Function of the Moving and Fixed Charge

F. F. Mende

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Keywords: equation of motion, charge, lagrangian, least-action principle, kinetic energy, potential energy, the laws of induction, scalar-vector potential.

I. INTRODUCTION

In the mechanic by Lagrange's function the particles understand the difference between its kinetic and potential energy

$$L=\frac{mv^2}{2}-U\,.$$

Least-action principle and Lagrange formalism can be disseminated also to the moving charge. Let us give in regard to this endurance from the well known course on theoretical physics [1]:

"Equation of motion takes the form

$$\frac{d}{dt}\frac{mv}{\sqrt{1-\frac{v^2}{c^2}}}=e\ grad\left\{\frac{(\mathbf{Av})}{c}-\varphi\right\}-\frac{e}{c}\frac{d\mathbf{A}}{dt} \qquad (23.9)$$

(in this relationship m, e, $\mathbf{v}$ - mass, charge and velocity of particle, c - the speed of light, φ, $\mathbf{A}$ - scalar and vector potential).

This equation of motion can be considered as Lagrange's equation, if Lagrange's function takes the form

$$L=-mc^2\sqrt{1-\frac{v^2}{c^2}}-e\varphi+\frac{e}{c}(\mathbf{Av}) \qquad (23.10)$$

Actually, in this case the generalized momentum

$$\mathbf{P}=\frac{\partial L}{\partial v}=\frac{mv}{\sqrt{1-\frac{v^2}{c^2}}}+\frac{e}{c}\mathbf{A}=\mathbf{p}+\frac{e}{c}\mathbf{A} \qquad (23.11)$$

Respectively generalized force

$$\mathbf{Q}=\frac{\partial L}{\partial r}=\frac{e}{c}grad(\mathbf{Av})-e\ grad\varphi$$

Lagrange's equation says:

$$\frac{d}{dt}\frac{\partial L}{\partial v}=\frac{\partial L}{\partial r}$$

or

$$\frac{d}{dt}\mathbf{P}=\mathbf{Q} \qquad (23.12)$$

Substitution $\mathbf{P}$ and $\mathbf{Q}$ in (23.12) again brings us k (23.9).

In the nonrelativistic approximation Lagrange's function takes the form

$$L\approx-mc^2\left(1-\frac{v^2}{2c^2}\right)+\frac{e}{c}(\mathbf{Av})-e\varphi=\frac{mv^2}{2}-e\varphi+\frac{e}{c}(\mathbf{Av})$$

(23.13)

In this case we lowered constant $(-mc^2)$, since into Lagrange's equation they enter only derivatives L, and most L it is determined only to the complete time derivative.

Comparing Lagrange's function particle in the electromagnetic field with the expression for Lagrange's function in the usual field of the forces

$$L=\frac{mv^2}{2}-U\,.$$

We see that during the motion in the field Lagrange's function contains still member, depending on speed and vector potential. "Therefore even in the relativistic approximation Lagrange's function in the electromagnetic field cannot be represented in the form differences in the kinetic and potential energy". (end of the quotation).

Last phrase causes bewilderment, it follows from it that the description of the properties of the charge, which moves in the electromagnetic field, cannot be described within the framework Lagrange

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formalism, and, therefore, to it cannot be applied least-action principle.

It will be shown below that this assertion is erroneous.

II. Law Of Magnetoelectric Induction In The Classical Electrodynamics

The basic task of the laws of induction consists in the explanation of the reasons for appearance in the space of induction electrical pour on, and, therefore, also the forces of those acting on the charge, at the particular point spaces. This is the primary task of the laws of induction, since. only electric fields, generated other one or method or another, exert power influences on the charge. Such fields can appear with a change in the arrangement of other charges around the given point of space. If around the point in question is some static configuration of charges, then the tension of electric field will be at the particular point determined by the relationship $\mathbf{E}=-grad\ \varphi$, where φ the scalar potential at the assigned point, determined by the assigned configuration of charges. If we change the arrangement of charges, then this new configuration will correspond other values of scalar potential, and, therefore, also other values of the tension of electric field. But, making this, it is necessary to move charges in the space, and this displacement in the required order is cmbined with their acceleration and subsequent retarding. Acceleration or retarding of charges also can lead to the appearance in the surrounding space of induction electrical pour on.

Faraday law, who for the vacuum is written as follows, is considered as the fundamental law of induction in the classical electrodynamics:

$$\oint \mathbf{E}\ d\mathbf{l}=-\frac{\partial \Phi_B}{\partial t}=-\mu\int \frac{\partial \mathbf{H}}{\partial t}\ d\mathbf{s}=-\int \frac{\partial \mathbf{B}}{\partial t}\ d\mathbf{s} \qquad (1.1)$$

where $\mathbf{B}=\mu\mathbf{H}$ - magnetic induction vector, $\Phi_B=\mu\int \mathbf{H}\ d\mathbf{s}$ - flow of magnetic induction, and μ - magnetic permeability of medium.

It follows from this law that the circulation integral of the vector of electric field is equal to a change in the flow of magnetic induction through the area, which this outline covers. It is immediately necessary to emphasize the circumstance that the law in question presents the processes of mutual induction, since. for obtaining the circulation integral of the vector $\mathbf{E}$ we take the strange magnetic field, formed by strange source. This law is integral and does not give the local connection between the magnetic and electric field. From relationship (1.1) obtain the first equation of Maxwell

$$rot\ \mathbf{E}=-\frac{\partial \mathbf{B}}{\partial t}. \qquad (1.2)$$

Let us immediately point out to the terminological error. Faraday law should be called not the law of electromagnetic, as is customary in the existing literature, but by the law of magnetoelectric induction, since. a change in the magnetic pour on it leads to the appearance of electrical pour on, but not vice versa.

Let us introduce the vector potential $\mathbf{A}_H$, which satisfies the equality $\mu\oint \mathbf{A}_H\ d\mathbf{l}\Phi=_B$, where the outline of the integration coincides with the outline of integration in relationship (1.1), and the vector $\mathbf{A}_H$ is determined in all its sections, then

$$\mathbf{E}=-\mu\frac{\partial \mathbf{A}_H}{\partial t}. \qquad (1.3)$$

Introduced thus vector $\mathbf{A}_H$ determines the local connection between it and by electric field, and also between the gradients this vector and the magnetic field. Consequently, knowing the derivatives of a vector $\mathbf{A}_H$ on the time and on the coordinates, it is possible to determine the induced electrical and magnetic fields. It is not difficult to show that introduced thus vector $\mathbf{A}_H$, is connected with the magnetic field with the following relationship:

$$rot\ \mathbf{A}_H=\mathbf{H}. \qquad (1.4)$$

Thus the vector $\mathbf{A}_H$ is more universal concept than the vector of magnetic field, since gives the possibility to define both magnetic and electric fields.

If there is a straight conductor with the current, then around it also there is a field of vector potential, the truth in this case $rot\ \mathbf{A}_H\neq 0$ in the environments of this conductor is, therefore, located also the magnetic field, which changes with a change of the current in the conductor. The section of wire by the length dl, over which flows the current I, generates in the distant zone (it is thought that the distance r considerably more than the length of section) the vector potential

$$d\mathbf{A}_H(r)=\frac{Id\mathbf{l}}{4\pi r}.$$

This relationship can be rewritten and differently:

$$d\mathbf{A}_H(r)=\frac{q\mathbf{v}}{4\pi r},$$

where q - the charge, which falls per unit of the length of the conductor, over which flows the current.

Let us note the circumstance that the vector potential in this case diminishes as $\frac{1}{r}$, and according to the same law, in accordance with relationship (1.3), diminish the induced electric fields. However, magnetic fields, since $\mathbf{H} = rot\ \mathbf{A}_H$, they diminish, as $\frac{1}{r^2}$, at large distances them can be disregarded. Thus, at large distances the law of induction continues to work; however, the induced electric fields already completely depend only on vector potential and, which is very important, they diminish no longer as $\frac{1}{r^2}$, as in the case of scalar potential, but as $\frac{1}{r}$, which is characteristic for the radiating systems.

Until now, resolution of a question about the appearance of electrical pour on in different inertial moving systems (IMS) it was possible to achieve in two ways. The first - consisted in the calculation of the Lorentz force, which acts on the moving charges, the alternate path consisted in the measurement of a change in the magnetic flux through the outline being investigated. Both methods gave identical result. This was incomprehensible. In connection with the incomprehension of physical nature of this state of affairs they began to consider that the unipolar generator is an exception to the rule of flow [2]. Let us examine this situation in more detail.

In order to answer the presented question, should be somewhat changed relationship (1.3), after replacing in it partial derivative by the complete:

$$\mathbf{E}' = -\mu \frac{d\mathbf{A}_H}{dt}. \tag{1.5}$$

Prime near the vector $\mathbf{E}$ means that this field is determined in the moving coordinate system, while the vector $\mathbf{A}_H$ it is determined in the fixed system. This means that the vector potential can have not only local, but also convection derivative, i.e., it can change both due to the change in the time and due to the motion in the three-dimensional changing field of this potential. In this case relationship (1.5) can be rewritten as follows:

$$\mathbf{E}' = -\mu \frac{\partial \mathbf{A}_H}{\partial t} - \mu(\mathbf{v}\nabla)\mathbf{A}_H,$$

where $\mathbf{v}$ - speed of the prime system.

Consequently, the extra force, which acts on the charge in the moving system, will be written down

$$\mathbf{F}'_{v,1} = -\mu e(\mathbf{v}\nabla)\mathbf{A}_H.$$

This force depends only on the gradients of vector potential and charge rate.

the charge, which moves in the field of the vector potential $\mathbf{A}_H$ with the speed $\mathbf{v}$, possesses potential energy [2]

$$W = -e\mu(\mathbf{v}\mathbf{A}_H).$$

Therefore must exist one additional force, which acts on the charge in the moving coordinate system, namely:

$$\mathbf{F}'_{V,2} = -grad\ W = e\mu\ grad(\mathbf{v}\mathbf{A}_H).$$

Thus, the value $\mu(\mathbf{v}\mathbf{A}_H)$ plays the same role, as the scalar potential φ, whose gradient also gives force. Consequently, the composite force, which acts on the charge, which moves in the field of vector potential, can have three components and will be written down as

$$\mathbf{F}' = -e\mu \frac{\partial \mathbf{A}_H}{\partial t} - e\mu(\mathbf{v}\nabla)\mathbf{A}_H + e\mu\ grad(\mathbf{v}\mathbf{A}_H). \tag{1.6}$$

The first of the components of this force acts on the fixed charge, when vector potential changes in the time and has local time derivative. Second component also determines changes of the vector potential with time, but they are connected already with the motion of charge in the three-dimensional changing field of this potential. Entirely different nature in force, which is determined by last term of relationship (1.6). It is connected with the fact that the charge, which moves in the field of vector potential, it possesses potential energy, whose gradient gives force. From relationship (1.6) follows

$$\mathbf{E}' = -\mu \frac{\partial \mathbf{A}_H}{\partial t} - \mu(\mathbf{v}\nabla)\mathbf{A}_H + \mu\ grad(\mathbf{v}\mathbf{A}_H). \tag{1.7}$$

This is a complete law of mutual induction. It defines all electric fields, which can appear at the assigned point of space, this point can be both the fixed and that moving. This united law includes and Faraday law and that part of the Lorentz force, which is connected with the motion of charge in the magnetic field, and without any exceptions gives answer to all questions, which are concerned mutual magnetoelectric induction. This law without any exceptions gives answer to all questions, which are concerned mutual magnetoelectric induction. It is significant, that, if we take rotor from both parts of equality (1.7), attempting to obtain the first equation of Maxwell, then it will be immediately lost the essential part of the information, since. rotor from the gradient is identically equal to zero.

If we IMS late those forces, which are connected with the motion of charge in the three-dimensional changing field of vector potential, and to consider that

$$\mu\ grad(\mathbf{v}\mathbf{A}_H) - \mu(\mathbf{v}\nabla)\mathbf{A}_H = \mu[\mathbf{v}\times rot\mathbf{A}_H],$$

that from (1.6) we will obtain

$$\mathbf{F}'_V = e\mu[\mathbf{v}\times rot\mathbf{A}_H]. \tag{1.8}$$

Taking into account (1.4), let us write down:

$$\mathbf{F}'_V=e\mu\left[\mathbf{v}\times\mathbf{H}\right] \qquad (1.9)$$

or

$$\mathbf{E}'_V=\mu\left[\mathbf{v}\times\mathbf{H}\right]. \qquad (1.10)$$

and it is final

$$\mathbf{F}'=e\mathbf{E}+e\mathbf{E}'_V=-e\frac{\partial \mathbf{A}_H}{\partial t}+e\mu\left[\mathbf{v}\times\mathbf{H}\right]. \qquad (1.11)$$

Can seem that relationship (1.11) presents Lorentz force; however, this not thus. In this relationship the field $\mathbf{E}$, and the field $\mathbf{E}'_V$ are induction: the first is connected with a change of the vector potential with time, the second is obliged to the motion of charge in the three-dimensional changing field of this potential. In order to obtain the total force, which acts on the charge, necessarily for the case, when system is not electrically neutral, to the right side of relationship (1.11) to add the term $-e\ grad\ \varphi$:

$$\mathbf{F}'_\Sigma=-e\ grad\ \varphi+e\mathbf{E}+e\mu\left[\mathbf{v}\times\mathbf{H}\right],$$

where φ - scalar potential, created at the observation point by the uncompensated charges.

In this case relationship (1.7) can be rewritten as follows:

$$\vec{E}'=-\mu\frac{\partial \mathbf{A}_H}{\partial t}-\mu\left(\mathbf{v}\nabla\right)\mathbf{A}_H+\mu\ grad\left(\mathbf{v}\mathbf{A}_H\right)-grad\ \varphi \qquad (1.12)$$

or, after writing down the first two members of the right side of relationship (1.12) as the derivative of vector potential on the time, and also, after introducing under the sign of gradient two last terms, we will obtain

$$\mathbf{E}'=-\mu\frac{d\mathbf{A}_H}{dt}+grad\left(\mu\left(\mathbf{v}\mathbf{A}\right)-\varphi\right). \qquad (1.13)$$

If both parts of relationship (1.13) are multiplied by the magnitude of the charge, then will come out the total force, which acts on the charge. From Lorentz force it will differ in terms of the force $-e\mu\frac{\partial \mathbf{A}_H}{\partial t}$. From relationship (1.13) it is evident that the value $\left(\mu\mathbf{v}\mathbf{A}\right)-\varphi$ plays the role of the generalized scalar potential. If we take rotor from both parts of relationship (1.13) and take into account that $rot\ grad=0$, then we will obtain:

$$rot\ \mathbf{E}'=-\mu\frac{d\mathbf{H}}{dt}.$$

If we in this relationship replace total derivative by the quotient, i.e., to consider that the fields are determined only in the assigned inertial system, then we will obtain the first equation of Maxwell. previously Lorentz force was considered as the fundamental experimental postulate, not connected with the law of induction. By calculation to obtain last term of the right side of relationship (1.11) was only in the framework of the special theory of relativity (SR), after introducing two postulates of this theory. In this case all terms of relationship (1.11) are obtained from the law of induction, using the conversions of Galileo. Moreover relationship (1.11) this is a complete law of mutual induction, if it are written down in the terms of vector potential. This is the very thing rule, which gives possibility, knowing fields in one IMS, to calculate fields in another inertial system, and there was no this rule, until now, in the classical electrodynamics.

The structure of the forces, which act on the moving charge, is easy to understand based on the example of the case, when the charge moves between two parallel planes, along which flows the current (Fig. 1).

Let us select for the coordinate axis in such a way that the axis z would be directed normal to planes, and the axis y was parallel axis. Then for the case, when the distance between the plates considerably less than their sizes (in this case on the picture this relationship not observed), the magnetic field H_x between them will be equal to the specific current I_y, which flows along the plates.

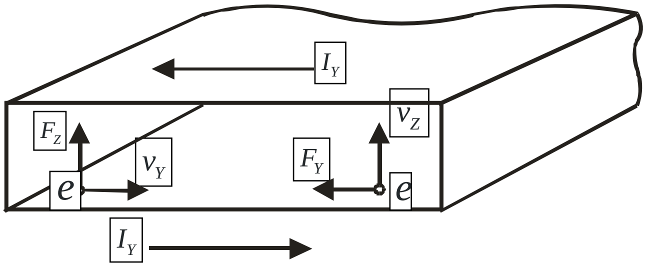

Fig. 1: Forces, which act on the charge, which moves in the field of vector potential.

If we putt hat the vector potential on the lower plate is equal to zero, then its y - the component, calculated off the lower plate, will grow according to the law $A_y=I_y z$.

If charge moves in the direction of the axis y near the lower plate with the speed v_y, then the force F_z, which acts on the charge, is determined by last term of relationship (1.6) and it is equal

$$F_z=e\mu v_y I_y. \qquad (1.14)$$

Is directed this force from the lower plate toward the upper.

If charge moves along the axis of z from the lower plate to the upper with the speed $v_z=v_y$, then for finding the force should be used already second term of the right side of relationship (1.6). This force in the absolute value is again equal to the force, determined by relationship (1.14), and is directed to the side opposite to axis. With any other directions of motion the composite force will be the vector sum of two forces, been last terms of relationship (1.6). However, the summary amount of this force will be determined by relationship (1.11), and this force will be always normal to the direction of the motion of charge. Earlier was considered the presence of this force as the action of the Lorentz force, whose nature was obscure, and it was introduced as experimental postulate. It is now understandable that it is the consequence of the combined action of two forces, different in their nature, whose physical sense is now clear. However, in this case one basic problem appears. As we already spoke, from the point of view of third Newton's law, if force acts on the charge, then it must be and resultant it force and place the application of this force must be known. The concept of the magnetic field of answer to this question does not give, since the magnetic field, and vector potential come out as the independent substance, with which occurs such an interaction.

Understanding the structure of forces gives to us the possibility to look to the already known phenomena from other side. With which is connected existence of the forces, which do extend loop with the current? In this case this circumstance can be interpreted not as the action of Lorentz force, but from an energy point of view. The current, which flows through the element of annular turn is located in the field of the vector potential, created by the remaining elements of this turn, and, therefore, it has it stored up potential energy. The force, which acts on this element, is caused by the presence of the potential gradient energy of this element and is proportional to the gradient to the scalar product of the current strength to the vector potential at the particular point. Thus, it is possible to explain the origin of ponderomotive (mechanical) forces. If current broken into the separate current threads, then they all will separately create the field of vector potential. Summary field will act on each thread individually, and, in accordance with last term of the right side of relationship (1.6), this will lead to the mutual attraction.

One should emphasize that in relationship (1.8) and (1.9) all fields have induction origin, and they are connected first with hp of the local derivative of vector potential, then hp by the motion of charge in the three-dimensional changing field of this potential. If fields in the time do not change, then in the right side of relationships (1.8) and (1.9) remain only last terms, and they explain the work of all existing electric generators with moving mechanical parts, including the work of unipolar generator. Relationship (1.7) gives the possibility to physically explain all composing tensions electric fields, which appears in the fixed and that moving the coordinate systems. In the case of unipolar generator in the formation of the force, which acts on the charge, two last addend right sides of equality (1.7) participate, introducing identical contributions. It is now clear that the idea of the law of induction in the terms of vector potential this is that „the basic principle", the absence of which is mentioned in the work [2].

The examination of the action of magnetic field to the moving charge has already been noted its intermediary role and absence of the law of the direct action between the moving charges. Introductions of vector potential also does not give answer to this question, this potential as before plays intermediary role and does not answer a question about the concrete place of application of force.

Now let us show that the relationships, obtained by the phenomenological introduction of magnetic vector potential, can be obtained and directly from the Faraday law. with conducting of experiments Faraday established that in the outline is induced the current, when in the adjacent outline direct current is switched on or is turned off or adjacent outline with the direct current moves relative to the first outline. Therefore in general form Faraday law is written as follows:

$$\oint \mathbf{E}'d\mathbf{l}'=-\frac{d\Phi_B}{dt}. \qquad (1.15)$$

This writing of law indicates that during the record of the circulation integral of the vector $\mathbf{E}$ in moving (prime) IMS near $\mathbf{E}$ and $d\mathbf{l}$ should be placed the primes, which indicate that that the flow is determined in one IMS, and field in another. But if circulation is determined in the fixed coordinate system, then primes near and be absent, but in this case to the right in expression (1.15) must stand particular time derivative.

Complete time derivative in relationship (1.15) indicates the independence of the eventual result of appearance electromotive force in the outline from the method of changing the flow. Flow can change both due to the local derivative of magnetic flux on the time and because IMS, in which is measured the circulation $\oint \mathbf{E}'d\mathbf{l}'$, it moves in the three-dimensional changing field $\mathbf{B}$. We calculate the value of magnetic flux in relationship (1.15) with the aid of the expression:

$$\Phi_B=\int \mathbf{B}d\mathbf{s}', \qquad (1.16)$$

where the magnetic induction $\mathbf{B}=\mu\mathbf{H}$ is determined in the fixed coordinate system, and the element $d\mathbf{s}'$ is determined in the moving system.

Taking into account (1.15), we obtain from (1.16)

$$\oint \mathbf{E}'d\mathbf{l}'=-\frac{d}{dt}\int \mathbf{B}d\mathbf{s}'.$$

since $\frac{d}{dt}=\frac{\partial}{\partial t}+\mathbf{v}\ \ grad$, let us write down:

$$\oint \mathbf{E}'d\mathbf{l}'=-\int \frac{\partial \mathbf{B}}{\partial t}\ d\mathbf{s}'-\oint\left[\mathbf{B}\times\mathbf{v}\right]d\mathbf{l}'-\int \mathbf{v}\ \ div\mathbf{B}\ \ d\mathbf{s}'. \quad (1.17)$$

In this case contour integral is taken on the outline $d\mathbf{l}'$, which covers the area $d\mathbf{s}'$. Let us immediately note that entire following presentation will be conducted under the assumption the validity of the conversions of Galileo, i.e., $d\mathbf{l}'=d\mathbf{l}$ and $d\mathbf{s}'=d\mathbf{s}$. Since $div\mathbf{B}=0$, from (1.17) we obtain the relationship

$$\mathbf{E}'=\mathbf{E}+\left[\mathbf{v}\times\mathbf{B}\right]. \quad (1.18)$$

From which follows that during the motion in the magnetic field the additional electric field, determined by last term of relationship appears (1.18). Let us note that this relationship is obtained not by the introduction of postulate about the Lorentz force, or from the conversions of Lorenz, but directly from the Faraday law, moreover within the framework the conversions of Galileo. Thus, Lorentz force is the direct consequence of the law of magnetoelectric induction.

From the Ampere law it is possible to obtain the relationship:

$$\mathbf{H}=rot\mathbf{A}_H .$$

Then pour on relationship (1.17) for those induced it is possible to rewrite

$$\mathbf{E}'=-\mu\frac{\partial \mathbf{A}_H}{\partial t}+\mu\left[\mathbf{v}\times rot\mathbf{A}\right],$$

and further

$$\mathbf{E}'=-\mu\frac{\partial \mathbf{A}_H}{\partial t}-\mu\left(\mathbf{v}\nabla\right)\mathbf{A}_H+\mu\ \ grad\left(\mathbf{v}\mathbf{A}_H\right). \quad (1.19)$$

Again came out relationship (1.7), but it is obtained directly from the Faraday law. The examination of the laws of induction from the point of view of magnetic vector potential and its complete record is for the first time demonstrated in the works [3-7]. True, and this way thus far not shedding light on physical nature of the origin of Lorentz force, since the true physical causes for appearance and magnetic field and vector potential to us nevertheless are not thus far clear.

III. Law Of Electromagnetic Induction In The Classical Electrodynamics

Faraday law shows, how a change in the magnetic pour on it leads to the appearance of electrical pour on. However, does arise the question about that, it does bring a change in the electrical pour on to the appearance of any others pour on and, in particular, magnetic? Maxwell gave answer to this question, after introducing bias current into its second equation. In the case of the absence of conduction currents the second equation of Maxwell appears as follows:

$$rot\mathbf{H}=\varepsilon\frac{\partial \mathbf{E}}{\partial t}=\frac{\partial \mathbf{D}}{\partial t},$$

where $\mathbf{D}=\varepsilon\mathbf{E}$ - electrical induction.

From this relationship it is not difficult to switch over to the expression

$$\oint \mathbf{H}d\mathbf{l}=\frac{\partial \Phi_E}{\partial t}, \quad (2.1)$$

where $\Phi_E=\int \mathbf{D}d\mathbf{s}$ the flow of electrical induction.

However for the complete description of the processes of the mutual electrical induction of relationship (1.1) is insufficient. As in the case Faraday law, should be considered the circumstance that the flow of electrical induction can change not only due to the local derivative of electric field on the time, but also because the outline, along which is produced the integration, it can move in the three-dimensional changing electric field. This means that in relationship (1.1), as in the case Faraday law, should be replaced the partial derivative by the complete. Designating by the primes of field and circuit elements in moving IMS, we will obtain:

$$\oint \mathbf{H}'d\mathbf{l}'=\frac{d\Phi_E}{dt},$$

and further

$$\oint \mathbf{H}'d\mathbf{l}'=\int \frac{\partial \mathbf{D}}{\partial t}\ d\mathbf{s}'+\oint\left[\mathbf{D}\times\mathbf{v}\right]\ d\mathbf{l}'+\int \mathbf{v}\ \ div\mathbf{D}\ \ d\mathbf{s}' \quad (2.2)$$

For the electrically neutral medium $div\mathbf{E}=0$; therefore the last member of right side in this expression will be absent. For this case relationship (2.2) will take the form:

$$\oint \mathbf{H}'d\mathbf{l}'=\int \frac{\partial \mathbf{D}}{\partial t}\ d\mathbf{s}' + \oint\left[\mathbf{D}\times\mathbf{v}\right]d\mathbf{l}' \quad (2.3)$$

If we in this relationship pass from the contour integration to the integration for the surface, then we will obtain:

$$rot\ \ \mathbf{H}'=\frac{\partial \mathbf{D}}{\partial t}+rot\left[\mathbf{D}\times\mathbf{v}\right] \quad (2.4)$$

If we, based on this relationship, write down fields in this inertial system, then prime near $\mathbf{H}$ and second member of right side will disappear, and we will obtain the bias current, introduced by Maxwell. But Maxwell introduced this parameter, without resorting to to the law of electromagnetic induction (2.2). If his law of magnetoelectric induction Faraday derived on the basis experiments with the magnetic fields, then experiments on the establishment of the validity of relationship (2.2) cannot be at that time conducted was, since. for conducting this experiment sensitivity of existing at that time meters did not be sufficient.

Pour on from (2.3) we obtain for the case of constant electrical:

$$\mathbf{H}'_V=-\varepsilon\left[\mathbf{v}\times\mathbf{E}\right]. \qquad (2.5)$$

For the vortex electrical pour on it is possible to express the electric field through the rotor of electrical vector potential, after assuming

$$\mathbf{E}=rot\mathbf{A}_E. \qquad (2.6)$$

But the introduction of this relationship is, in fact, the acknowledgement of existence of magnetic currents. Controversy about the presence of such currents and about the possibility of existence of magnetic monopoles in the scientific literature has long ago been conducted. There is no unity of opinion on this question as yet. But the presence of magnetic currents is very easy to understand based on this example. Let us assume that at our disposal there is a long rod, made from magnetic material. If we to one end of the rod place solenoid and to introduce into it current, then the end of the rod will be magnetized. But the magnetization, which arose at the end of the rod, immediately not to appear at its other end. The wave of magnetization will be extended along the rod some by the speed, which depends on the kinetic properties of the very process of magnetization. Thus, magnetic bar itself, in this case, similar to the conductor of electric current, it is the conductor of the magnetic flux, which, as conduction current, can be extended with the final speed.

Relationship (2.4) taking into account (2.6) will be written down:

$$\mathbf{H}'=\varepsilon\frac{\partial\mathbf{A}_E}{\partial t}-\varepsilon\left[\mathbf{v}\times rot\mathbf{A}_E\right].$$

Further it is possible to repeat all those procedures, which has already been conducted with the magnetic vector potential, and to write down the following relationships:

$$\mathbf{H}'=\varepsilon\frac{\partial\mathbf{A}_E}{\partial t}+\varepsilon(\mathbf{v}\nabla)\mathbf{A}_E-\varepsilon\ grad(\mathbf{v}\mathbf{A}_E),$$

$$\mathbf{H}'=\varepsilon\frac{\partial\mathbf{A}_E}{\partial t}-\varepsilon\left[\mathbf{v}\times rot\mathbf{A}_E\right],$$

$$\mathbf{H}'=\varepsilon\frac{d\mathbf{A}_E}{dt}-\varepsilon\ grad(\mathbf{v}\mathbf{A}_E).$$

Is certain, the study of this problem it would be possible, as in the case the law of magnetoelectric induction, to begin from the introduction of the vector $\mathbf{A}_E$, but this way is specially passed traditionally, beginning from the integral law in order to show the identity of processes for two different laws, and the logical sequence of the introduction of the electrical vector of potentials.

IV. Dynamic Potentials And The Field Of The Moving Charges

The path that has been demonstrated in the previous two sections concerning the introduction of complete derivative fields has been traversed in large part by Hertz. True, Hertz did not introduce the concept of vector potentials, and operated only on fields, but this does not detract from his merit. Hertz was mistaken only in that he considered electric and magnetic fields as velocity invariants.

Being located in assigned IMS, us interest those fields, which are created in it by the fixed and moving charges, and also by the electromagnetic waves, which are generated by the fixed and moving sources of such waves. The fields, which are created in this IMS by moving charges and moving sources of electromagnetic waves, we will call dynamic. Can serve as an example of dynamic field the magnetic field, which appears around the moving charges.

As already mentioned, in the classical electrodynamics be absent the rule of the conversion of electrical and magnetic pour on upon transfer of one inertial system to another. This deficiency removes SR, basis of which are the covariant conversions of Lorenz.

In this division will made attempt find the precisely physically substantiated ways of obtaining the conversions pour on upon transfer of one IMS to another, and to also explain what dynamic potentials and fields can generate the moving charges. The first step, demonstrated in the works [2-7], was made in this direction a way of the introduction of the symmetrical laws of magnetoelectric and electromagnetic induction. These laws, in the previous chapters are as shown written as follows:

$$\begin{aligned}\oint\mathbf{E}d\mathbf{l}'&=-\int\frac{\partial\mathbf{B}}{\partial t}d\mathbf{s}'+\oint\left[\mathbf{v}\times\mathbf{B}\right]d\mathbf{l}'\\ \oint\mathbf{H}'d\mathbf{l}'&=\int\frac{\partial\mathbf{D}}{\partial t}d\mathbf{s}'-\oint\left[\mathbf{v}\times\mathbf{D}\right]d\mathbf{l}'\end{aligned}, \qquad (3.1)$$

or

$$rot\mathbf{E}'=-\frac{\partial\mathbf{B}}{\partial t}+rot\left[\mathbf{v}\times\mathbf{B}\right]$$

$$rot\mathbf{H}' = \frac{\partial \mathbf{D}}{dt} - rot\left[\mathbf{v}\times\mathbf{D}\right] \quad . \qquad (3.2)$$

For the constants pour on these relationships they take the form:

$$\begin{aligned} \mathbf{E}' &= \left[\mathbf{v}\times\mathbf{B}\right] \\ \mathbf{H}' &= -\left[\mathbf{v}\times\mathbf{D}\right] \end{aligned} \quad . \qquad (3.3)$$

In relationships (3.1-3.3), which assume the validity of the conversions of Galileo, prime and not prime values present fields and elements in moving and fixed IMS respectively. It must be noted, that conversions (3.3) earlier could be obtained only from the conversions of Lorenz.

Of relationships (3.1-3.3), which present the laws of induction, do not give information about how arose fields in initial fixed IMS. They describe only laws governing the propagation and conversion pour on in the case of motion with respect to the already existing fields.

Of relationship (3.3) attest to the fact that in the case of relative motion of frame of references, between the fields $\mathbf{E}$ and $\mathbf{H}$ there is a cross coupling, i.e., motion in the fields $\mathbf{H}$ leads to the appearance pour on $\mathbf{E}$ and vice versa. From these relationships escape the additional consequences, which were for the first time examined in the work [4]. Электрическое поле $E = \frac{g}{2\pi\varepsilon r}$ за пределами заряженного длинного стержня, на единицу длины которого приходится заряд g, убывает по закону $\frac{1}{r}$, где r - расстояние от центральной оси стержня до точки наблюдения.

If we in parallel to the axis of rod in the field E begin to move with the speed Δv another IMS, then in it will appear the additional magnetic field $\Delta H = \varepsilon E \Delta v$. If we now with respect to already moving IMS begin to move third frame of reference with the speed Δv, then already due to the motion in the field ΔH will appear additive to the electric field $\Delta E = \mu\varepsilon E\left(\Delta v\right)^2$. This process can be continued and further, as a result of which can be obtained the number, which gives the value of the electric field $E'_v(r)$ in moving IMS with reaching of the speed of $v = n\Delta v$, when $\Delta v \to 0$, and $n \to \infty$. In the final analysis in moving IMS the value of dynamic electric field will prove to be more than in the initial and to be determined by the relationship:

$$E'(r, v_\perp) = \frac{g ch\frac{v_\perp}{c}}{2\pi\varepsilon r} = E ch\frac{v_\perp}{c} \ .$$

If speech goes about the electric field of the single charge e, then its electric field will be determined by the relationship:

$$E'(r, v_\perp) = \frac{e ch\frac{v_\perp}{c}}{4\pi\varepsilon r^2} \quad ,$$

where $v_\perp$ - normal component of charge rate to the vector, which connects the moving charge and observation point.

Expression for the scalar potential, created by the moving charge, for this case will be written down as follows [4-7]:

$$\varphi'(r, v_\perp) = \frac{e ch\frac{v_\perp}{c}}{4\pi\varepsilon r} = \varphi(r) ch\frac{v_\perp}{c} \ , \qquad (3.4)$$

where $\varphi(r)$ - scalar potential of fixed charge.

The potential o $\varphi'(r, v_\perp)$ can be named scalar-vector, since it depends not only on the absolute value of charge, but also on speed and direction of its motion with respect to the observation point. Maximum value this potential has in the direction normal to the motion of charge itself. Moreover, if charge rate changes, which is connected with its acceleration, then can be calculated the electric fields, induced by the accelerated charge.

V. On The Structure Of Lagrange's Function For The Fixed And Moving Charge

Now we can pass to the study of the problem about Lagrange's function from the point of view of scalar- vector potential.

It is accepted to write as follows Lagrange's function for the nonrelativistic charge [1]:

$$L = \frac{mv^2}{2} - e\left(\varphi(1) + \mathbf{v}\mathbf{A}\right)$$

where m and e - the mass of charge and its value, $\mathbf{v}$ - charge rate, $\varphi(1)$ - scalar potential field, in which move the charge, $\mathbf{A}$ - the vector potential of magnetic field, in which moves the charge.

In turn, scalar potential $\varphi(1)$ at the assigned point is determined by its all surrounding charges and is determined by the relationship:

$$\varphi(1) = \sum_j \frac{1}{4\pi\varepsilon} \frac{e_j}{r_{1j}}$$

It is not difficult to see that value $\left(\varphi(1) + \mathbf{v}\mathbf{A}\right)$ plays the role of the generalized scalar potential with respect to the moving charge. This determination of this parameter follows also from the relationship (1.13). Thus, assertion about the fact that Lagrange's function in the electromagnetic field cannot be presented in the form to a difference in the kinetic and potential energy, expressed in the work [1], erroneously.

Is in this work demonstrated new approach to the concept of the scalar potential, which creates the moving charge and it is shown that this potential without taking into account delay depends on speed as follows:

$$\varphi'(r,v_\perp)=\varphi(r)ch\frac{v_\perp}{c},$$

If some quantity of moving and fixed charges surrounds this point of space, then for finding the scalar potential in the given one to point it is necessary to produce the summing up of their potentials:

$$\varphi'(1)=\sum_j \varphi(r_j)ch\frac{v_{j\perp}}{c}=\sum_j \frac{1}{4\pi\varepsilon}\frac{e_j}{r_j}ch\frac{v_{j\perp}}{c}.$$

Earlier it was shown that this determination of the scalar potential of the moving charge excludes the need of using the concept vector potential.

Taking into account this circumstance Lagrangian of the charge e, which is found in the environment of the fixed and moving strange charges can be written down as follows:

$$L=-e\sum_j \frac{1}{4\pi\varepsilon}\frac{e_j}{r_j}ch\frac{v_{j\perp}}{c}. \qquad (4.1)$$

If the charge is moving relative to the selected IMS speed then its Lagrangian is determined by the ratio (4.1), except that as speeds are relative velocities of charges in relation to the charge and adds a member that defines the kinetic energy of the charge.

$$L=\frac{mv^2}{2}-e\sum_j \frac{1}{4\pi\varepsilon}\frac{e_j}{r_j}ch\frac{v_{j\perp}}{c}.$$

This relationship gives the fundamentally new treatment of Lagrange function and indicates that it can be recorded on the basis of the knowledge of the scalar-vector potential of the charges, which surround the assigned charge.

VI. CONCLUSION

In the article is introduced the concept of scalar-vector potential and on its basis is written Lagrange's function for the moving charge. This procedure of the introduction to function of Lagrange the moving charge earlier is not described. This made possible to write down Lagrangian of fixed charge, which is found in the environment of the strange fixed and moving charges.

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Remote Sensing of Mid/Upper Atmosphere using ELF/VLF Waves

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Abstract- Radio signals from lightning discharges such as tweeks, whistlers and emissions can be used in the study of radio wave propagations and ultimately the ionospheric/ magnetospheric conditions. In the present paper, we have used tweeks (extremely low-frequency waves) and whistlers (very low-frequency waves) as a diagnostic tool for remote sensing the mid/upper atmosphere. These ELF/VLF waves have been recorded by automatic whistler detector setup installed at our low latitude ground station, Lucknow (geomagnetic latttude = 17.6^0N, geomagnetic longitude = 154.5^0E, Mc Ilwain parameter, L = 1.10), India. Tweeks have been used to estimate the nighttime D-region electron density at the ionospheric reflection height while whistlers have provided information about magnetospheric medium parameters such as dispersion, electron density, total electron content in a flux tube and the propagation path of radio signal generated during lightning discharges. During our analysis, we obtained the existence duration of tweeks to be in the range of 10 - 55 ms, the D-region electron density were estimated from 22.51 - 132.46 cm-^{3} for cut-off frequencies at higher harmonics and ionospheric reflection height varied from 80 - 94.4 km.

Keywords: lightning discharges; tweeks; whistlers; ionosphere; magnetosphere; electron density; hybrid mode of propagation; dispersion.

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Strictly as per the compliance and regulations of:

Remote Sensing of Mid/Upper Atmosphere using ELF/VLF Waves

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Abstract- Radio signals from lightning discharges such as tweeks, whistlers and emissions can be used in the study of radio wave propagations and ultimately the ionospheric/ magnetospheric conditions. In the present paper, we have used tweeks (extremely low-frequency waves) and whistlers (very low-frequency waves) as a diagnostic tool for remote sensing the mid/upper atmosphere. These ELF/VLF waves have been recorded by automatic whistler detector setup installed at our low latitude ground station, Lucknow (geomagnetic latttude = 17.6^{0}N, geomagnetic longitude = 154.5^{0}E, Mc Ilwain parameter, L = 1.10), India. Tweeks have been used to estimate the nighttime D-region electron density at the ionospheric reflection height while whistlers have provided information about magnetospheric medium parameters such as dispersion, electron density, total electron content in a flux tube and the propagation path of radio signal generated during lightning discharges. During our analysis, we obtained the existence duration of tweeks to be in the range of 10 - 55 ms, the D-region electron density were estimated from 22.51 - 132.46 cm^{-3} for cut-off frequencies at higher harmonics and ionospheric reflection height varied from 80 - 94.4 km. We have interpreted the relevance of cut-off frequency and relative amplitude of tweeks observed during lightning discharges and found an irregular pattern in the amplitude. Dispersion analysis on the observed whistlers was applied and we estimated the magnetospheric electron density in the equatorial region that varied between 1572 and 210 electrons/cm^3 as L varied from L = 1.7 to L = 3.0. The minimum and maximum values of total electron content for observed whistlers are obtained about 4.00x10^{12} and 9.11x10^{12} electrons/cm^2-tube. The obtained results have their importance in the comparative interpretation of other low latitude results and also in remote sensing the mid-latitude (magnetosphere) as the recorded whistlers have traveled at higher latitudes.

Keywords: lightning discharges; tweeks; whistlers; ionosphere; magnetosphere; electron density; hybrid mode of propagation; dispersion.

I. INTRODUCTION

Grounds monitoring of extremely low frequency (ELF) / very low frequency (VLF) waves in satellite age have still its role because of the continuity and suitability in many respects. Ground observations of ELF/VLF waves are carried out with very simple and low-cost equipment and are very successful in the monitoring of mid/upper atmosphere. Till date monitoring of D-region atmosphere is being carried out by ELF/VLF waves because of the limitation of balloon experiments at higher height, and incapability of the satellite accessibility at lower region (Singh et al., 2014; 2016). For in-situ measurements of the lower ionosphere rockets have been used (Friedrich and Torkar, 2001; Nagano and Okada, 2000) but limitation with the rocket technique is that it can be launched only for specific time and might not be able for continuous monitoring. Some other ground-based active experiments like ionosondes and incoherent scatter radars in the HF-VHF range are used for lower atmosphere monitoring but these methods are not so successful in this region because they are unable to receive ionospheric echoes due to low electron densities (< 10^3 el./cm^3) especially in the nighttime (Hargreaves, 1992). MF radar has been utilized (Igarashi et al., 2000) at some locations but this method requires very high costs in comparison to ELF/VLF active radio measurements. Actually, at these frequencies, a major portion of electromagnetic energy radiated during the return strokes of lightning discharges propagates approximately the speed of light in the Earth-Ionosphere Waveguide (EIWG) at large distances by the process of multiple reflections. The return strokes of lightning discharges generate electromagnetic waves in a wide frequency range with peak spectral power at around 5 kHz (Prasad and Singh, 1982).

Earlier workers considered the tweek studies based on propagation characteristics only (Outsu, 1960; Yedemsky et al., 1992; Hayakawa et al., 1995; Sukhorukov and Stubbe, 1997; Kumar et al., 2008). Tweeks were used to study the land and the sea parameters (Prasad, 1981) while the polarization properties that revealed tweek tail is left-handed circular polarization that connect the vertical component of the geomagnetic field with it (Yedemsky et al., 1992; Hayakawa et al., 1995). But in the recent past the main focus of tweek studies have been in D – region investigations (Maurya et al., 2012; Shvets et al., 2014; Singh et al., 2016). Storey (1953) explained the details of whistler spectra regarding the magneto-ionic theory and predicted that the path of whistler propagation was more or less aligned with the Earth's magnetic field and extended between the hemispheres. Various researchers have studied the propagation characteristics of whistlers and have used whistler as potential tool for investigating ionosphere/ magnetosphere (Helliwell, 1965; Carpenter, 1966; Sazhin et al., 1992; Singh, 1995; Singh et al., 1998a,

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1998b, 1999; Carpenter, 2007; Singh, 2008; Lichtenberger, 2009; Singh et al., 2014). The propagation modes of whistlers are classified into ducted mode propagating along field-aligned irregularities of enhanced ionization (Cerisier, 1974; Singh and Singh, 1999) and non-ducted with greater wave normal angles to geomagnetic field lines (Aikyo et al., 1972). Ion cyclotron whistlers, only detectable in space, also provide some information on the ion composition (Gurnett et al., 1965; Singh et al., 1998c; Singh et al., 2003).

In this paper, we have considered both ELF/VLF phenomena (tweeks and whistlers) as remote sensing tool to explore mid/upper atmosphere. At lower latitude the D-region ionosphere extends within 60-100km and that depends on the variation in the solar zenith angle, solar flux, season and latitude as well (Friedrich and Rapp, 2009) while the collisions between charged particles and neutrals dominate and this region remains the least studied region of the ionosphere.

The reflection property of the ELF/VLF waves from the D-region are also used in the study of D-region through the VLF transmitters (Bainbridge and Inan, 2003; Thomson et al., 2007; Thomson and McRae, 2009) but the disadvantage of this technique is limited to only spatial coverage along the propagation path. As the wave velocity is a function of electron density, the dispersion analysis of whistlers are widely being used in obtaining the information about the ambient medium, electron acceleration and precipitation from radiation belts (Summers and Ma, 2000; Horne et al., 2005). Similarly, the non-linear wave-wave interactions with the Alfvén waves are used as a valuable tool in the characteristic study of the structure of the ionized terrestrial environment (Park et al., 1978; Sharma et al., 2010).

In this paper, we have attempted an empirical study of ELF/VLF waves and emphasized that these waves can serve as a diagnostic tool for remote sensing of the mid/upper atmosphere. The paper has been organized in a few sections. Introductory remarks have been provided in section 1. The details of experimental arrangements and the data analysis are presented in section 2 while section 3 has dealt with the discussion of results obtained, and finally, the conclusions are presented in section 4.

II. EXPERIMENTAL DATA AND METHOD OF ANALYSIS

The broadband ELF/VLF data analyzed in the present study have been recorded by the Automatic Whistler Detector (AWD) system installed at Physics Department, University of Lucknow, Lucknow (Geomagnetic latitude = 17.6^{0}N, Geomagnetic longitude = 154.5^{0}E, L = 1.10), India. ELF/VLF wave field as a function of time and frequency was continuously monitored and recorded by AWD setup. The detailed description of the AWD system operation and algorithm development can be found in Lichtenberger et al. (2008). This system has been especially devoted to the observation of ELF/VLF waves. The AWD system can record data in the synoptic mode with 1 min at every 15 min interval. Large numbers of tweeks and whistlers are recorded at our station (Lucknow) during the continuous observations. The data have been analyzed using a MATLAB code which produces dynamic spectrograms for the selected duration showing tweeks and whistlers.

Dynamic spectrograms of some higher harmonic tweeks recorded at our station (Lucknow) have been shown in Figure 1. The first order cut-off mode frequency *(fc)* of tweeks have been measured from the spectrograms and which is further used for the calculation of the ionospheric reflection height (h) and the D-region electron density *(ne)*. For the present study, we have selected tweeks recorded in July 2012 during night hours of local time (LT) [= UT (Universal time) + 5:30 hrs]. Mode numbers of tweeks have been labeled on every spectrogram. Spectrograms shown in figure 1 have also showed a horizontal line near 18.2 kHz frequency which is the VTX transmitter signal operated by India at Katabomman (latitude 8.47^{0}N, longitude 77.40^0 E). We have adopted electron gyrofrequency f_H = 1.1±0.2 MHz according to the International Geomagnetic Reference Field (IGRF) model because the tweeks are observed at lower latitudes. For the calculation of electron density n_e, we have used the expression obtained by Shvets and Hayakawa (1998):

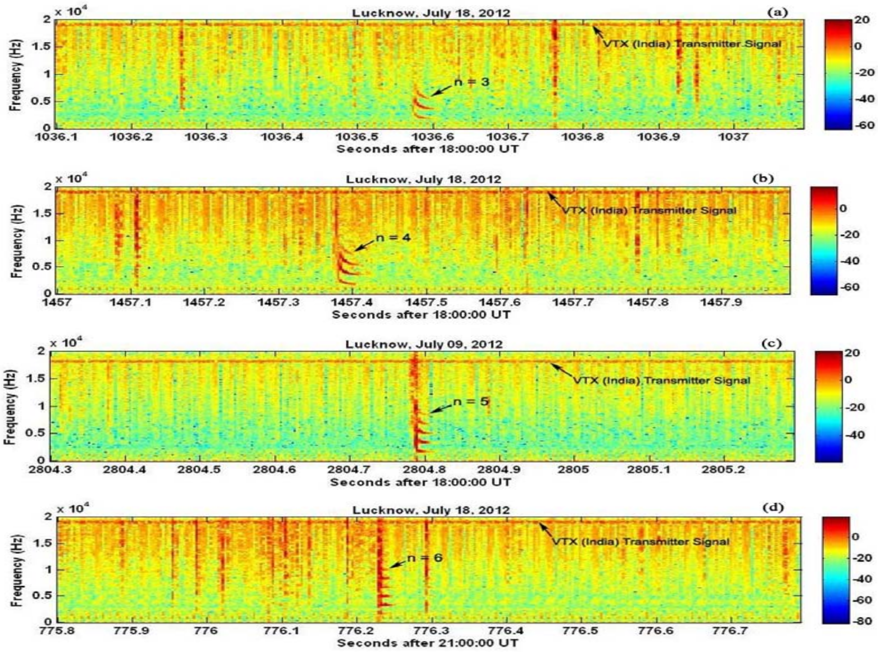

Figure 1: Dynamic spectra of some higher harmonic tweeks recorded in July 2012. The color scale shows the intensity variation of tweeks.

$$n_e = 1.39 \times 10^{-2} f_{cn} \ \ \text{cm}^{-3} \qquad (1)$$

where f_{cn} is the cut-off frequency of n^{th} mode. Here each mode is defined by its cut-off frequency that for the n^{th} mode is given by

$$f_{cn} = \frac{nc}{2h} \qquad (2)$$

where c is the velocity of light in the free space, h is the tweek reflection height and n is the mode number (Budden, 1961).

For magnetospheric studies, we have analyzed the data mainly for whistlers. The whistler occurrence rate at lower latitude stations is low and very sporadic (Singh et al. 1998b, 1999, 2014), but once it starts, the occurrence rate becomes comparable to that of mid-latitude stations (Singh et al. 2014). We have observed whistlers at Lucknow (L = 1.10) on 24/25 March 2015 during 00:20:00 – 01:01:00 hour LT (Local Time) for the first time. We have noticed 16 whistlers of good quality with sharp dynamic spectra observed on March 24/25, 2015 during nighttime. Based on visual inspection of every dynamic spectrogram, we can infer that the intensity of the spectra slightly varied from event to event, but no general pattern has been obtained.

The recorded data files (wav_files) have analyzed with the help of MATLAB programs. The ELF/VLF raw data was translated to the frequency-time spectrogram using Fast Fourier Transform (FFT) codes (awd_wav_browse_win). The occurrence pattern of whistlers seen from the spectrograms at this stage was identified and further run these wav-files in another MATLAB code (ftpairs512) which produces dynamic spectrogram of whistler. Using diffusive equilibrium (DE-1) model in MATLAB program, we have calculated various magnetospheric parameters like the dispersion of whistlers, path of the propagation (L-value), equatorial electron density and total electron content in a flux tube, etc. The analysis of whistlers from a ground-based station has been regarded as inexpensive and efficient tool for upper atmospheric diagnostics (Sazhin et al., 1992; Singh et al., 1998a; Carpenter, 2007).

III. Results And Discussion

The whistler mode waves (natural magnetospheric radio emissions) have been extensively studied for wave diagnostics. Of the multitude of ground observations of ELF/VLF waves in the literature comparatively a few studies present quantitative treatment of remote sensing observations/ measurements. In this paper, we have used tweeks for ionospheric probing and whistlers for magnetospheric probing. A total of 555 visible tweeks have been observed in July 2012 during night hours while not a single tweek has been reported during day hours may be due to strong attenuation in the earth-ionosphere waveguide during the daytime. The local nighttime was divided into two portions: pre-midnight (18:00 – 00:00 LT) and post-midnight (00:00 – 6:00 LT). The number of tweeks has been counted mode wise (harmonic). The overall occurrence of tweeks increased as the night advances, and the maximum has been obtained during the post-midnight period. Although it is the lightning activity that determines the occurrence pattern of tweeks at any observation site but the conditions at lower ionospheric height during different seasons may also have some contribution towards the occurrence of tweeks and their higher modes. Figure 2 has depicted the pattern of tweeks considered in the present study and has revealed that tweek occurrence was maximum in post-midnight hours as compared to pre-midnight and further it might be associated with attenuation.

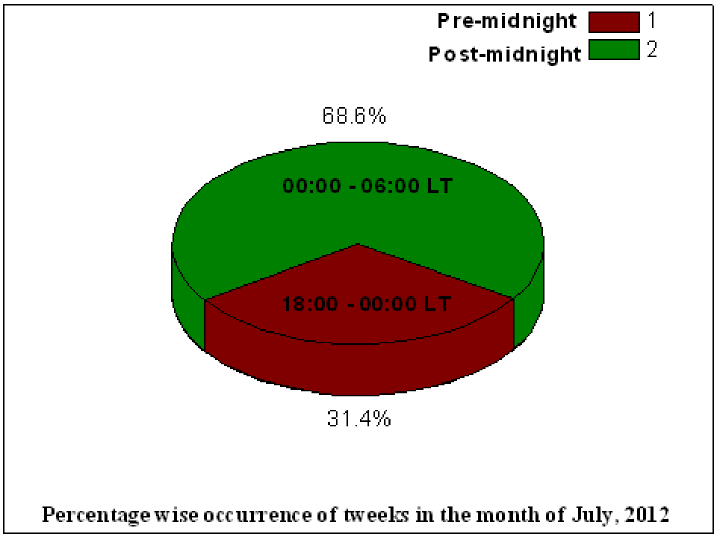

Figure 2: Piechart of percentage wise occurrence of tweek atmospherics during pre/post-midnight time sectors.

The D-region atmosphere is better reflector during the night hours than during the daytime, and this characteristic makes ELF/VLF waves a potential diagnostic tool to estimate the nighttime electron densities (n_e) at ionospheric reflection heights (h). These reflections occur because the electron density in the lower ionosphere increases rapidly and higher harmonics have been reflected from the higher altitudes. Danilov (1975) studied the chemistry and complicated cycle of ionization-recombination of the D-region atmosphere. Scattered Lyman α is well known source of the nighttime D-region ionization at the low/mid-latitudes while geocoronal Lyman α, Lyman β, and galactic cosmic rays are some other sources of the nighttime D-region ionization (Strobel et al., 1974). During our analysis the D-region electron density estimated from cut-off frequencies of the first-order mode ranged from 22.5 - 26.06cm^{-3} for the ionospheric reflection heights of 80.0 - 92.5 km while the electron density estimated for 6th harmonic varied from 22.51 - 132.46cm^{-3} over the ionospheric reflection height of 92.5 - 94.4 km in the altitude range of 1.9 km. The electron density for the second mode was almost double to that obtained from the first mode and so on for higher harmonics of tweeks. Figure 3 has shown the variation profile of nighttime electron density estimated using tweek analysis. The electron density has decreased during evening hours with the sunset, almost stabilized during post-midnight hours and again started increasing during morning hours with the sunrise. The obtained features were inconsistent with the variation of ionosphere during quiet geomagnetic conditions. We have also estimated the mean electron density (nem) with mode numbers that varied from 24.82-136.82cm^{-3} and have showed in Figure 4. We have calculated the mean reflection height which has increased with mode number showing that higher mode of same tweek has penetrated deeper into the D-region atmosphere. The relative amplitude of tweeks (shown in Figure 1) for different harmonics (n = 3 - 6) are calculated, and the variation of the same has been depicted in Figure 5. But we have not found any regular pattern in relative amplitude might be due to the return strokes of pulses suffer from successive reflections from the ionosphere. Table 1 has listed the details of parameters obtained from tweek analysis.

Table 1: Various remote sensing parameters observed from tweek analysis

Spectrogram	Date	Time of occurrence	Mode (n)	Electron Density (el/cm^3) (n_e)	Ionospheric Reflection Height (km) (h)
a	18 July 2012	23:30:1036.1hrs LT	1	23.76	87.7
			2	46.56	89.5
			3	68.38	91.4
b	18 July 2012	23:30:1457hrs LT	1	23.35	89.2
			2	45.73	91.1
			3	67.55	92.5
			4	89.09	93.6
c	09 July 2012	23:30:2804.3hrs LT	1	23.35	89.2
			2	46.28	90.0
			3	68.24	91.6
			4	90.51	92.1
			5	112.03	93.0
d	18 July 2012	02:30:775.8hrs LT	1	22.51	92.5
			2	44.61	93.4
			3	66.72	93.7
			4	88.68	94.0
			5	110.50	94.3
			6	132.46	94.4

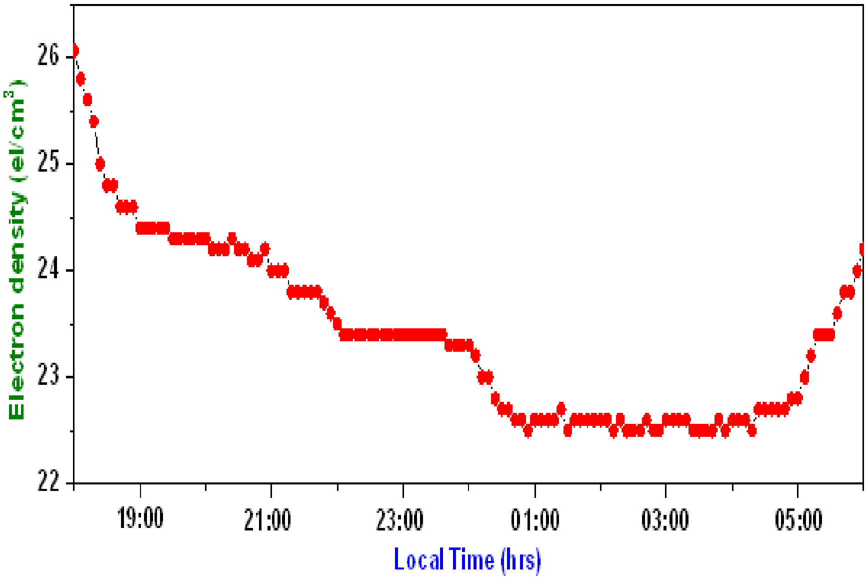

Figure 3: Temporal variation in the nighttime electron density of tweeks considered for the study.

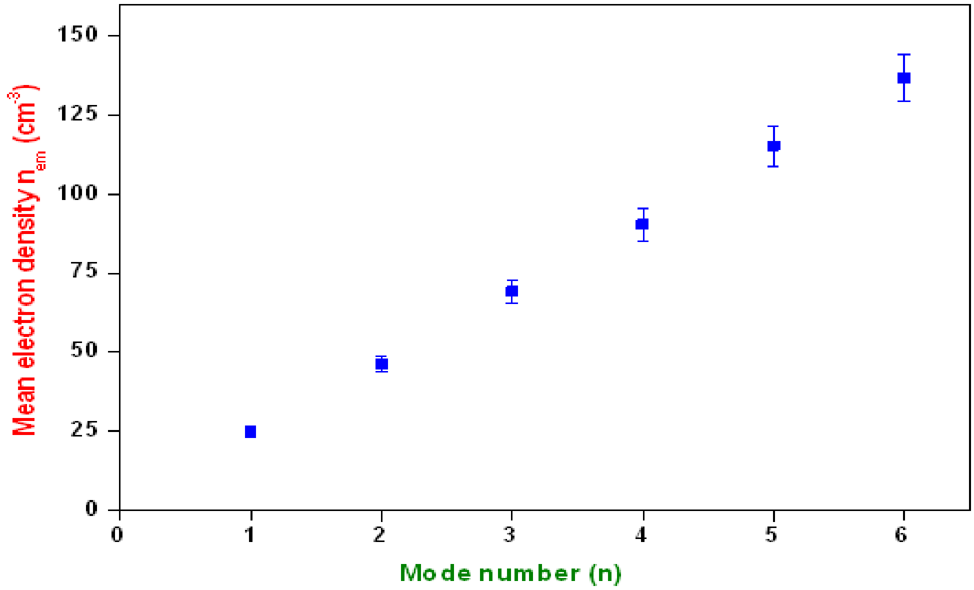

Figure 4: Variation of mean electron density (blue squares with error bar) with mode numbers of observed tweeks.

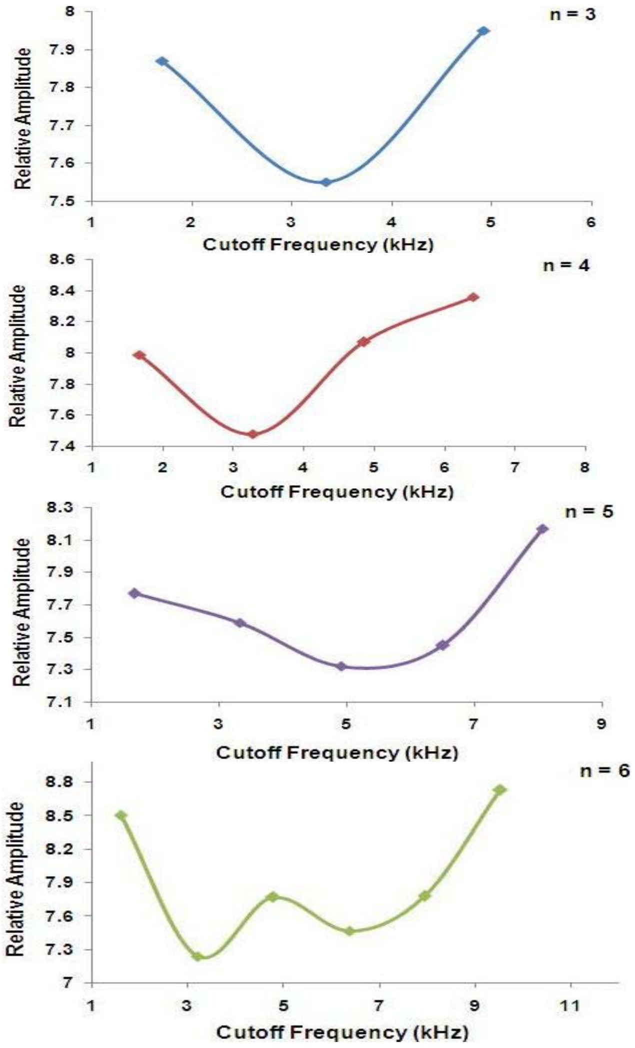

Figure 5: Variation of the relative amplitude of tweeks for different modes (3-6).

The second part of our analysis was devoted to whistler waves. Some good quality whistlers have been recorded on March 24/25, 2015 during the geomagnetically moderate period having maximum Kp index = 4 and Dst index < - 21nT. Figure 6 has represented the geomagnetic conditions during March 23-25, 2015. During the analysis, we found that the lowest frequency component of observed whistlers was well above the cut-off frequency of first-order mode of causative sferic (tweek) shown by its arrival time t_0. The causative sferics of whistlers have located by the intercept t_0 and was obtained by plotting time t versus $f^{-1/2}$ of the whistler frequencies and extrapolating the line to meet the time axis. The method of determination of causative sferic by the time t_0 for the whistlers observed is depicted in Figure 7 while Figure 8 has provided the spectra of some good quality whistlers recorded and analyzed.

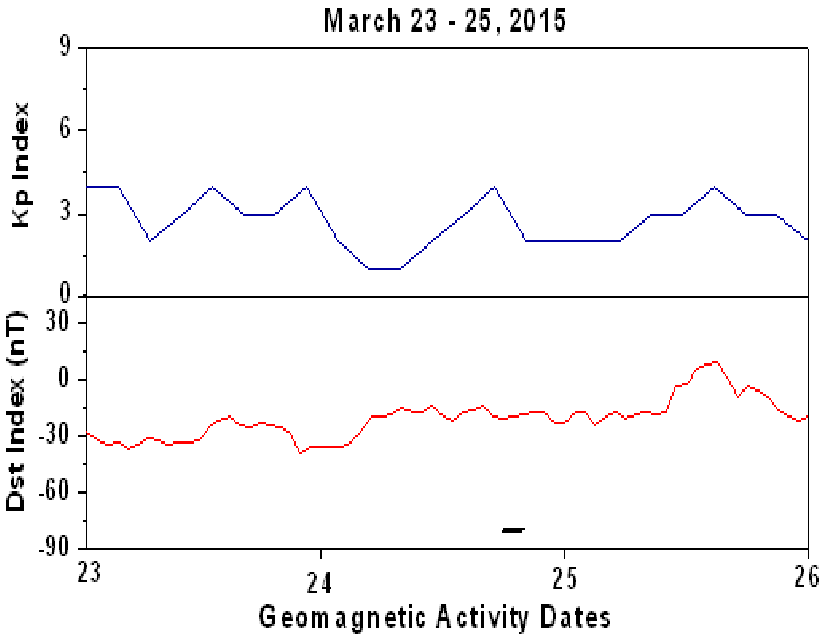

Figure 6: Variation in Dst and Kp indices during 23-25 March 2015 showing the moderate geomagnetic conditions. (Data Source: wdc.kugi.kyoto-u.ac.jp/index.html)

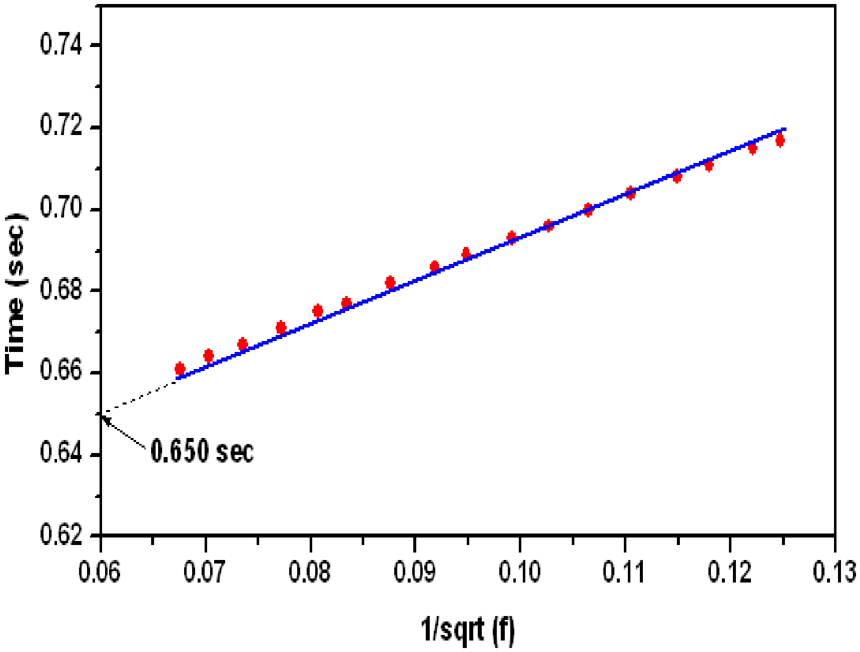

Figure 7: Time t versus f -1/2 plots for knowing the causative sferic locations of whistlers observed.

The products of travel time ($t - t_0$) of whistler frequency components ($f^{-1/2}$) gives dispersion D. Propagation mechanisms of very low latitude whistlers are still unclear. Both ducted and non-ducted theories have been given for the propagation (Singh, 1995; Singh and Singh, 1999). Generally, whistler occurrence activities at lower latitudes are very weak as compared to the mid/high latitudes may be due to location of conjugate points. The conjugate point of Lucknow lies over the Indian Ocean and hence thunderstorm activities are relatively very low as compared to that over the land (Christian et al. 2003). Due to the increased lightning activity in the Indian Ocean during March/April, this season is more pronounced for whistler activities at lower latitudes Indian stations.

Table 2 has listed the various parameters calculated from observed whistlers shown in Figure 8. Dispersion of the observed whistlers has varied from 20.2sec$^{1/2}$ to 36.9sec$^{1/2}$. The change in dispersion could be either due to change in electron density distribution or due to change in the location of the duct through which whistlers have propagated or it might be due to both reasons. On the other hand, the change in whistler path is interpreted as the drift of the plasma supporting the duct in the equatorial plane. This has been produced by the presence of a large-scale convective electric field in the region. Further, the propagation path of whistlers in the present study varied from L = 1.7 to L = 3.0 ($\Delta L = 1.3$), i.e., whistlers have propagated along higher L values.

Table 2: Various magnetospheric parameters estimated from observed whistlers shown in figure 8

S. No.	Occurrence time (LT)	Dispersion ($s^{1/2}$)	L – value	Electron density (cm^{-3})	Total Electron Content in a flux tube (electrons/cm^2-tube)
1	00:21:16.801	21.1 ± 0.4	1.950 ±0.089	999 ± 188	$4.62 \times 10^{12} \pm 0.05 \times 10^{12}$
2	00:21:16.916	22.6 ± 3.2	2.165 ± 0.429	633 ± 448	$4.64 \times 10^{12} \pm 0.44 \times 10^{12}$
3	00:21:16.949	21.2 ± 0.8	1.954 ± 0.165	998 ± 346	$4.66 \times 10^{12} \pm 0.08 \times 10^{12}$
4	00:22:48.149	21.7 ± 1.0	2.284 ± 0.218	434 ± 169	$4.00 \times 10^{12} \pm 0.08 \times 10^{12}$
5	00:22:48.226	32.4 ± 12	3.050 ± 0.287	210 ± 58	$6.53 \times 10^{12} \pm 4.20 \times 10^{12}$
6	00:26:06.928	20.4 ± 0.3	1.822 ± 0.107	1406 ± 367	$4.77 \times 10^{12} \pm 0.13 \times 10^{12}$
7	00:29:41.659	23.1 ± 1.0	2.225 ± 0.098	565 ± 77	$4.66 \times 10^{12} \pm 0.20 \times 10^{12}$
8	00:31:38.518	21.1 ± 0.3	1.917 ± 0.083	1105 ± 206	$4.74 \times 10^{12} \pm 0.07 \times 10^{12}$
9	00:31:38.555	21.3 ± 1.9	1.863 ± 0.493	1345 ± 546	$5.06 \times 10^{12} \pm 0.50 \times 10^{12}$
10	00:31:38.601	36.9 ± 4.5	2.808 ± 0.039	411 ± 80	$9.11 \times 10^{12} \pm 2.10 \times 10^{12}$
11	00:31:38.610	20.4 ± 0.4	1.860 ± 0.038	1310 ± 266	$5.04 \times 10^{12} \pm 0.05 \times 10^{12}$
12	00:31:38.633	21.0 ± 0.8	1.962 ± 0.157	959 ± 313	$4.55 \times 10^{12} \pm 0.08 \times 10^{12}$
13	00:33:53.175	20.6 ± 0.6	1.796 ± 0.174	1569 ± 663	$4.99 \times 10^{12} \pm 0.19 \times 10^{12}$
14	00:33:53.340	24.1 ± 3.3	2.246 ± 0.163	583 ± 58	$5.01 \times 10^{12} \pm 1.00 \times 10^{12}$
15	00:36:18.285	20.2 ± 0.4	1.786 ± 0.158	1572 ± 631	$4.86 \times 10^{12} \pm 0.23 \times 10^{12}$
16	01:00:51.666	22.0 ± 1.4	1.965 ± 0.268	1044 ± 588	$5.00 \times 10^{12} \pm 0.16 \times 10^{12}$

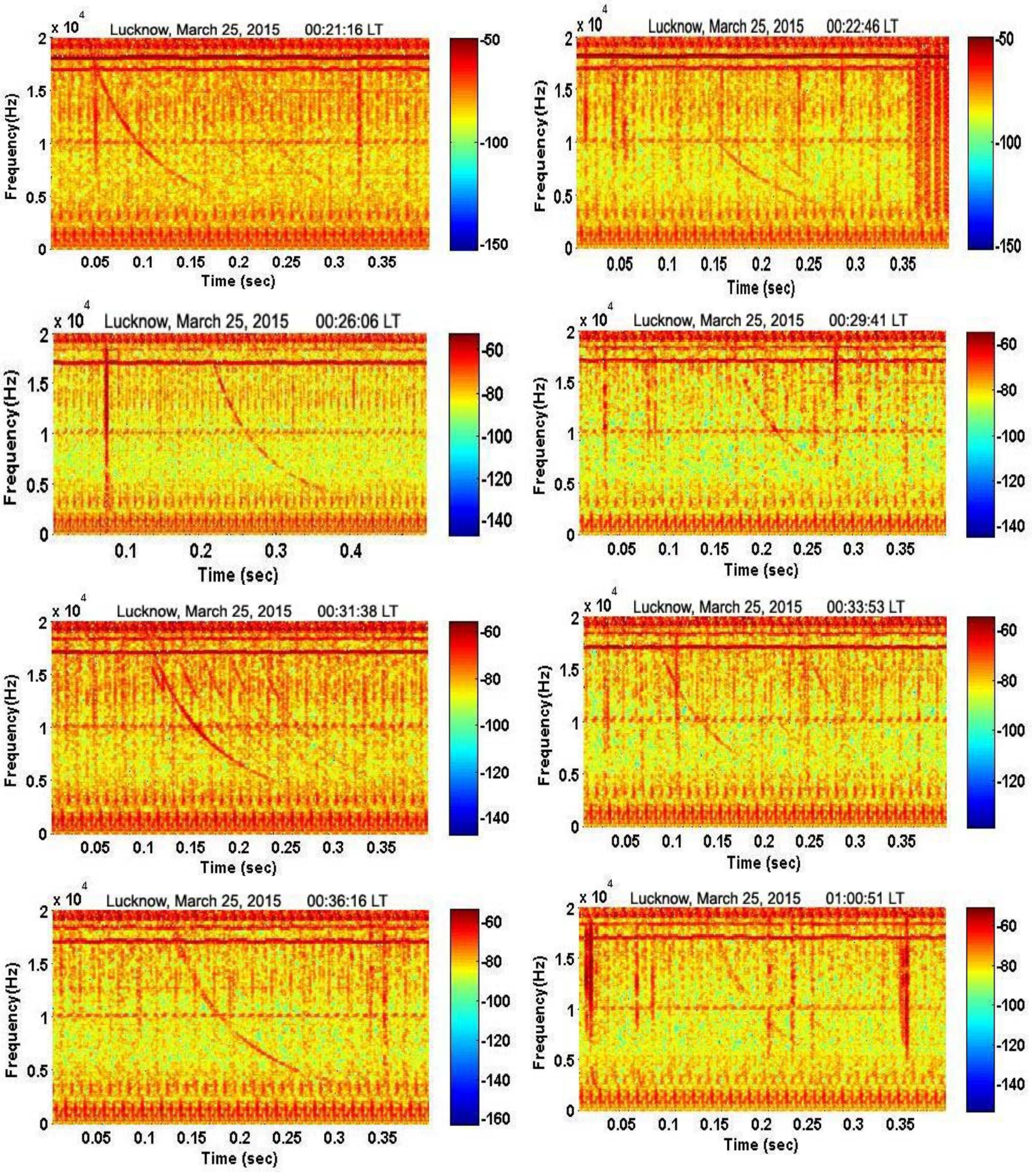

Figure 8: Dynamic spectra of some whistlers recorded at Lucknow (L = 1.10) on 24/25 March 2015.

Dispersion analysis of observed whistlers has indicated about the existence of various ducts in the magnetosphere, and it is evident that different whistlers have propagated along the geomagnetic field lines in different ducts. The lower and higher values of the L-shell for the observed whistlers come out to be 1.7 and 3.0, and equatorial electron density was calculated from 1572 to 210 electrons cm-3. The reported values of these parameters are very much comparable to the values reported by some earlier workers (Tarcsai et al., 1988; Singh, 1995; Singh et al., 1998b). The minimum and maximum value of total electron content for whistlers recorded at Lucknow were obtained as 4.00×10^{12} and 9.11×10^{12} electrons/cm2-tube respectively. The change in total electron content might be due to change in the path of propagation of whistlers.

IV. CONCLUSIONS

In this paper, we have used ELF/VLF waves (tweeks and whistlers) as remote sensing tool to explore the mid and upper atmosphere. Tweeks are used in the estimation of nighttime electron density at reflection heights from the cut-off frequencies of different harmonics. The D-region electron densities have been found of the order of 22.5-26.06cm^{-3} over ionospheric reflection height of 80.0-92.5 km. We have shown the variation in relative amplitude of tweeks and have not found any particular trend in its variability. The whistler data recorded on March 24/25, 2015 during night hours were analyzed to study the propagation characteristics and for estimation of some ambient medium parameters like dispersion, L-values (path of propagation), the equatorial electron density and the total electron content in a flux tube. Dispersion of the observed whistlers varied between 20.2 and 36.9 sec$^{1/2}$. We have observed that whistlers recorded at low latitude station (Lucknow) have traveled along higher L-values lying in the range of 1.7 to 3.0 and have propagated in the ducted mode along the geomagnetic field line in the magnetosphere, and waveguide mode after exit from the ionosphere into the Earth-ionosphere waveguide. The electron density in the equatorial region varied between 1572 and 210 electrons/cm^3 as L varied from L = 1.7 to L = 3.0. The minimum and maximum values of total electron content for whistlers were calculated to be 4.00×10^{12} and 9.11×10^{12} electrons/cm^2-tube respectively. High values of dispersion and other parameters have supported the statement of the propagation of whistler waves traveling through higher latitude. Importance of the present results might be in providing a good input to understand the propagational mechanism to ELF/VLF waves, electron density profiling of ionosphere and magnetosphere as well as the ground-based remote sensing of the mid/upper atmosphere.

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Life's Principle before Materialistic Universe

By Stupar Milanko & Stefanovic Slavica

Abstract- In this paper there is an attempt to prove that the production of the matter in the Universe has been preceded by a life force, a certain principle of life. This vital force gives the meaning to the whole Universe. Without it, the entire material world would have no sense to exist. This way of "thinking" was guaranteed by the existence of the "mislion"; the basic entity of thoughts, ideas, and activity of the presupposed principle of life.

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Life's Principle before Materialistic Universe

Stupar Milanko [α] & Stefanovic Slavica [σ]

Abstract- **In this paper there is an attempt to prove that the production of the matter in the Universe has been preceded by a life force, a certain principle of life. This vital force gives the meaning to the whole Universe. Without it, the entire material world would have no sense to exist. This way of "thinking" was guaranteed by the existence of the "mislion"; the basic entity of thoughts, ideas, and activity of the presupposed principle of life.**

I. INTRODUCTION

It is difficult to find a rational response to this setting, and therefore only scientific and experimental facts should be taken into account; completely excluding subjectivism, i.e., egoism of the *Homo sapiens sapiens*. Analyzing the role of genes and their products in various biochemical processes, interesting data has been found. During the experimental work regarding the new processes such an RNA editing in wheat mitochondria, on DNA miss-much repair via the double-strand break in rat cells, the question arises: which process in the brain produces thoughts, ideas? The answer is simple: NO ONE.

For about one-third of the genes, for app. 7000 of it, their role in the cells are not known. So, there are probably still some of the undiscovered processes in the cells. Whether the processes discovered in the future will bring something new in this direction is quite doubtful. All that biochemical genetics produces in a living system, even in the brain, are biochemical compounds, i.e. matter. Ideas and thoughts are not material, they have no mass, spin, electrical charges. From where they are coming if they are not material, or in other words matter does not produce a non- material entities. If this is a true, then who produces matter, i.e. singularity, having in mind the general recognized theory; if they are true. There must be something that produces matter.

In reality, there is no matter without mass. Photon, graviton, they have mass, ten to minus 67 g. Otherwise photon would not turn in the huge gravitational field. Or, way the photon on it endless path does not slow down, from where he gets energy, from within or outside? It is no wonder that Dokuchaev assumes that there would be life in the black hole (1). Due to the captured photons black hole is bright inside. It could be that photon is smashed down, like every other astroparticle, thus black hole is black inside.

II. MATERIAL AND METHOD

In the book "Progress in String Theory Research", Stupar M. and Stefanovic S.: "Strings, Water, and DNA united by mislion, results in life" chapter IV. 2015. Copyright "Nova Publishing" (2).

III. DISCUSION

In nature, there are many examples where living organisms produce electricity, light, but there is nowhere to be seen that light or electricity produce the living being. It would be logical to conclude that the life principle is older than dead nature, i.e., that this principle produces matter. So, the idea that "mislion" preceding the material world makes sense. All biological beings that possess nucleic acids, RNA or DNA, or new RNA-DNA hybrid viruses, can receive and choose the "mislions" which suit to them. A good example is the Influence virus (3). Every app. 10 years the structure of neuraminidase (N), or haemagglutinin (H) were changed. Unnatural conditions, human vaccines, have forced virus if wants to survive, to reduce the frequency of changes to the corresponding level.

Of all four physical forces, weak and strong nuclear forces, gravity and electromagnetism, none of them can explain what's alive is. Which then quality makes differences between these forces and living organisms? The human beings can explain physical structures, but another way round explanation does not exist. In living organisms, all of the puzzles in the cells are based on the biochemical reactions, in these pathways, all participants are materialistic, realistic. DNA, as a matter that is visible under the electronic microscope, even by necked eyes, is transcribed into the RNA, which is in its turn visible under the electronic microscope. The final products of genes expression are proteins, also the major physical entities. But, what is that in biochemistry that makes biology? The answer to this question can be found in the way the brain functions. The basic role of the brain is to think, to produce ideas, plans. Analyzing the expression of the genes in the brain, looking for biochemical processes involving in the productions of the thoughts, ideas, none of it has been found. The conclusion is clear, our brain, and even all bio-kingdom, does not produce thoughts, it means that we do not think!!! Who then thinks instead of us? This conclusion is alright because thoughts is not a physical phenomenon, it has no mass, no spin, there is no frequency, in one word speaking there is nothing in common with physical entities in our koino-observable

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Universe. Thus, thoughts can be "produced" by some idealistic sources, or going deeper into the origin of the "All of the Universes", something that makes idealistic sources.

It can be that all astroparticles spend a little time as a combination of all others particles, it speaks in favor that astroparticles know each others, that they have awareness of others particles. The property that would be responsible for this behavior in the world of astroparticles, can be attributed to the "mislion", and not to the strings or any other physical entities.

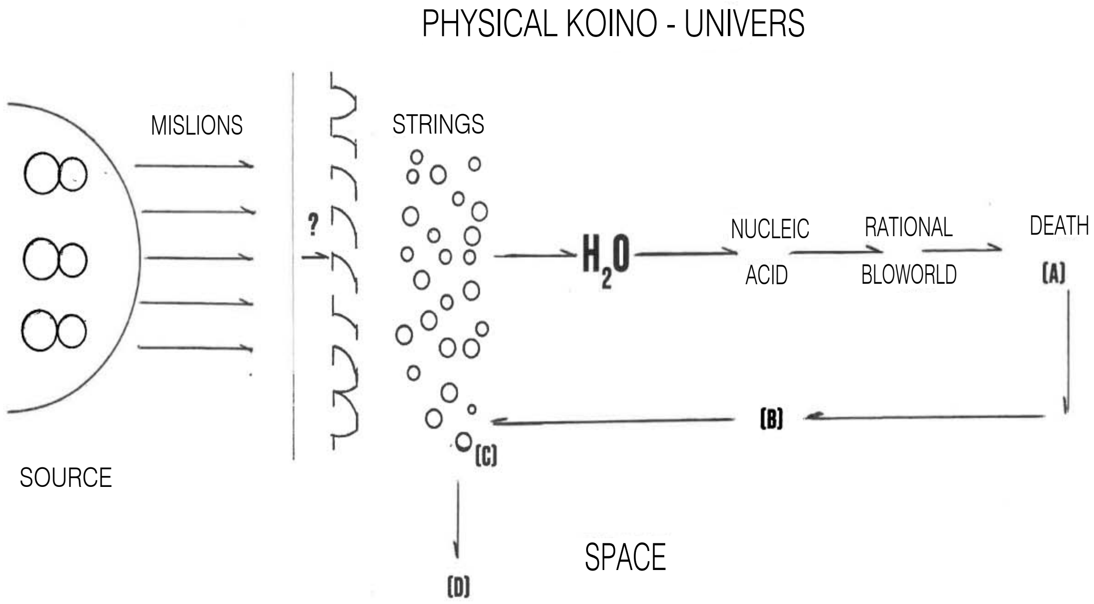

Fig. 1: Human journey throughout the Cosmos.

"Mislion" is also a product of life's principle. Around each pair of nucleotides, there are about 30 molecules of water ion-bound to DNA, which makes 100 billions of water molecules for one genome. Each 0,5 – 1 nanosecond molecule of water enters and live from its ionic bond, scanning and forming DNA three-dimensional structure. (A) - At the moment of death, the molecules of water expelled guest (DNA) leaving a mold of the cavity, which spatially corresponds to a fixed three-dimensional DNA configuration, therefore serves "junk" DNA, among others, (4)– (B). After dispersion of the water molecules remains DNA fingerprint in closed strings – (C); since strings are the basis energy of the material world, having in mind its tension (10 to power 42kg)+. The closed strings connected in catennaceous structures, in this case, makes so-called "soul", or the storehouse of our and self-accepted thoughts, which shape our DNA during a lifetime. Only now, from the moment of death, the bio-organism possesses its thoughts that have been chosen (providence) throughout life (D). +Weight of the whole Universe is 10 to power 53 t.

So that, reincarnation does not exist, everyone has a different accumulation of the thoughts, as well as a unique three-dimensional DNA structure. But, if there are spores cells (5), if they exist, then there is a chance of resurrection.

Gravitation, as a propagating force of the Universe, has a propagating speed, determined by standard experimental techniques, not less than 2 x 10 to power 10c (6). Gravitational field, even "static" ones, is continually regenerated (faded) through entities that must propagate at some very high speed. The speed of gravity has a finite velocity, which is up to 10 to power 60c. Even then, this is a finite velocity, because finite speed is acausal.

Whether at such a high speed a gravitational string can be interrupted and from "closed string state", passes into the "open string state" that remains trapped on the branes.

At such a high speed, the string's tension threshold is overpassed. If this is true, then this is another proof that the "mislion" fead graviton with a new closed string (one string = one photon, one string = one graviton). This "states the idea" that the "mislion" continually produces the string, i.e. matter. Having in mind the existence of the "mislion", the statement that: "infinite speeds are acausal" can be called into question. "Speed of "mislion" is not speed in a classical term, and is infinite and causal, i.e. "mislion" is everywhere.

IV. Conclusion

The difference between non-living matter and living beings is enormous. What makes such a huge leap?

After several varied experiments, it was concluded that life is given by entities which do not belong to the koino-Universe. That entity is called "mislion" (misliti = thinking; misli on = he thinks). Preliminary results confirm his existence, of course, many new ideas "need to be received" to clarify in details what's going on. But, for the moment it is like it is. Analyzing experimental data published in the above-mentioned book (Nova Publishing), if the "mislion" organized nucleotides in the given order, then way he should not make strings. If this is a true then the "mislion", i.e., principle of life was preceded material Universe.

This way of looking at the structure of the Universe might have a huge impact on leading theories of the origin and development of the Reality.

From this, it can be concluded that "mislion" continuously produces strings, the energy of matter. This may support the presumed expansion of the Universe. In that case there no return to the singularity. So, for this point of view is better suited to the theory of "Steady State Holographic Universe" (7), with the addition that it was constantly expanding. Is better to say that Universe is mobile; "Moving State Holographic Universe". This could also explain the Kotov's non-Doppler effect.

And so, the "mislion" produces and controls the strings, and they, in the "warehouse of thoughts" behave as the accepted "mislions" wants.

So that, with the discovery of Higgs bosons and String Theory is not the end of physicians way of thinking about construction of Universe. Than we can consider that life's principle guide the past, present, and future existence of the Universe in unknown direction. Or, in the direction of the collectively consciousness. The entry of the "mislion" on the scene gives a new biological taste to the meaning and existence of the Universe.

All of above mentioned can take conventional Physics to the next plato, to the idealistic sphere.

Just a moment, source of principle of life and "mislions" is not a God.

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Effect of Non-Inertial Acceleration on Thermal Convection in an Anisotropic Porous Medium with Temperature-Dependent Darcy and Brinkman Frictions

By R. K. Vanishree
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Abstract- A linear stability analysis is performed for monodiffusive convection in an anisotropic rotating porous medium with temperature-dependent viscosity. The Galerkin technique is used to obtain the eigen value of the problem. The effect of Taylor number (both small and large values) and the other parameters of the problem is considered for both stationary and oscillatory convection in the presence and absence of non-inertial acceleration. Some new results on the parameters' influence on convection in the presence of rotation, for both high and low rotation rates, are presented. Low-porosity medium results are also discussed for constant viscosity liquids.

Keywords: *anisotropy, rotation, porous medium, variable viscosity, thermal convection.*

GJSFR-A Classification: *FOR Code: 020399*

Effect of Non-Inertial Acceleration on Thermal Convection in an Anisotropic Porous Medium with Temperature-Dependent Darcy and Brinkman Frictions

R. K. Vanishree

Abstract- A linear stability analysis is performed for mono-diffusive convection in an anisotropic rotating porous medium with temperature-dependent viscosity. The Galerkin technique is used to obtain the eigen value of the problem. The effect of Taylor number (both small and large values) and the other parameters of the problem is considered for both stationary and oscillatory convection in the presence and absence of non-inertial acceleration. Some new results on the parameters' influence on convection in the presence of rotation, for both high and low rotation rates, are presented. Low-porosity medium results are also discussed for constant viscosity liquids.

Keywords: anisotropy, rotation, porous medium, variable viscosity, thermal convection.

I. Introduction

Thermal convection in a rotating porous medium is a phenomenon relevant to many fields. It has various applications in geophysics, food processing and engineering and nuclear reactors. Many authors have investigated the effect of external constraint like rotation on convection in a porous medium. Cellular convection in a rotating fluid through porous medium was studied by Rudraiah and Rohini (1975). Rudraiah and Srimani (1976) investigated thermal convection in a rotating fluid through a porous medium. Stability of finite amplitude and overstable convection of conducting fluid through fixed porous bed was studied by Rudraiah and Vortmeyer (1978). Palm and Tyvand, (1984) investigated thermal convection in a rotating porous layer. Effect of Coriolis force and non-uniform temperature gradient on the Rayleigh-Bénard convection was established by Rudraiah and Chandna (1985). Jou and Liaw (1987) studied the thermal convection in a porous medium subject to transient heating and rotation. Vadasz, 1993, 1994, 1997, 1998a, 1998b) extensively studied the flow through a porous medium with rotational effects like three dimensional free convection in a long rotating porous box, stability of free convection in a narrow porous layer subject to rotation, stability of free convection in a rotating porous layer distant from the axis of rotation, flow in rotating porous media, Coriolis effect on gravity-driven convection in a rotating porous layer heated from below and free convection in a porous media. Transition and chaos for free convection in a rotating porous layer was studied by Vadasz and Olek (1998). Straughan (2001) established a sharp nonlinear stability threshold in rotating porous convection. Govender and Vadasz (2002) made a moderate time linear study of moderate Stephan number convection in rotating mushy layers. Riahi (2003, 2006) studied stationary and oscillatory modes of flow instability in a rotating porous layer during alloy solidification and non linear convection in a rotating mushy layer. Khiri (2004) analyzed the Coriolis effect on convection for a low Prandtl number fluid. Govender (2006) studied the effect of anisotropy on stability of convection in a rotating porous layer distant from the center of rotation. Riahi (2007a, 2007b) analyzed the inertial effects on rotating flow in a porous layer and inertial and coriolis effects on oscillatory flow in a horizontal dendrite layer. Combined effect of thermal modulation and rotation on the onset of stationary convection in a porous layer was studied by Malashetty and Mahantesh Swamy (2007). Govender and Vadasz (2007) studied the effect of mechanical and thermal anisotropy on the stability of gravity driven convection in rotating porous media in the presence of thermal non-equilibrium. Effect of temperature modulation on the onset of Darcy convection in a rotating porous medium was studied by Bhadauria (2008). Linear stability of solutal convection in rotating solidifying mushy layers with permeable mush-melt interface was established by Govender (2008).

Most of the above investigators have studied convection in a low-porosity, rotating, and isotropic porous medium with constant viscosity. Temperature-dependence of viscosity gives rise to temperature-dependent Darcy and Brinkman frictions. Patil and Vaidyanathan (1983) analyzed setting up of convection currents in a rotating porous medium under the influence of variable viscosity. Richardson and Straughan (1993) studied the non-linear stability and the Brinkman effect on convection with temperature dependent viscosity (linear dependence) in a porous

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medium. Effect of radiation on non-Darcy free convection from a vertical cylinder embedded in a fluid-saturated porous medium with a temperature-dependent viscosity was studied by El-Hakiem and Rashad (2007). Vanishree and Siddheshwar (2010) investigated the effect of rotation on thermal convection in an anisotropic porous medium with temperature-dependent viscosity. Siddheshwar *et. al.* (2012) studied the heat transport in Bénard -Darcy convection with g-jitter and thermo-mechanical anisotropy in variable viscosity liquids. A good account of convection problems in porous media is given in Vafai and Hamid (2000), Ingham and Pop (2002) and Nield and Bejan (2006), Dullien (2012), Vadasz (2015).

The object of this paper is to study the effect of non-inertial acceleration on mono-diffusive convection in a high-porosity, anisotropic porous medium with temperature-dependent Darcy and Brinkman frictions.

II. MATHEMATICAL FORMULATION

Consider a horizontal porous layer of infinite extent occupied by a Boussinesquian fluid with temperature dependent viscosity, confined between stress free isothermal boundaries at $z = 0$ and $z = d$ at which the temperatures are T_0 and T_1 respectively, which is kept rotating at constant rate. Let Ω denote the angular velocity of rotation. The porous medium is assumed to have high porosity and hence the fluid flow is governed by Brinkman model with effect of Coriolis force and centrifugal acceleration. An appropriate single-phase heat transport equation is chosen with effective heat capacity ratio and effective thermal diffusivity. Thus the governing equations for the Rayleigh-Bénard situation in a fluid with non-Boussinesq effect occupying a rotating porous layer for temperature dependent viscosity are:

Conservation of mass

$$\nabla.\vec{q} = 0, \tag{2.1}$$

Conservation of linear momentum

$$\begin{aligned}\frac{\rho_R}{\Phi}\frac{\partial \vec{q}}{\partial t} &= -\nabla p + \rho\vec{g} - \mu_f \mathbf{k}.\vec{q} + \mu_e \nabla^2 \vec{q} \\ &\quad + 2\frac{\rho_R}{\Phi}\left(\vec{q}\times\vec{\Omega}\right) + \nabla.\left[\mu_p\left(\nabla\vec{q} + \nabla\vec{q}^{Tr}\right)\right],\end{aligned} \tag{2.2}$$

Conservation of energy

$$\gamma\frac{\partial T}{\partial t} + \vec{q}.\nabla T = \chi_{Tv}\left[\eta\left(\frac{\partial^2 T}{\partial x^2} + \frac{\partial^2 T}{\partial y^2}\right) + \frac{\partial^2 T}{\partial z^2}\right], \tag{2.3}$$

Equation of state

$$\rho = \rho_R\left[1 - \alpha\left(T - T_0\right)\right], \tag{2.4}$$

$$\mu_f(T) = \mu_1\left[1 - \Gamma_1\left(T - T_0\right) - \Gamma_2\left(T - T_0\right)^2\right], \tag{2.5}$$

$$\mu_p(T) = \mu_2\left[1 - \Gamma_1\left(T - T_0\right) - \Gamma_2\left(T - T_0\right)^2\right], \tag{2.6}$$

where

$$p = p^* - \frac{\rho_R}{2\Phi}\nabla\left(\left|\vec{\Omega}\times\vec{r}\right|^2\right).$$

We have neglected the inertial acceleration term in Eq. (2.2) since we are making a linear stability analysis of convection.

a) Basic state

The basic state of the liquid being quiescent is described by

$$\begin{gathered}\frac{\partial(\ )}{\partial t} = 0,\ \vec{q}_b = (0,0,0),\ T = T_b(z), \\ \rho = \rho_b(z),\ \mu_f = \mu_{f_b}(z),\ \mu_p = \mu_{p_b}(z).\end{gathered} \tag{2.7}$$

The temperature T_b, pressure p_b and density ρ_b satisfy

$$\frac{dp_b}{dz} = -\rho_b g, \tag{2.8}$$

$$\frac{d^2 T_b}{dz^2} = 0 \tag{2.9}$$

$$\rho_b = \rho_R\left[1 - \alpha(T_b - T_0)\right], \tag{2.10}$$

$$\mu_{f_b} = \mu_1\left[1 - \Gamma_1(T_b - T_0) - \Gamma_2(T_b - T_0)^2\right], \tag{2.11}$$

and

$$\mu_{p_b} = \mu_2\left[1 - \Gamma_1(T_b - T_0) - \Gamma_2(T_b - T_0)^2\right]. \tag{2.12}$$

Solving Eq. (2.9) for T_b using the boundary conditions

$$T_b = T_0 \text{ at } z = 0,$$

$$T_b = T_1 \text{ at } z = 1,$$

we get

$$T_b - T_0 = -\beta_1 z, \tag{2.13}$$

$$\rho_b = \rho_R\left[1 + \alpha\beta_1 z\right], \tag{2.14}$$

$$\mu_{f_b} = \mu_1\left[1 + \Gamma_1\beta_1 z - \Gamma_2\beta_1^2 z^2\right], \tag{2.15}$$

and $$\mu_{p_b} = \mu_2\left[1 + \Gamma_1\beta_1 z - \Gamma_2\beta_1^2 z^2\right]. \tag{2.16}$$

where

$$\beta_1 = \frac{T_0 - T_1}{d} > 0.$$

b) Linear stability analysis

Let the basic state be disturbed by an infinitesimal thermal perturbation. We now have

$$\begin{gathered}\vec{q} = \vec{q}_b + \vec{q}',\ T_b = T_b(z) + T',\quad p_b = p_b(z) + p',\ \rho_b = \rho_b(z) + \rho', \\ \mu_f = \mu_{f_b}(z) + \mu'_f,\ \mu_p = \mu_{p_b}(z) + \mu'_p.\end{gathered} \tag{2.17}$$

The prime indicates that the quantities are infinitesimal perturbations. Substituting Eq. (2.17) into Eqs. (2.1)-(2.3), and using the basic state solution, we get the linearized equations governing the infinitesimal perturbations in the form:

$$\nabla.\vec{q}' = 0, \tag{2.18}$$

$$\begin{aligned}\frac{\rho_R}{\Phi}\left[\frac{\partial \vec{q}'}{\partial t}\right] = {}& -\nabla p' + \alpha\rho_R g T'\hat{k} + 2\frac{\rho_R}{k_v}\left(\vec{q}'\times\vec{\Omega}\right) \\ & -\mu_{f_b}\,\mathbf{k}.\vec{q}' + \nabla\mu_{p_b}.\left(\nabla\vec{q}' + \nabla\vec{q}'^{Tr}\right) + \mu_{p_b}\nabla^2\vec{q}',\end{aligned} \tag{2.19}$$

$$\gamma\frac{\partial T'}{\partial t} = \beta w' + \chi_{Tv}\left[\eta\left(\frac{\partial^2 T'}{\partial x^2} + \frac{\partial^2 T'}{\partial y^2}\right) + \frac{\partial^2 T'}{\partial z^2}\right]. \tag{2.20}$$

Operating curl twice on Eq. (2.19), to eliminate pressure, we get

$$\begin{aligned}-\frac{\rho_R}{\Phi}\frac{\partial}{\partial t}\left(\nabla_1^2 w'\right) = {}& -\alpha\rho_R g\nabla_1^2 T' - \mu_{p_b}\nabla^4 w' - 2\frac{\partial\mu_{p_b}}{\partial z}\nabla^2\left(\frac{\partial w'}{\partial z}\right) \\ & + \frac{\mu_{f_b}}{k_v}\nabla_1^2 w' + \frac{\mu_{f_b}}{k_v}\frac{1}{\varepsilon}\frac{\partial^2 w'}{\partial z^2} + \frac{1}{k_v}\frac{1}{\varepsilon}\frac{\partial\mu_{f_b}}{\partial z}\frac{\partial w'}{\partial z} \\ & + \frac{\partial^2\mu_{p_b}}{\partial z^2}\left[\nabla_1^2 w' - \frac{\partial^2 w'}{\partial z^2}\right] + 2\frac{\rho_R}{\Phi}\Omega\frac{\partial\zeta}{\partial z},\end{aligned} \tag{2.21}$$

where

$\zeta = \left(\frac{\partial v'}{\partial x} - \frac{\partial u'}{\partial y} \right)$ is the z-component of vorticity, $\vec{\omega}' = \nabla \times \vec{q}'$.

Now the equation for ζ can be obtained by differentiating x and y components of Eq. (2.17) partially w.r.t. y and x respectively and then subtracting the resulting equations from one another, which is

$$\frac{\rho_R}{\Phi}\frac{\partial \zeta}{\partial t} = 2\frac{\rho_R}{\Phi}\Omega\frac{\partial w'}{\partial z} - \frac{\mu_{fb}}{k_v}\frac{1}{\varepsilon}\zeta + \frac{\partial \mu_{Pb}}{\partial z}\frac{\partial \zeta}{\partial z} + \mu_{Pb}\nabla^2\zeta. \tag{2.22}$$

We now non-dimensionalize Eqs. (2.20)-(2.22) using the following definitions,

$$(x^*, y^*, z^*) = \left(\frac{x}{d}, \frac{y}{d}, \frac{z}{d} \right), w^* = \frac{w'}{\left(\chi_v / d \right)}, T^* = \frac{T'}{\beta d}, \zeta^* = \frac{\zeta}{\left(\chi_v / d^2 \right)}, t^* = \frac{t}{\left(d^2 / \nu \right)}. \tag{2.23}$$

Substituting Eq. (2.23) along with Eqs. (2.11) and (2.12) in Eqs (2.20)-(2.22), we get (after dropping the asterisks)

$$\begin{aligned} \frac{\partial}{\partial t}(\nabla^2 w) = {} & R\nabla_1^2 T + \Lambda(1+V_1 z - V_2 z^2)\nabla^4 w - 2\Lambda(V_1 - 2V_2 z)\nabla^2\left(\frac{\partial w}{\partial z}\right) \\ & - Da^{-1}(1+V_1 z - V_2 z^2)\left(\nabla_1^2 w + \frac{1}{\varepsilon}\frac{\partial^2 w}{\partial z^2} \right) - \frac{Da^{-1}}{\varepsilon}(1+V_1 z - V_2 z^2)\frac{\partial^2 w}{\partial z^2} \\ & - \frac{Da^{-1}}{\varepsilon}(V_1 - 2V_2 z)\frac{\partial w}{\partial z} - \sqrt{Ta}\frac{\partial \zeta}{\partial z} + 2\Lambda V_2\left(\nabla_1^2 w - \frac{\partial^2 w}{\partial z^2} \right), \end{aligned} \tag{2.24}$$

$$\begin{aligned} \frac{\partial \zeta}{\partial t} = {} & \sqrt{Ta}\frac{\partial w}{\partial z} - \frac{Da^{-1}}{\varepsilon}(1+V_1 z - V_2 z^2)\zeta - \Lambda(V_1 - 2V_2 z)\frac{\partial \zeta}{\partial z} \\ & + \Lambda(1+V_1 z - V_2 z^2)\nabla^2\zeta, \end{aligned} \tag{2.25}$$

$$Pr\frac{\partial T}{\partial t} = w + \left[\eta\left(\frac{\partial^2 T}{\partial x^2} + \frac{\partial^2 T}{\partial y^2} \right) + \frac{\partial^2 T}{\partial z^2} \right], \tag{2.26}$$

The dimensionless groups that appear are R, Thermal Rayleigh number, ε, mechanical anisotropy parameter, η, thermal anisotropy parameter, Da^{-1}, inverse Darcy number, Λ, Brinkmann number, Pr, Prandtl number, Ta, Taylor number, V_1, linear variable viscosity parameter and V_2, quadratic variable viscosity parameter. The Eqs. (2.24)-(2.26) are three equations in three unknowns w, ζ and T.

Eqs. (2.24)-(2.26) are to be solved subject to the conditions

$$w = \nabla^2 w = D\zeta = T = 0 \text{ at } z = 0,1. \tag{2.27}$$

The infinitesimal perturbations w, T and ζ are assumed to be periodic waves and hence these permit normal mode solutions in the form (see Chandrasekhar 1961)

$$\begin{bmatrix} w \\ \zeta \\ T \end{bmatrix} = e^{\sigma t}\begin{bmatrix} w(z) \\ \zeta(z) \\ T(z) \end{bmatrix} e^{i(lx+my)} \tag{2.28}$$

where the imaginary part of σ is the frequency, $w(z)$, $\zeta(z)$ and $T(z)$ are the amplitudes and l and m are the horizontal components of the wave number such that $a^2 = l^2 + m^2$. These satisfy the boundary conditions of Eqs. (2.27). Substituting Eq. (2.28) into Eqs. (2.24)-(2.26), we get

$$\begin{aligned}&\Lambda(1+V_1z-V_2z^2)\left(D^2-a^2\right)^2 w-\ \sigma\left(D^2-a^2\right)w-\ Ra^2T\\&-2\Lambda(V_1-2V_2z)\left(D^2-a^2\right)Dw+Da^{-1}(1+V_1z-V_2z^2)a^2w\\&-\frac{Da^{-1}}{\varepsilon}(1+V_1z-V_2z^2)D^2w-\frac{Da^{-1}}{\varepsilon}(V_1-2V_2z)Dw\\&-\sqrt{Ta}\frac{d\zeta}{dz}-2\Lambda V_2\left(D^2+a^2\right)w=0,\end{aligned} \tag{2.29}$$

$$\begin{aligned}&\Lambda(1+V_1z-V_2z^2)\left(D^2-a^2\right)\zeta-\sigma\zeta+\sqrt{Ta}Dw\\&-\frac{Da^{-1}}{\varepsilon}(1+V_1z-V_2z^2)\zeta+\Lambda(V_1-2V_2z)D\zeta=0,\end{aligned} \tag{2.30}$$

$$\left(D^2-\eta a^2\right)T-Pr\sigma T+w=0, \tag{2.31}$$

where σ is in general complex and $D=\dfrac{d}{dz}$. For marginal stability we take σ to be purely imaginary and discuss both stationary and oscillatory convection.

III. APPLICATION OF GALERKIN VARIANT OF WEIGHTED-RESIDUALS TECHNIQUE

Eqs. (2.29)-(2.31) are solved using the Galerkin variant of weighted -residuals technique (Finlayson, 1972). This method gives the general results on the eigen value of the problem using the trial functions for the lowest eigen value. We obtain an approximate solution of the differential equations with the given boundary conditions by choosing trial functions for velocity and temperature perturbations that may satisfy the boundary conditions but may not exactly satisfy the differential equations. This leads to residuals when the trial functions are substituted into the differential equations. The Galerkin variant of weighted -residuals method requires the residual to be orthogonal to each individual trial function. In the Galerkin variant of weighted -residuals procedure, we expand the velocity and temperature by

$$\begin{aligned}w(z,t)&=\sum A_i(t)w_i(z),\\ \zeta(z,t)&=\sum B_i(t)\zeta_i(z),\\ T(z,t)&=\sum C_i(t)T_i(z),\end{aligned} \tag{3.1}$$

where $w_i(z),\zeta_i(z)$ and $T_i(z)$ are trial functions that have to satisfy the boundary conditions. For the purpose of illustration we present below the single-term Galerkin variant of weighted -residuals technique.

Multiplying Eqs. (2.29)-(2.31) by *w*, ζ and *T* respectively and integrating the resulting equations by parts with respect to *z* between 0 and 1 and taking $w=Aw_1, T=BT_1 \text{ and } \zeta=C\zeta_1,$ in which *A*, *B* and *C* are constants and w_1, T_1 and ζ_1 are trial functions that satisfy the boundary conditions, yield the following equations for the Rayleigh number, *R* :

$$R=\frac{\left(G_3+Pr\sigma E_2\right)\left[\left(G_1+\sigma G_2\right)\left(G_4-\sigma F_5\right)+TaF_1D_9\right]}{a^2D_8^2\left(G_4-\sigma F_5\right)}, \tag{3.2}$$

where

$$\begin{aligned}G_1=&\Lambda\left(D_1+a^4D_2-2a^2D_3\right)-2\Lambda\left(D_4-a^2D_5\right)+2\Lambda V_2\left(-D_6+a^2D_7\right)\\&+Da^{-1}a^2D_2-\frac{Da^{-1}}{\varepsilon}\left(D_3+D_5\right),\end{aligned}$$

$$G_2=\left(D_6+a^2D_7\right), G_3=E_1+\eta_1 a^2E_2, G_4=\Lambda\left(F_2-a^2F_3\right)+\Lambda F_4-\frac{Da^{-1}}{\varepsilon}F_3,$$

$$D_1=\left\langle w_1\left(1+V_1z-V_2z^2\right)D^4w_1\right\rangle, D_2=\left\langle w_1\left(1+V_1z-V_2z^2\right)w_1\right\rangle,$$

$$D_3=\left\langle w_1\left(1+V_1z-V_2z^2\right)D^2w_1\right\rangle, D_4=\left\langle w_1\left(V_1-2V_2z\right)D^3w_1\right\rangle,$$

$$D_5=\left\langle w_1\left(V_1-2V_2z\right)Dw_1\right\rangle, D_6=\left\langle\left(Dw_1\right)^2\right\rangle, D_7=\left\langle w_1^2\right\rangle, D_8=\left\langle w_1T_1\right\rangle,$$

$$D_9=\left\langle w_1D\zeta_1\right\rangle, E_1=\left\langle\left(DT_1\right)^2\right\rangle, E_2=\left\langle T_1^2\right\rangle, F_1=\left\langle\zeta_1Dw_1\right\rangle,$$

$$F_2=\left\langle\zeta_1\left(1+V_1z-V_2z^2\right)D^2\zeta_1\right\rangle, F_3=\left\langle\zeta_1\left(1+V_1z-V_2z^2\right)\zeta_1\right\rangle,$$

$$F_4=\left\langle\zeta_1\left(V_1-2V_2z\right)D\zeta_1\right\rangle, F_5=\left\langle\zeta_1^2\right\rangle,$$

$\langle\cdots\rangle$ denotes integration with respect to z between z = 0 and *z* = 1.We note here that *R* in Eq. (3.2) is a functional and the Euler-Lagrange equations for the extremization of *R* are Eqs. (2.29)-(2.31).

For stationary convection we set $\sigma=0$ and then Eq. (3.2) becomes

$$R^s=\frac{G_3\left(G_1G_4+Ta\,F_1D_9\right)}{a^2G_4D_8^2}. \qquad (3.3)$$

For oscillatory instability we set $\sigma=i\omega$ in Eq.(3.2), which gives

$$R^o=\frac{G_3G_4(G_1G_4+Ta\,F_1D_9)+\omega^2\left(G_1G_3F_5^2-PrE_2\left\{\begin{matrix}F_1F_5D_9Ta+G_2G_4^2\\+\omega^2F_5^2G_2\end{matrix}\right\}\right)+i\omega N}{a^2D_8^2\left(G_4^2+\omega^2F_5^2\right)}, \qquad (3.4)$$

where

$$N=\left(G_3G_4-\omega^2PrE_2F_5\right)\left(G_2G_4-G_1F_5\right)$$
$$+\left(G_3F_5+PrE_2G_4\right)\left(G_1G_4+TaF_1D_9+\omega^2G_2F_5\right). \qquad (3.5)$$

Since *R* is a real quantity, either $\omega=0$ (stationary) or $N=0$ ($\omega\neq0$, oscillatory). The latter condition, on simplification, yields the frequency of oscillations and the oscillatory Rayleigh number in the form:

$$\omega^2=\frac{-\left[G_2G_3G_4^2+G_3F_1F_5D_9Ta+PrE_2G_4\left(G_1G_4+Ta\,F_1D_9\right)\right]}{F_5^2\left(PrE_2G_1+G_2G_3\right)}. \qquad (3.6)$$

$$R^o=\frac{G_3G_4(G_1G_4+Ta\,F_1D_9)+\omega^2\left(G_1G_3F_5^2-PrE_2\left\{\begin{matrix}F_1F_5D_9Ta+G_2G_4^2\\+\omega^2F_5^2G_2\end{matrix}\right\}\right)}{a^2D_8^2\left(G_4^2+\omega^2F_5^2\right)}, \qquad (3.7)$$

In evaluating R^s and R^o we have assumed $w_1 = T_1 = \sin(\pi z)$ and $\zeta_1 = \cos(\pi z)$. The choice of trigonometric sine and cosine as the trial function gives us the results equivalent of the higher-order Galerkin variant of weighted -residuals method.

IV. LOW-POROSITY MEDIA (VADASZ, 1998) FORMULATION

Let us consider Eqs. (2.24)-(2.26) in a form that would facilitate arriving at the Vadasz (1998) formulation.

$$Va\frac{\partial T}{\partial \tau} = w + \left[\eta\left(\frac{\partial^2 T}{\partial x^2} + \frac{\partial^2 T}{\partial y^2}\right) + \frac{\partial^2 T}{\partial y^2}\right] \tag{4.1}$$

$$\begin{aligned}\frac{\partial}{\partial \tau}(\nabla^2 w) = R_D \nabla_1^2 T + Br_D(1+V_1 z - V_2 z^2)\nabla^4 w - 2Br_D(V_1 - V_2 z)\nabla^2\left(\frac{\partial w}{\partial z}\right) \\ -(1+V_1 z - V_2 z^2)\left(\nabla_1^2 w + \frac{1}{\varepsilon}\frac{\partial^2 w}{\partial z^2}\right) - \frac{1}{\varepsilon}(V_1 - V_2 z)\frac{\partial w}{\partial z} \\ + \sqrt{Va_D}\,\frac{\partial \varsigma}{\partial z} + 2Br_D V_2\left(\nabla_1^2 w - \frac{\partial^2 w}{\partial z^2}\right),\end{aligned} \tag{4.2}$$

$$\begin{aligned}\frac{\partial \zeta}{\partial \tau} = -\sqrt{Va_D}\,\frac{\partial w}{\partial z} - \frac{1}{\varepsilon}(1+V_1 z - V_2 z^2)\zeta - Br_D(V_1 - V_2 z)\frac{\partial \zeta}{\partial z} \\ + Br_D(1+V_1 z - V_2 z^2)\nabla^2 \zeta.\end{aligned} \tag{4.3}$$

In the above equations, the following dimensionless quantities are introduced as done by Vadasz (1998):

$\tau = tDa^{-1}$ (scaled dimensionless time)

$Va = PrDa$ (Vadasz number),

$\sqrt{Va_D} = \sqrt{Ta}\,\mathrm{Da}$ (Taylor-Vadasz number),

$R_D = RDa$ (Darcy-Rayleigh number) and

$Br_D = \Lambda Da$ (Brinkman-Darcy number).

For a low-porosity media, $Br_D = 0$ and hence Eqs.(4.1)-(4.3) read as:

$$\frac{\partial}{\partial \tau}(\nabla^2 w) = R_D \nabla_1^2 T - (1+V_1 z - V_2 z^2)\left(\nabla_1^2 w + \frac{1}{\varepsilon}\frac{\partial^2 w}{\partial z^2}\right)\zeta - \frac{1}{\varepsilon}(V_1 - V_2 z)\frac{\partial w}{\partial z} + \sqrt{Va_D}\,\frac{\partial}{\partial z}, \tag{4.4}$$

$$\frac{\partial \zeta}{\partial \tau} = -\sqrt{Va_D}\,\frac{\partial w}{\partial z}\zeta - \frac{1}{\varepsilon}(1+V_1 z - V_2 z^2)\ . \tag{4.5}$$

Eq. (4.1) remains the same for low-porosity media. Thus Eqs. (4.1), (4.4) and (4.8) are the governing equations for rotating porous-media convection with mechanical and thermal anisotropies, and also temperature-dependent viscosity. We now move on to obtain the Rayleigh number for stationary (R_D^s) and oscillatory (R_D^o) modes of convection for a constant viscosity fluid occupying an anisotropic porous medium. Assuming $V_1 = V_2 = 0$ in the Eqs. (4.4) and (4.5), we get

$$\frac{\partial}{\partial \tau}(\nabla^2 w) + \nabla_1^2 w + \frac{1}{\varepsilon}\frac{\partial^2 w\zeta}{\partial z^2} = R_D \nabla_1^2 T + \sqrt{Va_D}\,\frac{\partial}{\partial z}, \tag{4.6}$$

$$\frac{\partial \zeta}{\partial \tau}+\frac{1}{\varepsilon}\zeta=-\sqrt{Va_D}\,\frac{\partial w}{\partial z}. \qquad (4.7)$$

Through routine procedure, we can easily obtain R_D in the form:

$$\frac{R_D}{\pi^2}=\frac{\left(\frac{Va}{\pi^2}\sigma^*+\frac{\delta_2^2}{\pi^2}\right)\left[\left(\frac{\delta^2}{\pi^2}\sigma^*+\frac{\delta_1^2}{\pi^2}\right)\left(\sigma^*+\frac{1}{\varepsilon}\right)+Va_D\right]}{\frac{a^2}{\pi^2}\left(\sigma^*+\frac{1}{\varepsilon}\right)}. \qquad (4.8)$$

In Eq (4.8) the various symbols have the following definition:

$\delta^2=\pi^2+a^2,\ \delta_1^2=\frac{\pi^2}{\varepsilon}+a^2,\ \delta_2^2=\pi^2+\eta a^2$ and σ^* is, in general complex.

The Rayleigh numbers R_D^s and oscillatory R_D^o can be obtained by substituting $\sigma^*=0$ and $\sigma^*=i\omega$ (ω: frequency of oscillations) respectively, and doing some algebra for oscillatory mode. The expressions of R_D^s and R_D^o are:

$$R_D^s=\frac{\varepsilon\delta_2^2\left[\frac{\delta_1^2}{\varepsilon}+Va_D\pi^2\right]}{a^2}, \qquad (4.9)$$

$$R_D^o=\frac{\delta_2^2\delta_1^2\left(\omega^2+\frac{1}{\varepsilon^2}\right)-Va\omega^2\left(\delta^2\left(\omega^2+\frac{1}{\varepsilon^2}\right)-Va_D\right)\frac{Va_D}{\varepsilon}\delta_2^2}{a^2\left(\omega^2+\frac{1}{\varepsilon^2}\right)}. \qquad (4.10)$$

The frequency of oscillations is given by the following equation:

$$\omega^2=\frac{(\delta_2^2-\frac{Va}{\varepsilon})Va_D}{\left(\delta^2\delta_2^2+Va\delta_1^2\right)}-\frac{1}{\varepsilon^2}. \qquad (4.11)$$

One may easily check that Eq. (4.8) is, indeed, the expression obtained by Vadasz (1998) when it is assumed that $\varepsilon=\eta=1$(isotropic medium). Further, as pointed out by Vadasz (1998), the condition for oscillatory convection to manifest is

$$Va<\varepsilon\delta_2^2 \text{ and } Va_D>\frac{\delta^2\delta_2^2+Va\delta_1^2}{\varepsilon\left[\varepsilon\delta_2^2-Va\right]}.$$

We are unable to derive a condition for over stability like this for the variable viscosity case because of almost impossible tedious algebra involved.

V. RESULTS AND DISCUSSIONS

In the paper a study is made of the effects of temperature-dependent Darcy and Brinkman frictions, and rigid-body rotation on convection in a fluid saturated anisotropic porous medium at the onset of convection.

The temperature dependence of the Darcy and Brinkman frictions arises due to the viscosity varying with temperature. It is important to note here that viscosity decreases with increase in temperature and this relation is exponential in many situations. However, for small temperature gradients one may take a few terms in the Taylor series expansion of the exponential term. If we take just the linear term it can be easily seen that it leads to the result that variable viscosity leads to stabilization which is quite contrary to the physics. In view of this we need to take at least terms up to the quadratic term in the Taylor series. The exponential term must, in the strictest sense, be taken as it is but with the available computational facility it was impossible to do so and hence the truncation in the Taylor series. It is important to make another observation here in regard to the $\mu-T$ relationship. One might have a doubt that some of the obtained results of the paper which seem incorrect are essentially due to the choice of T_0 (temperature of lower boundary) as reference temperature, rather than T_m (mean temperature of upper and lower boundaries). The appendix demonstrates the effect of the choice of T_m in place of T_0. Quite clearly we observe that a linear $\mu - T$ relationship (see Eqs. (A2)) again leads to the result that the variable viscosity leads to stabilization! In view of this we decided on the appropriateness of Eqs. (2.5) and (2.6) for this variable viscosity convection problem.

With the motivation of control of convection, the following effects on the classical Rayleigh- Bénard problem are considered:

i. porous medium inhibition of convection,
ii. anisotropy of the medium ,
iii. variable viscosity and
iv. Coriolis force.

These four effects are, respectively, represented by the inverse Darcy number Da^{-1}, anisotropy parameters (ε, η), variable viscosity parameters (also called thermo rheological parameters) V_1 and V_2 and the Taylor number *Ta*. The present formulation of the porous media problem for an infinite porous layer with rotation parallel to gravity is based on the Chandrasekhar (1961) formulation of the problem in a clear fluid layer. This formulation involves several assumptions (Knobloch, 1998) - the lateral boundaries are far enough not to influence rotating convection and that the Froude number is quite small. The latter assumption facilitates the restoration of the conduction state as an equilibrium solution. Experimentally, the lateral boundary effect and the centrifugal effect have been shown by Ecke *et al*. (1992) to be quite important but in a theoretical study to keep the problem manageable and focus on Bénard -like situations, it is common place to exclude these effects. The main emphasis of the present study is to consider the effect of temperature-dependent viscosity on the onset of convection via the stationary or oscillatory modes. Before embarking on a discussion of the results depicted by the figs. 1 to 10, we note that as in the case of clear fluid critical convection is always stationary as overstable motion is restricted to very low values of the Prandtl number, when Da^{-1} is quite large. For low values of Da^{-1}, the critical value is stationary or overstable.

Fig. (1a) reveals that the effect of increasing quadratic thermo rheological parameter V_2 is to destabilize the system for small rotation rates and clearly for these rotation rates the effect of varying Da^{-1} is also discernible. We further find from Fig. (1b) that, as the rotation rate is increased, its effect is the same for all values of Da^{-1}. This is due to the fact that large rotations do not allow the internal structure of the porous medium to affect convection. In addition we also observe that at large rotation rates the effect of increasing V_2 is to stabilize convection. This is one surprise result. Such surprising results also arise in the case of very small Da^{-1} with respect to the influence of the anisotropy parameters on the onset of convection. This result may also be due to the fact that the choice of terms up to the quadratic is inadequate in the viscosity-temperature relationship. As mentioned earlier computations beyond what has been done is impossible with the available computers in the department.

Fig. (2a,b) reveals that the effect of increasing Da^{-1} is to increase the cell size at the onset of convection for all rotation rates. This result can be seen from the fact that the wave length is inversely proportional to the wave number.

At small rotation rates up to a particular value of V_2 the effect of increasing ε is to decrease the value of R_c^s and then beyond that particular value the reverse effect is seen. However, at high rotation rates, we see that the effect of increasing ε is to increase R_c^s and η does not have a similar effect. The above results are seen in Fig. (3a, b, c). We have seen that for higher rotation rates the result is similar to that in Fig. (3c).

The effect of increasing V_2 and ε is to decrease the cell size at onset and the reverse effect is seen in the case of increasing η and these are clearly demonstrated in figs. (4a,b,c). The effect of high rotation rates together with the other varying parameters is as seen earlier (see Fig. 4c).

In what follows we discuss the results of oscillatory convection which is possible in the case of small Prandtl numbers for high-porosity media. It is interesting to note that this is different from the case of low-porosity media wherein oscillatory convection may exist for low values of Da^{-1} and depending on other parameters including a scaled Taylor number.

Fig. (5) shows the destabilizing effect of V_2 on R_c^o for high rotation rates. We have included the result of just two rotation rates here as a representative plot of all rotation rates in the case of high-porosity media. Fig. (6) is a result that is opposite to that of stationary convection (see Figs. 2a, b). The frequency of oscillations is, shown in Fig. (7), to increase with increase in *Ta,* and decrease with decrease in Da^{-1}. The effects of increasing ε and η are opposite to each other and the same is shown in Fig. (8).This result is similar to what we saw in the case of stationary convection. The surprises in results on comparing the low and high rotation ones are similar to the ones of stationary convection. Comparing Figs. (4c) and (9) we find that the results of increasing ε and η are qualitatively similar for stationary and oscillatory convection. Fig. (10) shows that the frequency of oscillations increases with increase in ε and η.

Due to the restriction of pages we now mention the result of computation on the effect of Λ on R_c^s, R_c^o, a_c^s, a_c^o and ω_c. Computation reveals a surprising result at low and high rotation rates in the case of varying Λ. We find that the effect of Λ on R_c^s and R_c^o are not the same at the extremes of low and high rotation rates. We are unable to reason this out. Clearly at low rotation rates the result of increasing Λ is the same as what we see in the case of no rotation. This aspect of the problem needs further investigation. In spite of such a result in the case of R_c^s, there is no such result in the case of a_c^s. Computation shows that the effect of Λ on R_c^o and a_c^o is similar to the case of stationary convection. In the case of low rotation rate the effect is opposite to that of the high rotation rate and this is true of many other parameters as well, as noted earlier. We find that the effect of increasing Λ, in the case of high rotation rates, is to decrease the frequency of oscillations and the opposite is seen in the case of low rotation rates. The reasoning for the results, as seen in the paper, for high rotation rates is the same as that put forward by Chandrasekhar (1961) for clear fluid and Vadasz (1998) for porous media.

We have not included a comparison of our numerical results with those of Vadasz for constant viscosity fluid occupying rotating porous media of low porosity. It is a fact that our results match quite well with those relevant ones available in the literature.

VI. Conclusions

Oscillatory convection is preferred for small values of the Prandtl number in the case of rotating convection in high-porosity media. At high rates of rotation, the internal structure of the porous medium does not affect convection, and also viscosity destabilizes the system. This is in concurrence with classical results of Chandrasekhar (1961) and Vadasz (1998). In the presence of rotation, the effect of anisotropy parameters may not be the same (in fact some times the effect is opposite) as what is observed in its absence. This result can be easily extracted if one obtains the derivative of the eigen value of the problem with respect to the parameter under question.

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APPENDIX A

Calculation of critical value of Rayleigh and wave numbers for the viscosity-temperature relationship as taken by Nield (1996)

Nield (1996) assumed a viscosity-temperature relationship in the form

$$\mu_f(T) = \frac{\mu_1}{1 + a(T - T_m)}, \qquad \mu_p(T) = \frac{\mu_2}{1 + a(T - T_m)}. \tag{A1}$$

We have presented the $\mu - T$ relationship of Nield (1996) in a way that is in keeping with the requirements of our paper. On using Taylor series expansion in Eq. (A1) and truncating beyond the second term, we get

$$\left.\begin{aligned} \mu_f(T) &= \mu_1\left[1 - \Gamma_1\left(T - T_m\right)\right], \\ \mu_p(T) &= \mu_2\left[1 - \Gamma_1\left(T - T_m\right)\right], \end{aligned}\right\} \tag{A2}$$

where $T_m = T_0 + \frac{\Delta T}{2}$.

We assume the following equation of state:

$$\rho = \rho_R\left[1 - \alpha\left(T - T_m\right)\right] \tag{A3}$$

Adopting the procedure of the main paper with the above relationship we get the following equations in place of Eq. (2.24) and Eq. (2.25):

$$\frac{\partial}{\partial t}\nabla^2 w = R\nabla_1^2 T + \Lambda\left[1+V\left(z+\frac{1}{2}\right)\right]\nabla^4 w + 2\Lambda V\,\nabla^2\left(\frac{\partial w}{\partial z}\right) - Da^{-1}\left[1+V\left(z+\frac{1}{2}\right)\right]\nabla_1^2 w$$

$$-\frac{Da^{-1}}{\varepsilon}\left[1+V\left(z+\frac{1}{2}\right)\right]\frac{\partial^2 w}{\partial z^2} - \frac{Da^{-1}}{\varepsilon}V\frac{\partial w}{\partial z} - \sqrt{Ta}\,\frac{\partial \zeta}{\partial z}, \tag{A4}$$

$$\frac{\partial \zeta}{\partial t} = \sqrt{Ta}\,\frac{\partial w}{\partial z} - \frac{Da^{-1}}{\varepsilon}\left[1+V\left(z+\tfrac{1}{2}\right)\right]\zeta - \Lambda V\frac{\partial \zeta}{\partial z} + \Lambda\left[1+V\left(z+\tfrac{1}{2}\right)\right]\nabla^2\zeta, \tag{A5}$$

where $V = \Gamma_1 \Delta T,$ the variable viscosity parameter for the Nield viscosity-temperature relationship. The boundary conditions are given by Eq. (2.27). Applying the normal mode solution (2.28) into the above equations and applying one-term weighted residual Galerkin method, we get the following equation for R, for both stationary and oscillatory modes in the form:

Stationary convection

$$R^s = \frac{H_3\left(H_1H_4 + TaL_1A_9\right)}{a^2 H_4 I_8^2}. \tag{A6}$$

Oscillatory instability

$$R^o = \frac{H_3 H_4\left(H_1 H_4 + TaL_1 I_9\right) + \omega^2\left(H_1H_3L_5^2 - \Pr J_2\left\{\begin{array}{c} L_1L_5I_9Ta + H_2H_4^2 \\ +\,\omega^2 L_5^2 H_2\end{array}\right\}\right)}{a^2 I_8^2\left(H_4^2 + \omega^2 L_5^2\right)}, \tag{A7}$$

where

$$\omega^2 = \frac{-\left[H_2H_3H_4^2 + H_3L_1L_5I_9Ta + \Pr J_2H_4\left(H_1H_4 + TaL_1I_9\right)\right]}{L_5^2\left(\Pr J_2H_1 + H_2H_3\right)}, \tag{A8}$$

which is the square of the frequency of oscillations.

$$H_1 = \Lambda\left(I_1 + a^4I_2 - 2a^2I_3\right) - 2\Lambda\left(I_4 - a^2I_5\right) + 2\Lambda V_2\left(-I_6 + a^2I_7\right)$$

$$+ Da^{-1}a^2I_2 - \frac{Da^{-1}}{\varepsilon}\left(I_3 + I_5\right),$$

$$H_2 = \left(I_6 + a^2I_7\right), H_3 = J_1 + \eta_1 a^2 J_2, H_4 = \Lambda\left(L_2 - a^2L_3\right) + \Lambda L_4 - \frac{Da^{-1}}{\varepsilon}L_3,$$

$$I_1 = \left\langle w_1\left[1+V\left(z+\tfrac{1}{2}\right)\right]D^4w_1\right\rangle, I_2 = \left\langle w_1\left[1+V\left(z+\tfrac{1}{2}\right)\right]w_1\right\rangle,$$

$$I_3 = \left\langle w_1\left[1+V\left(z+\tfrac{1}{2}\right)\right]D^2w_1\right\rangle, I_4 = \left\langle w_1D^3w_1\right\rangle, I_5 = \left\langle w_1Dw_1\right\rangle,$$

$$I_6 = \left\langle \left(Dw_1\right)^2\right\rangle, I_7 = \left\langle w_1^2\right\rangle, I_8 = \left\langle w_1T_1\right\rangle, I_9 = \left\langle w_1D\zeta_1\right\rangle, J_1 = \left\langle \left(DT_1\right)^2\right\rangle, J_2 = \left\langle T_1^2\right\rangle,$$

$$L_1 = \langle \zeta_1 D w_1 \rangle, L_2 = \left\langle \zeta_1 \left[1 + V\left(z + \tfrac{1}{2}\right)\right] D^2 \zeta_1 \right\rangle, L_3 = \left\langle \zeta_1 \left[1 + V\left(z + \tfrac{1}{2}\right)\right] \zeta_1 \right\rangle,$$

$$L_4 = \langle \zeta_1 D \zeta_1 \rangle, L_5 = \left\langle \zeta_1^2 \right\rangle,$$

$$H_1 = \Lambda\left(I_1 + a^4 I_2 - 2a^2 I_3\right) - 2\Lambda\left(I_4 - a^2 I_5\right) + 2\Lambda V_2\left(-I_6 + a^2 I_7\right)$$

$$+ Da^{-1} a^2 I_2 - \frac{Da^{-1}}{\varepsilon}\left(I_3 + I_5\right),$$

$$H_2 = \left(I_6 + a^2 I_7\right), H_3 = J_1 + \eta_1 a^2 J_2, H_4 = \Lambda\left(L_2 - a^2 L_3\right) + \Lambda L_4 - \frac{Da^{-1}}{\varepsilon} L_3,$$

$$I_1 = \left\langle w_1 \left[1 + V\left(z + \tfrac{1}{2}\right)\right] D^4 w_1 \right\rangle, I_2 = \left\langle w_1 \left[1 + V\left(z + \tfrac{1}{2}\right)\right] w_1 \right\rangle,$$

$$I_3 = \left\langle w_1 \left[1 + V\left(z + \tfrac{1}{2}\right)\right] D^2 w_1 \right\rangle, I_4 = \left\langle w_1 D^3 w_1 \right\rangle, I_5 = \langle w_1 D w_1 \rangle,$$

$$I_6 = \left\langle \left(D w_1\right)^2 \right\rangle, I_7 = \left\langle w_1^2 \right\rangle, I_8 = \langle w_1 T_1 \rangle, I_9 = \langle w_1 D \zeta_1 \rangle, J_1 = \left\langle \left(D T_1\right)^2 \right\rangle, J_2 = \left\langle T_1^2 \right\rangle,$$

$$L_1 = \langle \zeta_1 D w_1 \rangle, L_2 = \left\langle \zeta_1 \left[1 + V\left(z + \tfrac{1}{2}\right)\right] D^2 \zeta_1 \right\rangle, L_3 = \left\langle \zeta_1 \left[1 + V\left(z + \tfrac{1}{2}\right)\right] \zeta_1 \right\rangle,$$

$$L_4 = \langle \zeta_1 D \zeta_1 \rangle, L_5 = \left\langle \zeta_1^2 \right\rangle,$$

$\langle \cdots \rangle$ denotes integration with respect to z between z = 0 and z = 1.

The critical value of R and a obtained from Eqs. (A6) and (A7) are documented in tables 1 and 2 for both stationary and oscillatory modes of convection.

Table 1

Ta	Da^{-1}	ε	η	Λ	V					
					0.0		0.3		0.6	
					R_c^s	a_c^s	R_c^s	a_c^s	R_c^s	a_c^s
10^3	30	1.2	1.2	1.2	2614.2	2.8474	3143.5	2.7169	3689.2	2.6450
10^4					5956.6	4.2027	6040.1	3.7639	6255.1	3.4736
10^4	10	1.2	1.2	1.2	5983.4	4.8652	5885.6	4.3663	5889.8	4.0114
	20				5951.4	4.5069	5931.7	4.0300	6031.0	3.7026
	30				5956.6	4.2027	6040.1	3.7639	6255.1	3.4736
10^4	30	0.8	1.2	1.2	5619.5	3.9822	5824.8	3.6041	6169.8	3.3648
		1			5801.0	4.1029	5930.9	3.6883	6196.9	3.4192
		1.2			5956.6	4.2027	6040.1	3.7639	6255.1	3.4736
10^4	30	1.2	0.8	1.2	4577.9	4.4412	4737.1	4.0031	4981.8	3.7101
			1		5273.8	4.3090	5396.6	3.8708	5627.6	3.5795
			1.2		5956.6	4.2027	6040.1	3.7639	6255.1	3.4736
10^4	30	1.2	1.2	0.8	6053.6	4.6039	6068.4	4.0905	6086.3	3.7504
				1	5987.4	4.3847	6004.4	3.9126	6160.1	3.6001
				1.2	5956.6	4.2027	6040.1	3.7639	6255.1	3.4736

R_c^s **and** a_c^s for different parameters when μ - T relationship is linear.

Table 2

Ta	Da^{-1}	ε	η	Λ	V								
					0.0			0.3			0.6		
					R_c^o	a_c^o	ω_c	R_c^o	a_c^o	ω_c	R_c^o	a_c^o	ω_c
10^3	30	1.2	1.2	1.2	5141.3	2.6429	----	7072.6	2.6650	----	9182.5	2.6845	----
10^4					5605.3	2.8548	34.229	7636.3	2.8539	----	9833.6	2.8546	----
10^5					8422.4	3.7705	155.42	11187.0	3.7208	138.62	14070.4	3.6750	118.31
10^4	10	1.2	1.2	1.2	5593.5	3.5987	176.66	7537.1	3.5573	167.31	9162.9	3.5182	157.13
	20				7001.4	3.7007	165.69	9255.0	3.6545	153.00	11584	3.6113	138.49
	30				8422.4	3.7705	155.42	11187.0	3.7208	138.62	14070.4	3.6750	118.31
10^4	30	0.8	1.2	1.2	9975.5	3.8761	141.44	13360.7	3.8279	116.82	16938.9	3.7843	82.281
		1			9039.7	3.8158	149.42	12048.2	3.7666	130.36	15203.7	3.7215	105.56
		1.2			8422.4	3.7705	155.42	11187.0	3.7208	138.62	14070.4	3.6750	118.31
10^4	30	1.2	0.8	1.2	7742.4	4.0924	132.86	10293.9	4.0218	109.28	12961.5	3.9575	76.662
			1		8088.7	3.9160	142.90	10748.9	3.8575	121.72	16425.9	3.7546	50.442
			1.2		8422.4	3.7705	155.42	11187.0	3.7208	138.62	14070.4	3.6750	118.31
10^4	30	1.2	1.2	0.8	6847.6	3.9084	161.64	9270.4	3.8679	149.23	11376.4	3.8308	134.92
				1	7634.8	3.7882	158.73	10127.2	3.7882	144.21	12719.8	3.7462	127.10
				1.2	8422.4	3.7705	155.42	11187.0	3.7208	138.62	14070.4	3.6750	118.31

R_c^o, a_c^o **and** ω_c for different parameters when $\mu - T$ relationship is linear.

(The broken lines in certain columns indicate that oscillatory convection is not preferred for that particular parameters's combination)

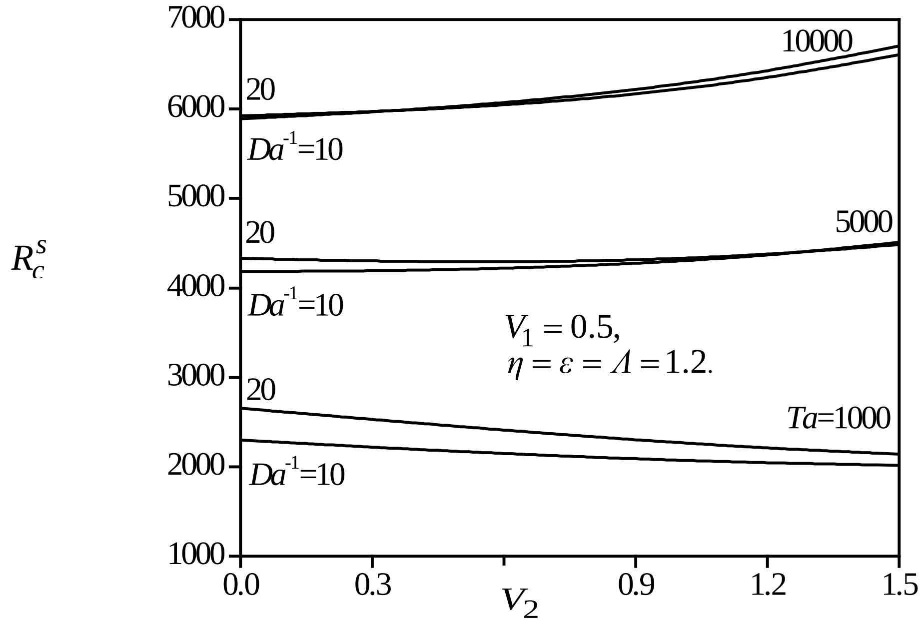

Fig. 1a: Plot of critical Rayleigh number R_c^s (stationary) Vs. quadratic variable viscosity parameter V_2 for different values of porous parameter Da^{-1} and Taylor number ***Ta.***

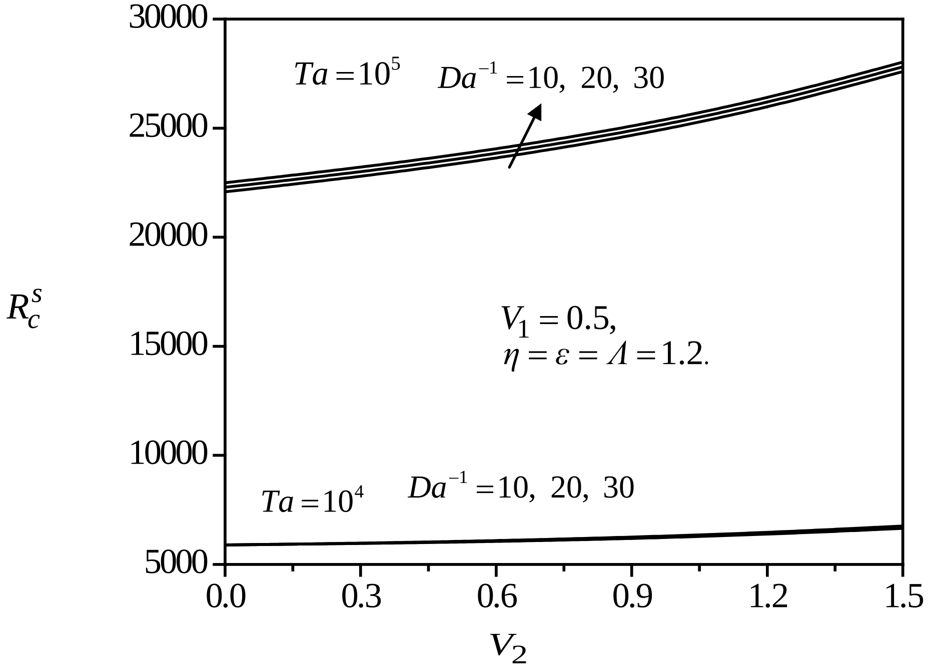

Fig. 1b: Plot of R_c^s (stationary) Vs. V_2 for different values of Da^{-1} and Ta.

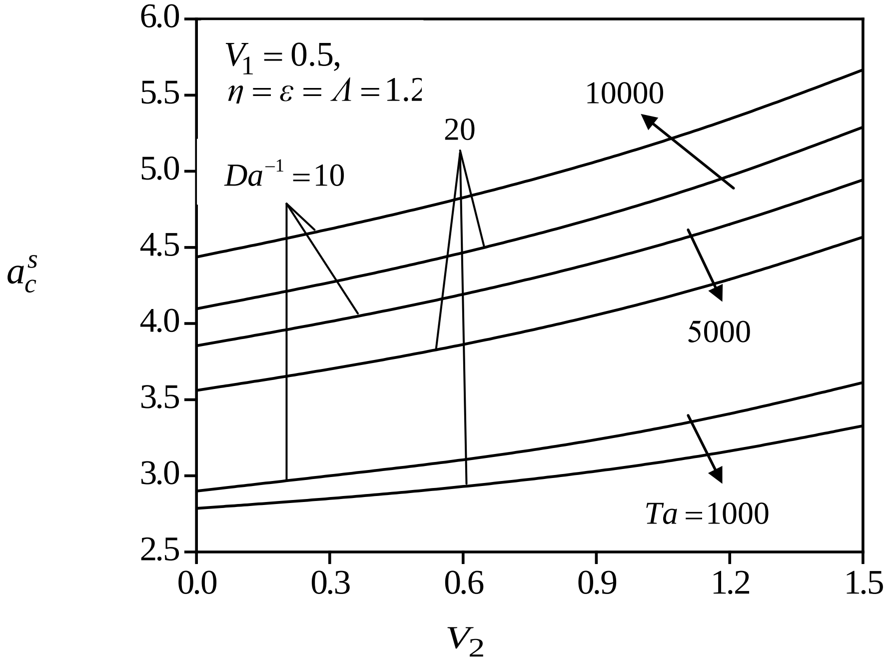

Fig. 2a: Plot of critical wave number a_c^s (stationary) Vs. V_2 for different values of Da^{-1} and Ta

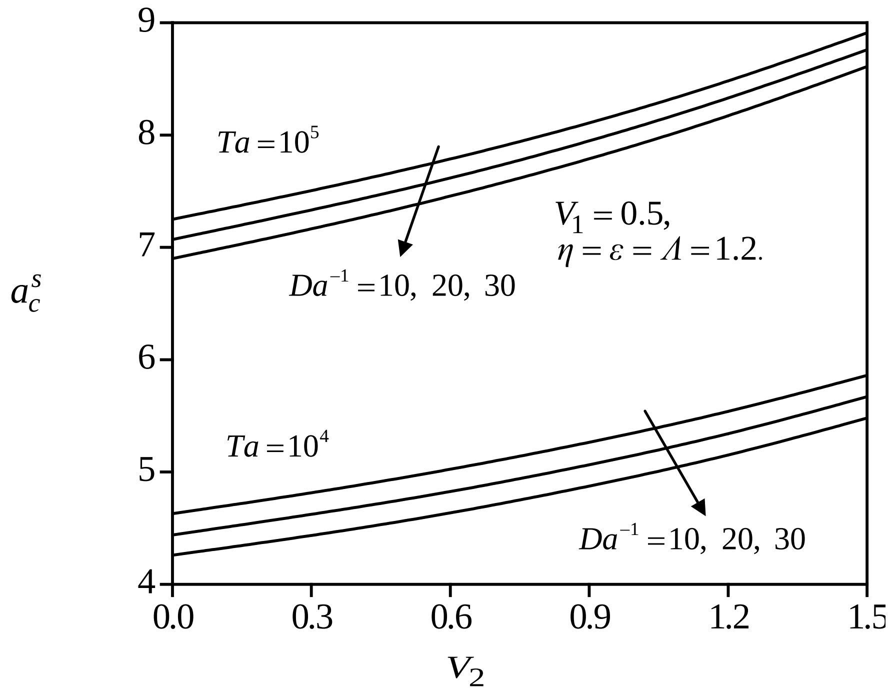

Fig. 2b: Plot of a_c^s (stationary) Vs. V_2 for different values of Da^{-1} and Ta

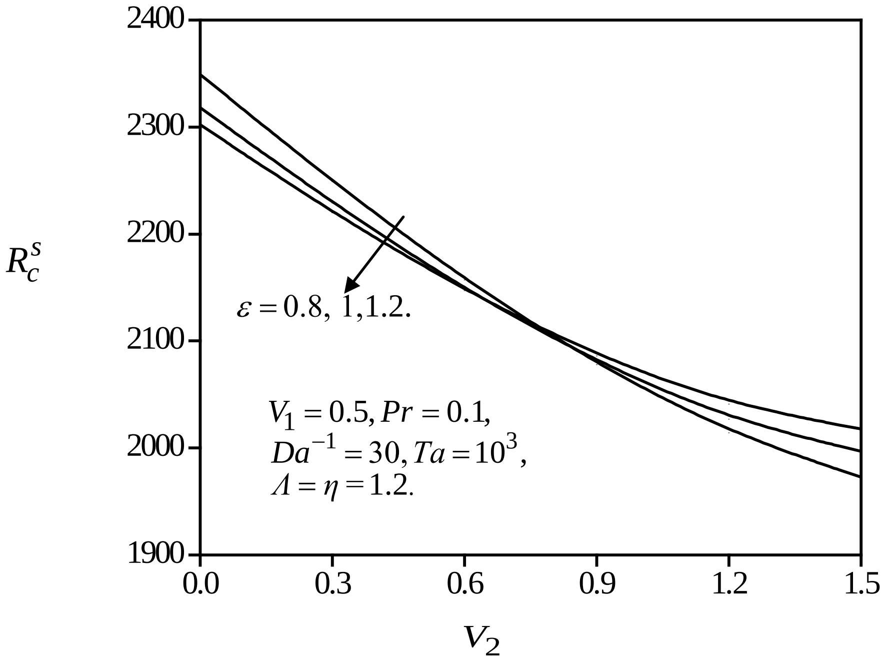

Fig. 3a: Plot of R_c^s Vs. V_2 for different values of ε.

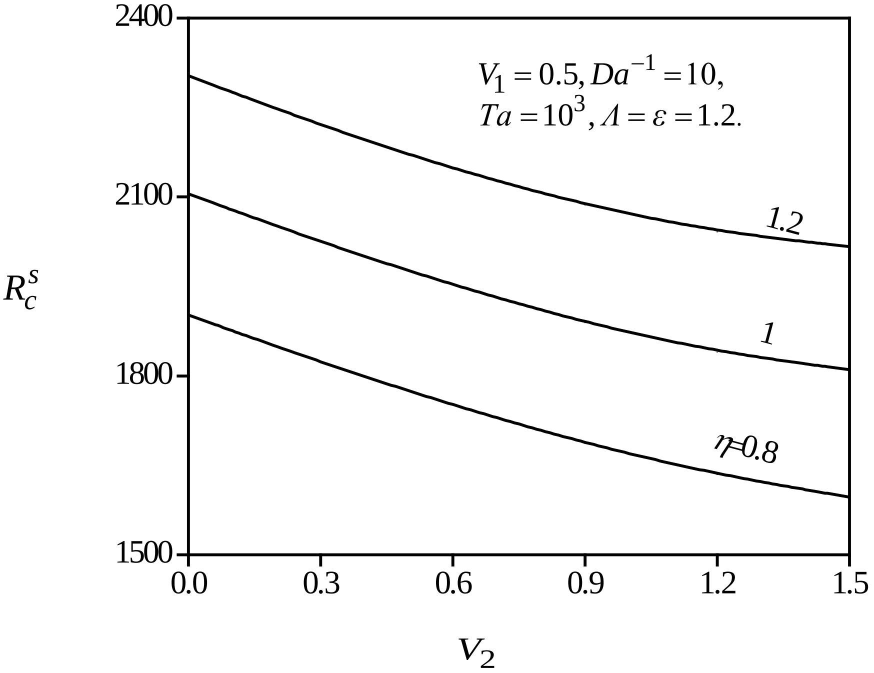

Fig. 3b: Plot of R_c^s Vs. V_2 for different values of η.

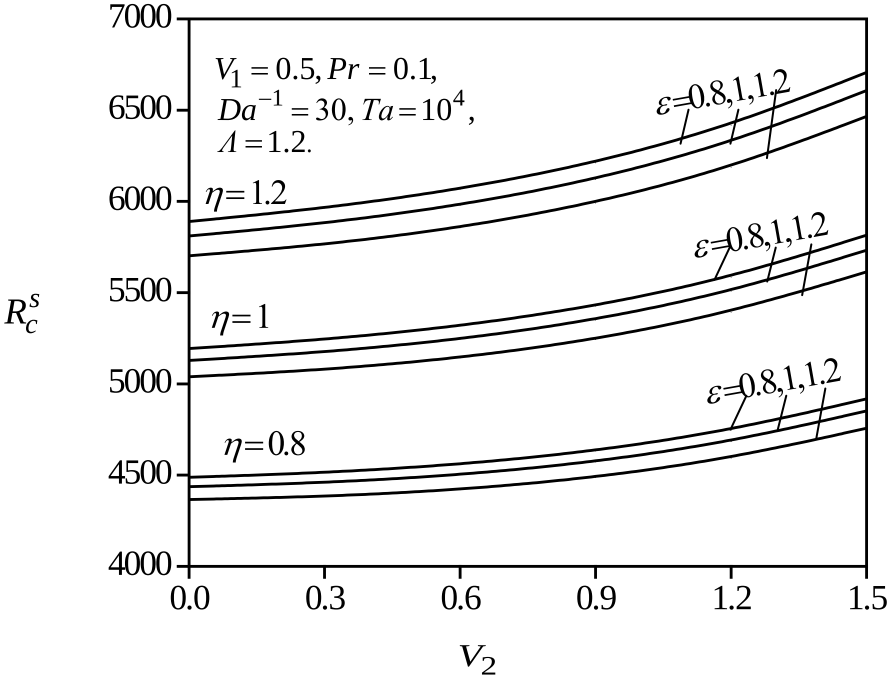

Fig. 3c: Plot of R_c^s Vs. V_2 for different values of thermal and mechanical anisotropy parameters η and ε.

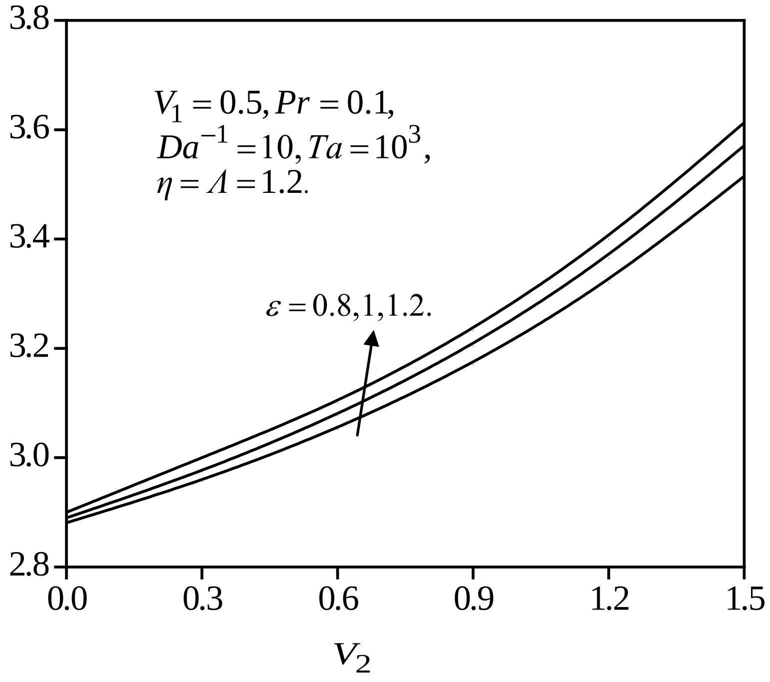

Fig. 4a: Plot of $\boldsymbol{a_c^s}$ Vs. $\boldsymbol{V_2}$ for different values of $\boldsymbol{\varepsilon}$.

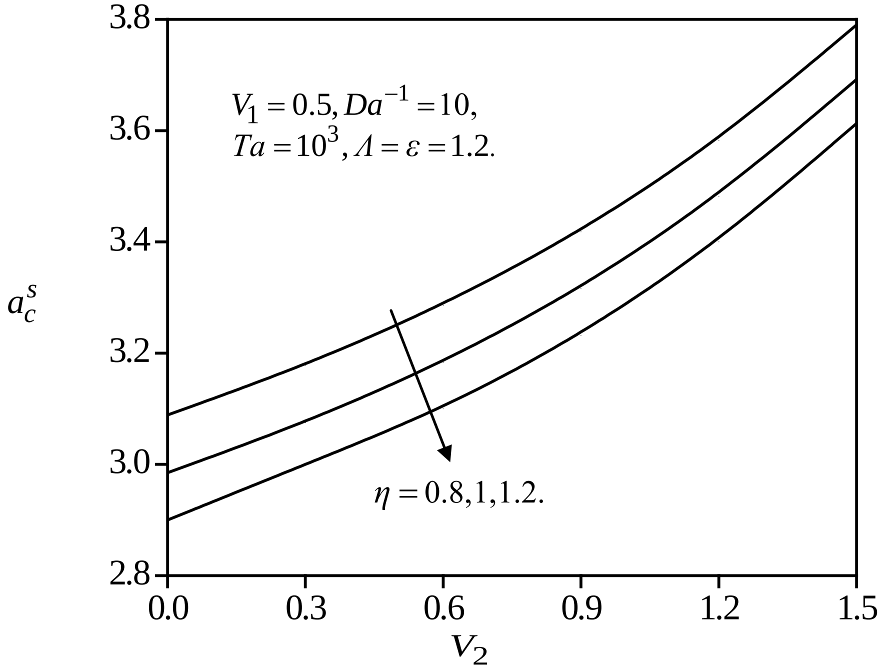

Fig. 4b: Plot of $\boldsymbol{a_c^s}$ Vs. $\boldsymbol{V_2}$ for different values of $\boldsymbol{\eta}$.

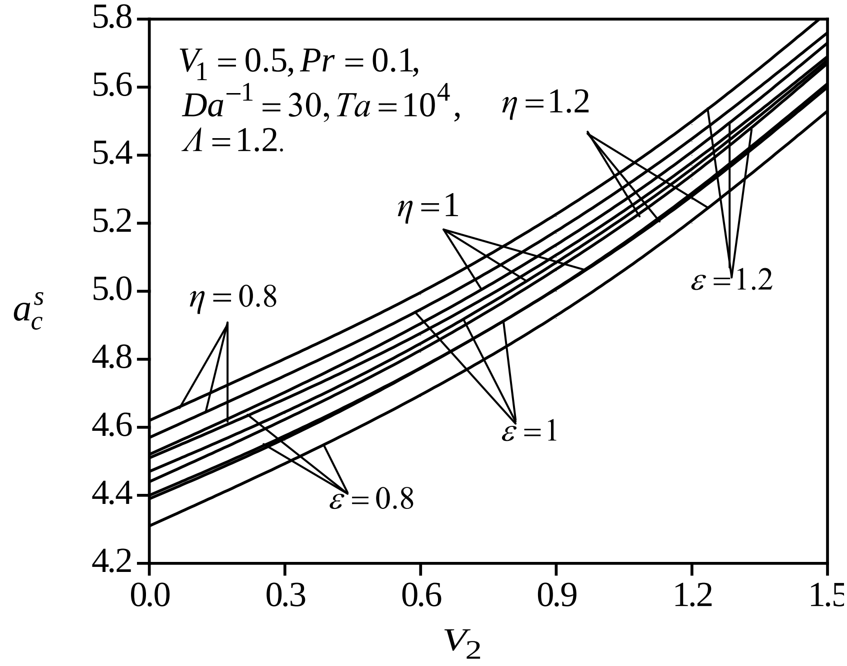

Fig. 4c: Plot of a_c^s Vs. V_2 for different values of η and ε.

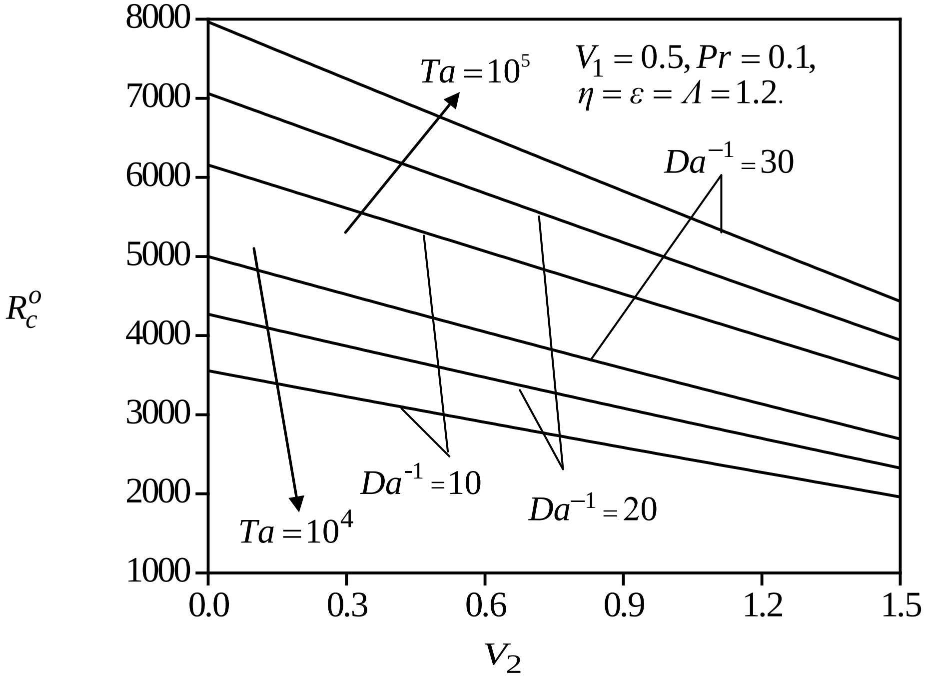

Fig. 5: Plot of R_c^o (oscillatory) Vs. V_2 for different values of Da^{-1} and Ta.

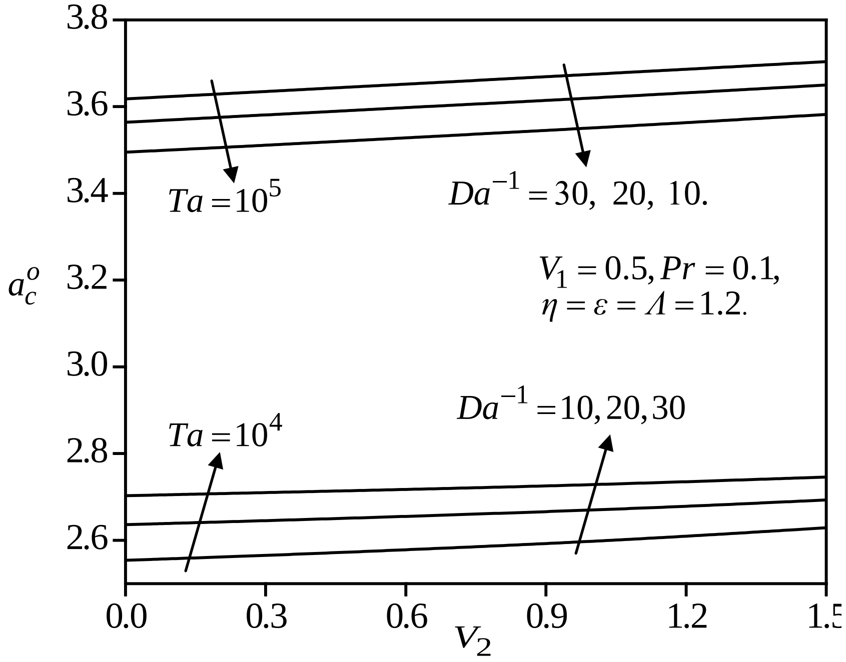

Fig. 6: Plot of a_c^o (oscillatory) Vs. V_2 for different values of Da^{-1} and Ta .

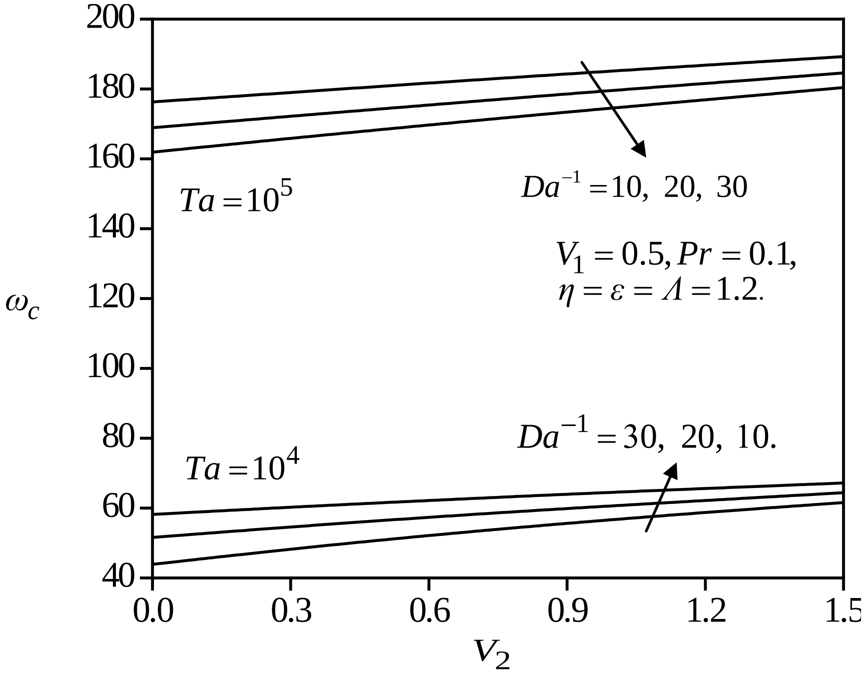

Fig. 7: Plot of ω_c Vs. V_2 for different values of Da^{-1} and Ta .

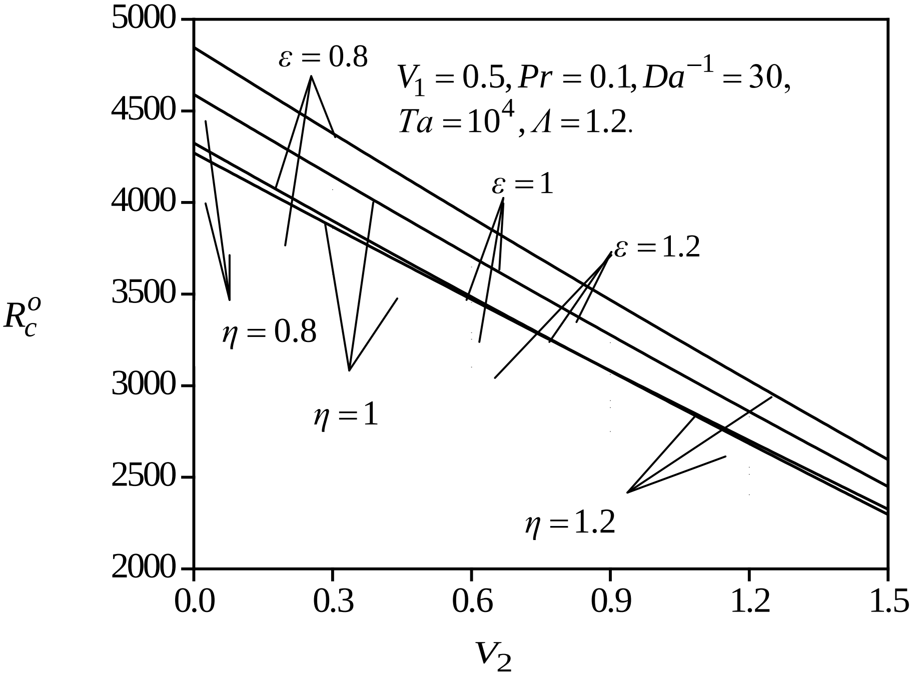

Fig. 8: Plot of $\boldsymbol{R_c^o}$ Vs. $\boldsymbol{V_2}$ for different values of $\boldsymbol{\eta}$ and $\boldsymbol{\varepsilon}$.

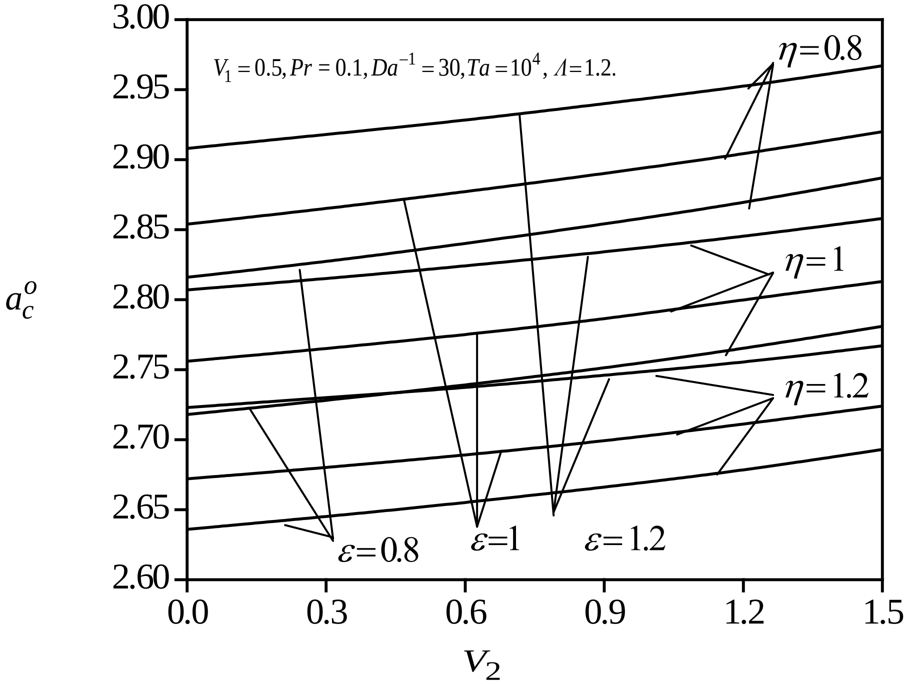

Fig. 9: Plot of $\boldsymbol{a_c^o}$ Vs. $\boldsymbol{V_2}$ for different values of $\boldsymbol{\eta}$ and $\boldsymbol{\varepsilon}$

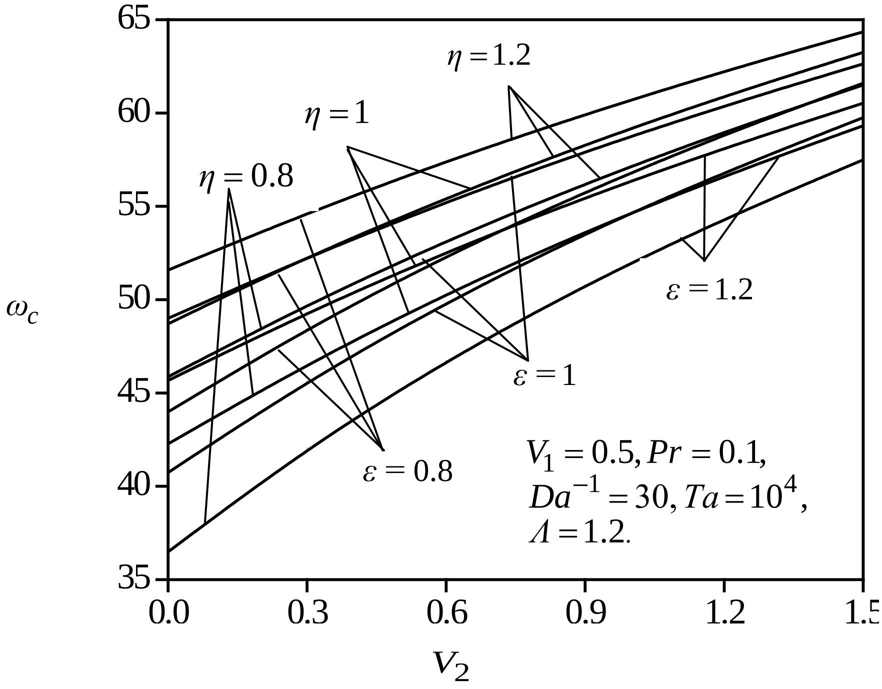

Fig. 10: Plot of $\boldsymbol{\omega_c}$ Vs. $\boldsymbol{V_2}$ for different values of $\boldsymbol{\eta}$ and $\boldsymbol{\varepsilon}$.

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Is there a Magnetic Field and a Vector Potential of the Electric Field

By F. F. Mende

Abstract- The beginning to electrodynamics assumed such put outting themselves of physics as amperes, Faraday, Veber, Maxwell. These scientists on the primitive research equipment established those laws, which we use to the these rapids. They were geniuses and they could examine in the dark of prejudices and superstition the top of that huge iceberg, which the electrodynamics is. But those contradictions and disagreement, which occur in the electrodynamics and today, they speak, that not all problems are already solved. In Maxwell's equations is not contained the information about power interaction of the current carrying systems, but the Lorentz force, which defines such an interaction, it is introduced as hotel experimental postulate. Therefore electrodynamics itself consists as of two not connected together parts. From one side this of Maxwell's equations, which give the possibility to obtain wave equation for the electromagnetic waves, while another – postulate about the Lorentz force, which makes it possible to calculate power interaction of the current carrying systems. Magnetic field is also introduced not on the basis experimental facts and does not be founded upon basis.

Keywords: electrodynamics, maxwell's equation, ampere law, magnetic field, equation of induction, magnetic vector potential, electrical vector potential, lorentz force.

GJSFR-A Classification: FOR Code: 020107

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Keywords: electrodynamics, maxwell's equation, ampere law, magnetic field, equation of induction, magnetic vector potential, electrical vector potential, lorentz force.

I. INTRODUCTION

In the existing classical electrodynamics unavoidable crisis phenomena still at the beginning of past century were outlined. Already then it was clear that Maxwell's equations do not include the rules of conversion fields on upon transfer of one inertial system (IS) into another. And there was no understandable as in the limits of electrodynamics existing on that day such conversion to obtain. This a question was solved by volitional method by the way of introduction into the electrodynamics of two postulates of the special theory of relativity (SR). Quotation from the work reflects well the characteristic of this theory [1]: "The theory of relativity arose as a result the prolonged accumulation of the experimental material, which led to the deep conversion of our physical ideas about the forms of material and motion. And other physical quantities to the newly open experimental facts it was revealed after the whole series of the attempts to adapt previous ideas about the space, time that for these purposes it is necessary to reconstruct all these concepts radically. This task was executed in basic a. By Einstein in 1905 (special theory of relativity) and in 1915 (general theory of relativity). In other the task was executed was only in the sense that given the ordered formal mathematical description of new state of affairs. The task of the deep, really physical substantiation of this mathematical diagram still stands before physics".

In Maxwell's equations also is not contained the information about power interaction of the current carrying systems, but the Lorentz force, which defines such an interaction, it is introduced as hotel experimental postulate. Therefore electrodynamics itself consists as of two not connected together parts. From one side this of Maxwell's equations, which give the possibility to obtain wave equation for the electromagnetic waves, while another – postulate about the Lorentz force, which makes it possible to calculate power interaction of the current carrying systems.

Since in the electrodynamics are units logic not connected together and other omissions, i.e. it is not possible to consider as the united final science, in which there are united beginnings, from which follow all its laws. But for this difficult and to design. The beginning to electrodynamics assumed such put outting themselves of physics as amperes, Faraday, Veber, Maxwell. These scientists on the primitive research equipment established those laws, which we use to the these rapids. They were geniuses and they could examine in the dark of prejudices and superstition the top of that huge iceberg, which the electrodynamics is. But those contradictions and disagreement, which occur in the electrodynamics and today, they tell us, that is similar, in spite of its brilliance, they in the electrodynamics of something did not notice.

II. INTERACTION OF ELECTRONIC FLUXES AND BIAS CURRENTS

In the classical mechanics the force, which acts on the fixed body is determined the gradient of scalar potential φ , which it presents potential energy of body in the assigned field

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$$\mathbf{F}_{\Pi}=-grad\ \varphi .$$

In the case of the rectilinear inertial motion of body a change in its energy is connected with the action on it of the force

$$\mathbf{F}_{K}=m\mathbf{a} .$$

In this case a velocity increment is always connected with this force coincides with it in the direction. And we know in the mechanics not of one such example, if in the case of rectilinear motion a velocity increment led to the appearance of forces, normal to the direction of motion.

But in the electrodynamics this example is located. This is Lorentz force

$$\mathbf{F}_{L}=e\left[\mathbf{v}\times\mathbf{B}\right]=e\mu\left[\mathbf{v}\times\mathbf{H}\right].$$

This force even during the inertial motion of charge, for example in the superconductors, is directed normal to the direction of the motion of charge. And arises question, is actual whether this some new law, or this incomprehension of physical nature of this force. Let us immediately point out that the introduction of Lorentz force is not the consequence of some generalizations, based on the laws of mechanics or electrodynamics, but it is introduced as the separate experimental postulate, which generalizes experimental data.

Magnetic field was introduced by ampere by phenomenological way on the basis of the observation of power interaction between the conductors, along which flows the current. The Ampere law, expressed in the vector form, determines magnetic field at the point

$$\mathbf{H}=\frac{1}{4\pi}\int\frac{I\left[d\mathbf{l}\ \ \mathbf{r}\right]}{r^{3}} ,$$

where I - current in the element $d\mathbf{l}$, $\mathbf{r}$ - vector, directed from to the point $d\mathbf{l}$ (Fig.1) .
It is possible to show that

$$\frac{[d\mathbf{l}\mathbf{r}]}{r^{3}}=\left[grad\left(\frac{1}{r}\right)d\mathbf{l}\right] ,$$

and, besides the fact that

$$\left[grad\left(\frac{1}{r}\right)d\mathbf{l}\right]=rot\left(\frac{d\mathbf{l}}{r}\right)-\frac{1}{r}rotd\mathbf{l} .$$

Fig. 1: The formation of vector potential by the element of the conductor dl , along which flows the current I .

But the rotor $d\mathbf{l}$ is equal to zero and therefore is final

$$\mathbf{H}=rot\int I\left(\frac{d\mathbf{l}}{4\pi r}\right)=rot\mathbf{A}_{H} ,$$

where

$$\mathbf{A}_{H}=\int I\left(\frac{d\mathbf{l}}{4\pi r}\right) \qquad (1.1)$$

vector potential of magnetic field.

It was also established that the scalar product of vector potential and charge rate, which moves in the field of this potential, presents the potential energy

$$W_{\Pi}=e\mu(\mathbf{vA}) .$$

The gradient of this energy gives the force, which acts on the charge

$$\mathbf{F}_{\Pi}=-grad\ W_{\Pi}=e\mu\ grad(\mathbf{vA}). \qquad (1.2)$$

In this posing of the question one should recognize that the field of scalar potential possesses special property to convert the kinetic motion of charge into the potential energy, which also does not tally to the fundamental laws of mechanics.

We already indicated that the introduction and magnetic fields and Lorentz forces are the generalization of experimental facts and are in fact the postulates, which are introduced without the proper understanding of physical nature of these parameters.

However, one essential inaccuracy is allowed during the formal introduction of these values. Looking at the given relationships to easily see that they are recorded for the secluded flow of the charged particles. And here we immediately encounter an unavoidable deficiency in the concept of magnetic field. Two parallel electronic fluxes, charges in which move with the identical speed, besides Coulomb repulsion must still and be attracted in accordance with it. That this so, it is not difficult to show, if we use ourselves the relationships (1.1, 1.2). But if we pass into the inertial system, which moves with the electron velocity, then vector potential will there be absent and only Coulomb repulsion will remain. This nonconformity of the conclusions, which follow from the relationships (1.1, 1.2), connected with the fact that the experiments, on basis of which was introduced the magnetic field and the vector potential they were carried out not on the secluded electronic fluxes, but on the conductors, along which it flows current. Such conductors, besides the moving electrons have positively charged crystal lattice (Fig. 2), which in the existing theory is not considered.

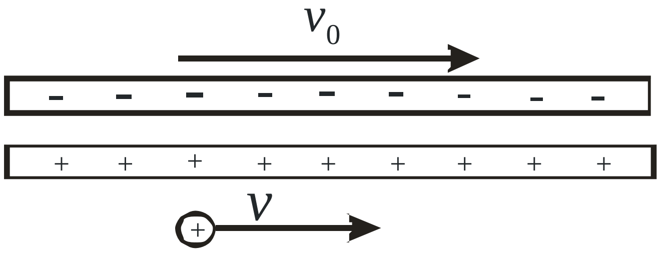

Fig. 2: Conductor with the current, along which moves the observer

In the conductors the density of positive and negative charges is identical, therefore they are neutral and electric field in them is absent. In the figure for larger convenience in the examination the system of positive and negative charges is moved on the vertical line. If electron stream moves with speed v, that for the fixed observer current will be determined by the relationship

$$I = nev_0 \pi r^2 ,$$

where e and n - charge and electron density, and r - a radius of conductor.

If observer moves, the like to relation to it will move the charges of the positively charged lattice, which is equivalent to reverse electron motion. The full current for the moving observer will be written down taking this into account.

$$I_\Sigma = ne(v_0 - v)\pi r^2 + nev\pi r^2 = nev_0 \pi r^2$$

Thus, full current for the fixed and for the moving observer proves to be identical. And again this conclusion does not correspond to reality, since. the Lorentz force acts on the moving charge, while no to – the fixed.

In the classical electrodynamics there exists two completely equivalent situations, which at the experimental level give different results. The concept of magnetic field consists in the fact that any flow of the moving charged particles generates around itself axial magnetic field. If in this magnetic field another flow of the same particles moves with the same speed, then besides Coulomb repulsion must occur and the attraction of such flows to each other. If we examine the motion of charges in the conductors, then the effect indicated occurs. In connection with this in its time experimental postulate about the Lorentz force was accepted.

This postulate made possible to correctly explain all power effects, connected with the flow of currents in the conducting systems, including the ponderomotive (mechanical) forces, applied to the surface of conductors, over which flows the current.

However, with the examination of power interaction of the unidirectional electronic fluxes, in which the charges move with the identical speed, this approach gives failure. If we examine power interaction of such flows that in the concept of the magnetic field between them, besides Coulomb repulsion, must occur and attraction. However, if we pass into the frame of reference, which moves together with the flows with the speed of the motion of charges in the flows, then in this system magnetic fields be absent and, therefore, there remains only Coulomb repulsion. It is considered that the magnetic field is this the form of material, but is obtained so that with the aid of the selection of frame of reference this form of material it can be destroyed.

Analogous situation is observed also with the bias currents. If bias currents possess magnetic field, then this must lead to the transverse compression of the changing in the time electrical fields on. Furthermore, if bias currents have magnetic field, then such fields in accordance with the relationship (1) must in a power manner act on the charges, which move in this field. But in accordance with third Newton's law to any acting force must occur the counterforce of reaction. But in this case there is no that material object, as, for instance, wire or electronic flux, which would ensure reacting force. Therefore in this case appear the large doubts apropos of existence of magnetic fields on around the bias currents.

The second Maxwell equation connects the presence of magnetic field with existence of the flows of the charged particles, such as electronic fluxes, and also with the bias currents

$$rot\mathbf{H}=\mathbf{j}+\varepsilon_0\frac{\partial \mathbf{E}}{\partial t}=ne\mathbf{v}+\varepsilon_0\frac{\partial \mathbf{E}}{\partial t},$$

where n and $\mathbf{v}$ - the charge density in the electronic flux and their speed respectively.

Taking into account the considerations given above, it is necessary to recognize that the introduction of magnetic field in accordance with the second Maxwell equation does not be founded upon soil. But this means that and the first equation of Maxwell also becomes meaningless, since. in it the magnetic field also is present. Therefore a question about stands, from the electrodynamics generally excluding of this concept as magnetic field.

III. INDUCTION EQUATIONS, RECORDED IN THE TOTAL DERIVATIVES

Main reaching SR should be considered that the fact that it predicted the dependence of the scalar potential of charge on its relative speed, and also the connection of this potential with the magnetic vector potential. Specifically, this circumstance made it possible obtain the conversions fields on from which one should the phase aberration and the transverse Doppler effect, which cannot be explained within the framework classical electrodynamics. However, these results were obtained by the price of colossal physical victims by the way of the introduction of the covariant conversions, from which follow absurd from the physical point sight results. For example, material bodies with reaching of the speed of light must be compressed to the zero sizes in the direction of their motion.

Question arises, can the principles of classical electrodynamics give correct results regarding fields on in the moving coordinate systems at least in some approximation, and if yes, then as the equations of electromagnetic induction must appear in this case. Lorentz force

$$\vec{F}'=e\left[\vec{V}\times\vec{B}\right]. \qquad (2.1)$$

therefore is named Lorent's name, that it follows from its conversions, with the aid of which the fields in the moving coordinate systems can be recorded, if fields in the fixed system are known. We will note fields and forces, which appear in the moving coordinate system, by prime subsequently.

Of indication of how can be recorded fields in the moving coordinate system, if they are known in the fixed, there are already in the Faraday law, if we use ourselves the substantional derivative. For the study of this problem let us rewrite Faraday law in the precise form:

$$\oint \vec{E}'\,d\,\vec{l}'=-\frac{d\,\Phi_B}{d\,t}. \qquad (2.2)$$

The refinement of law, is more accurate than its record, it concerns only that circumstance that if we determine contour integral in the moving (prime) coordinate system, then near $\vec{E}$ and $d\vec{l}$ must stand primes. But if circulation is determined in the fixed coordinate system, then primes near $\vec{E}$ and $d\vec{l}$ be absent, but in this case to the right in expression (1.2) must stand particular time derivative. Usually this circumstance in the literature on this question is not specified.

The substantional derivative in relationship (2.2) indicates the independence of the eventual result of appearance electromotive force in the outline from the method of changing the flow, i.e., flow can change both due to the local time derivative of the induction $\vec{B}$ and because the system, in which is measured $\oint \vec{E}'d\,\vec{l}'$, it moves in the three-dimensional changing field $\vec{B}$. In the relationship (2.2)

$$\Phi_B=\int \vec{B}\,d\,\vec{S}', \qquad (2.3)$$

where the magnetic induction $\vec{B}=\mu\vec{H}$ is determined in the fixed coordinate system, and the element $d\,\vec{S}'$ is determined in the moving system. Taking (2.3) into account, we obtain from (2.2)

$$\oint \vec{E}'d\,\vec{l}'=-\frac{d}{d\,t}\int \vec{B}\,d\,\vec{S}', \qquad (2.4)$$

and further, since $\frac{d}{d\,t}=\frac{\partial}{\partial\,t}+\vec{V}\,grad$, let us write down

$$\oint \vec{E}'d\,\vec{l}'=-\int\frac{\partial\,\vec{B}}{\partial\,t}\,d\,\vec{S}-\int\left[\vec{B}\times\vec{V}\right]\,d\,\vec{l}'-\int\vec{V}\,div\,\vec{B}\,d\,\vec{S}'. \qquad (2.5)$$

In this case contour integral is taken on the outline $d\,\vec{l}'$, which covers the area $d\,\vec{S}'$. Let us immediately note that entire following presentation will be conducted under the assumption the validity of the conversions of Galileo, i.e., $d\,\vec{l}'=d\,\vec{l}$ and $d\,\vec{S}'=d\,\vec{S}$. From (2.5) follows the well known result

$$\vec{E}'=\vec{E}+\left[\vec{V}\times\vec{B}\right], \qquad (2.6)$$

from which follows that during the motion in the magnetic field the additional electric field, determined by last term of relationship appears (2.6). Let us note that this relationship we obtained not of the conversions of Lorenz, but altogether having only refined Faraday law. Thus, Lorentz force is the consequence of this precise law.

From relationship (2.6) it follows that during the motion in the magnetic field to the charge acts the force perpendicular to direction of motion. However, physical nature of this force nowhere is examined. Specifically, with this is connected that confusion, which occurs with the explanation of the operating principle of unipolar generator, and also the impossibility of explanation from the point of view of Maxwell's equations the appearances of electrical fields on out of the infinitely long solenoid.

For explaining physical nature of the appearance of last term in relationship (1.6) let us write down $\vec B$ and $\vec E$ through the magnetic vector potential $\vec A_B$:

$$\vec B = rot\ \vec A_B, \qquad \vec E = -\frac{\partial \vec A_B}{\partial t}. \tag{2.7}$$

Then relationship (2.6) can be rewritten

$$\vec E' = -\frac{\partial \vec A_B}{\partial t} + \left[\vec V \times rot\ \vec A_B\right] \tag{2.8}$$

and further

$$\vec E' = -\frac{\partial \vec A_B}{\partial t} - \left(\vec V\ \nabla\right)\vec A_B + grad\ \left(\vec V\ \vec A_B\right) \tag{2.9}$$

The first two members of the right side of equality (2.9) can be gathered into the total derivative of vector potential on the time, namely:

$$\vec E' = -\frac{d\ \vec A_B}{d\ t} + grad\ \left(\vec V\ \vec A_B\right) \tag{2.10}$$

From relationship (2.9) it is evident that the field strength, and consequently also the force, which acts on the charge, consists of three parts.

The first of them is obliged to purely temporary changes in the magnetic vector potential. The sense of second term of the right side of relationship (2.9) is also intelligible. It is connected with a change in the vector potential, but already because charge moves in the three-dimensional changing field of this potential. Other nature of last term of the right side of relationship (2.9). It is connected with the presence of potential forces, since. potential energy of the charge, which moves in the potential field $\vec A_B$ with the speed $\vec V$, is equal $e\ \left(\vec V\ \vec A_B\right)$. The value $e\ grad\ \left(\vec V\ \vec A_B\right)$ gives force, exactly as gives force the gradient of scalar potential.

Relationship (2.9) gives the possibility to physically explain all composing tensions electric fields, which appears in the fixed and that moving the coordinate systems. If the discussion deals with the appearance of electrical fields on out of the long solenoid, where there are no magnetic fields on, then in this case first term of the right side of equality works (2.9). In the case of unipolar generator in the formation of the force, which acts on the charge, two last addend right sides of equality (2.9) participate, introducing identical contributions.

In the work [3] is indicated that the unipolar generator is an exception to the rule of flow, but this conclusion incorrect, since rule of flow is this totality of all three components. Taking rotor from both parts of equality (2.10) and taking into account that *rot grad* ≡ 0, we obtain

$$rot\ \vec E' = -\frac{d\ \vec B}{d\ t}. \tag{2.11}$$

If there is no motion, then relationship (2.11) is converted into the first Maxvell equation. Certainly, on its informativeness relationship (2.11) strongly is inferior to relationship (2.2), since. in connection with the fact that *rot grad* ≡ 0, in it there is no information about the potential forces, designated through $e\ grad\ \left(\vec V\ \vec A_B\right)$. Therefore, if us interest all components of electrical fields on, that act on the charge both in the fixed and in that moving the coordinate systems, we must use relationship (2.2).

Summing up the preliminary sum, it is possible to say that with the more careful examination of Faraday law (2.2) it is possible to sufficient clearly understand all special features of the work of unipolar generator, it is possible to also assert that the operating principle of unipolar generator is not an exception to the rule of flow (2.2), but it is its consequence. The assertion of Feynman about the fact that the rule $\left[\vec V \times \vec B\right]$ for "moving outline" and $\nabla \times \vec E = -\frac{\partial \vec B}{\partial t}$ for "changing field" they are two completely different laws it does not correspond to reality. Exactly that united basic principle, absence of which indicates Feynman , and is Faraday law. Is repeated one additional treatment of Feynman which should be refined, namely: "The observations of Faraday led to the discovery of new law about the connection of electrical and magnetic fields on: in the field, where magnetic field changes in the course of time, is generated electric field". This formulation is accurate, but incomplete, since. we already indicated that the electric field can be generated and, where magnetic fields be absent, namely, out of the infinitely long solenoid. More complete formulation escapes from relationship (2.9), and for the vortex fields on by more complete it appears the relationship of $\vec E = -\frac{d\ \vec A_B}{d\ t}$, than the relationship of $rot\ \vec E = -\frac{\partial \vec B}{\partial t}$.

Consequently, we must conclude that the moving or fixed charge interacts not with the magnetic field, but with the field of magnetic vector potential, and only knowledge of this potential and its evolution they give the possibility to calculate all force components, which act on the charges. However, magnetic field appears altogether only of the gradient of such vectorial field.

From the aforesaid it follows that the record of Lorentz force in the terms of the magnetic vector potential:

$$\vec{F}\,' = e\,\vec{E} + e\,[\vec{V}\times rot\,\vec{A}_B] = e\,\vec{E} - e(\vec{V}\,\nabla)\vec{A}_B + e grad\,(\vec{V}\,\vec{A}_B) \qquad (2.12)$$

is more preferable, since the possibility to understand the complete structure of this force gives.

Faraday law (2.2) is called the law of electromagnetic induction in connection with the fact that it shows how a change in the magnetic fields on it leads to the appearance of electrical fields on. However, in the classical electrodynamics there is no law of magnetoelectric induction, which would show, how a change in the electrical fields on, or motion in them, it leads to the appearance of magnetic fields on. The development of classical electrodynamics followed along another way. Was first known the Ampere law

$$\oint \vec{H}\,d\,\vec{l} = I\,, \qquad (2.13)$$

where *I* - current, which crosses the area, included by the outline of integration. In the differential form relationship (2.13) takes the form:

$$rot\,\vec{H} = \vec{j}_\sigma\,, \qquad (2.14)$$

where $\vec{j}_\sigma$ - current density of conductivity.

Maxwell supplemented relationship (2.14) with bias current

$$rot\,\vec{H} = \vec{j}_\sigma + \frac{\partial\,\vec{D}}{\partial\,t}\,. \qquad (2.15)$$

However, if Faraday conducted measurements with the changing flows of electrical induction, thus I could establish the following law

$$\oint \vec{H}'d\,\vec{l}' = \frac{d\,\Phi_D}{d\,t}\,, \qquad (2.16)$$

where of the flow of electrical induction.

$$\oint \vec{H}'d\,\vec{l}' = \int \frac{\partial\,\vec{D}}{\partial\,t} d\,\vec{S} + \oint [\vec{D}\times\vec{V}] d\,\vec{l}' + \int \vec{V}\,d\,vi\,\vec{D}\,d\,\vec{S}'. \qquad (2.17)$$

In contrast to the magnetic fields, when $div\vec{B} = 0$, for the electrical fields $div\vec{D} = \rho$ and last term in the right side of relationship (2.17) it gives the conduction current and from relationship (2.16) the Ampere law immediately follows. From relationship (2.17) follows also the equality:

$$\vec{H} = [\vec{D}\times\vec{V}]\,, \qquad (2.18)$$

which earlier could be obtained only from the Lorenz conversions.

As shown in the work [4], from relationship (2.18) follows and Bio-Savara law, if for enumerating the magnetic fields on to take the electric fields of the moving charges. In this case the last member of the right side of relationship (2.17) can be simply omitted, and the laws of induction acquire the completely symmetrical form

$$\begin{aligned} \oint \vec{E}'\,d\,\vec{l}' &= -\int \frac{\partial\,\vec{B}}{\partial\,t} d\,\vec{S} - \oint [\vec{B}\times\vec{V}] d\,\vec{l}', \\ \oint \vec{H}'d\,\vec{l}' &= \int \frac{\partial\,\vec{D}}{\partial\,t} d\,\vec{S} + \oint [\vec{D}\times\vec{V}] d\,\vec{l}'. \end{aligned} \qquad (2.19)$$

$$\begin{aligned} E' &= \vec{E} + [\vec{V}\times\vec{B}], \\ H' &= \vec{H} - [\vec{V}\times\vec{D}]. \end{aligned} \qquad (2.20)$$

Let us note that previously relationships (2.20) could be obtained only from the covariant Lorentz conversions, i.e. within the framework the special theory of relativity (SR). Thus, with an accuracy down to the terms $\sim \frac{V}{c}$ results SR follow from the laws of the induction within the framework of the conversions of Galileo. Further we will show that they follow from conversions (2.19) and results SR with an accuracy $\sim \frac{V^2}{c^2}$. However, before this we will introduce one additional vector potential, which in the classical electrodynamics was not introduced. For the vortex fields on let us accept [2]

$$\vec{D} = rot\,\vec{A}_D\,, \qquad (2.21)$$

where $\vec{A}_D$ – the electrical vector potential. Then from (1.19) follows

$$\vec{H}' = \frac{\partial\,\vec{A}_D}{\partial\,t} + [\vec{V}\,\nabla]\vec{A}_D - grad\,[\vec{V}\,\vec{A}_D]\,, \qquad (2.22)$$

or

$$\vec{H}'=\frac{\partial\ \vec{A}_D}{\partial\ t}-[\vec{V}\times rot\ \ \vec{A}_D] \qquad (2.23)$$

or

$$\vec{H}'=\frac{d\ \vec{A}_D}{d\ t}-grad\ \ [\vec{V}\ \vec{A}_D]. \qquad (2.24)$$

These relationships are the writing of the law of magnetoelectric induction in the terms of electrical vector potential.

The importance of the introduction of electrical vector potential consists of the following. Let us visualize situation similar to that, which occurs with the infinitely long solenoid with the only difference that now the place of the vectors $\vec{B}$ we must engage the vectors $\vec{D}$. This situation exists. This is the case, when space between the plates of parallel-plate capacitor is filled with dielectric with the large ε. In this case practically entire displacement flux is located inside the dielectric. If we in this case attempt ourselves to calculate magnetic field out of the space, occupied with dielectric, i.e. there where $\vec{D}\cong 0$, then we will encounter the same difficulty, as in the case with the infinitely long solenoid with the calculation outside of him fields on $\vec{E}$. Introduction of electrical vector potential gives the possibility to correctly solve this task. And again arises question, which is primary, and that for a second time. Certainly, electrical vector potential is primary, and vortex electric fields exist only, where the rotor of this potential it is different from zero.

The relationship (2.20) attest to the fact that in the case of relative motion of frame of references, between the fields $\vec{E}$ and $\vec{H}$ there is a cross coupling, i.e., motion in the fields $\vec{H}$ leads to the appearance fields on $\vec{E}$ and vice versa [5,6]. These special features lead to the additional consequences, which within the framework classical electrodynamics previously were not examined. For their illustration let us examine two parallel conducting planes, between which there is an electric field $\vec{E}$ and, correspondingly, the surface charge ρ_S which falls per unit of the area of each plate, is equal εE. If we in parallel to plates in the field E begin to move with the speed ΔV another frame of reference $\Delta H = \Delta V\varepsilon E$. Then in it will appear the additional field E. If we now with respect to the already moving frame of reference begin to move third frame of reference with the speed ΔV, then already due to the motion in the field ΔH will appear the additive $\Delta E = \mu\varepsilon\Delta V^2E$,, which will be added to the field E. Thus, the field E' in this moving system will prove to be greater than in the fixed. Consequently, we are right to consider that not only increased the field E, but also surface charge on the planes of reference system increased by the value $\mu\varepsilon^2\Delta V^2 E$.

The process of calculation fields on thus it is described in work [2]. If we designate $\vec{E}_{||}$ and $\vec{H}_{||}$ as components fields on, parallel to direction speeds, and $\vec{E}_\perp$ and $\vec{H}_\perp$ as components perpendicular to it, then end value fields on with reaching of the speed V they will be written down

$$\vec{E}'_{||}=\vec{E}_{||},$$

$$\vec{E}'_\perp=\vec{E}_\perp ch\frac{V}{c}+\frac{Z_0}{V}[\vec{V}\times\vec{H}_\perp]sh\frac{V}{c},$$

$$\vec{H}'_{||}=\vec{H}_{||},$$

$$\vec{H}'_\perp=\vec{H}_\perp ch\frac{V}{c}-\frac{1}{Z_0V}[\vec{V}\times\vec{E}_\perp]sh\frac{V}{c}, \qquad (2.25)$$

where $Z_0=\sqrt{\frac{\mu}{\varepsilon}}$ - impedance of space, $c=\sqrt{\frac{1}{\mu\ \varepsilon}}$ - speed of light in the medium in question.

Conversions (2.25) they bear the name of the Mende conversions [7-9].

These conversions give the results, which coincide with SR already with an accuracy down to the terms $\sim\frac{V^2}{c^2}$. The corrections of the following orders with results SR do not coincide. However, it should be noted that and experimental check SR is carried out up to now not more precise than the terms $\sim\frac{V^2}{c^2}$.

We show how, for example (2.25) it is possible to explain the phenomenon of phase aberration, which did not have within the framework existing classical electrodynamics of explanations.

We will consider that there are components of the plane wave H_Z and E_X, which is extended in the direction x , and primed system moves in the direction of the axis of with the speed V_X. . Then components fields on in the prime coordinate system will be written down:

$$E_X{}'=E_X,$$

$$E_Y{}'=H_Z sh\frac{Vx}{c}, \qquad (2.27)$$

$$H_Z{}'=H_Z ch\frac{V_X}{c}.$$

thus, the summary field E in the moving system will be written down

$$E'=\left[\left(E_X'\right)^2+\left(E_Y'\right)^2\right]^{1/2}=E_X\ ch\ \frac{V_X}{c}\,. \qquad (2.28)$$

The Poynting vector now also directed no longer along the axis *y*, but being located in the plane *xy*, it is inclined toward the axis oy to the angle, determined by relationships (2.27). However, the relation of the absolute values of the vectors *E* and *H* in both systems they remained identical. This is a phenomenon of phase aberration in the classical electrodynamics.

IV. Conclusion

The beginning to electrodynamics assumed such put outting themselves of physics as amperes, Faraday, Veber, Maxwell. These scientists on the primitive research equipment established those laws, which we use to the these rapids. They were geniuses and they could examine in the dark of prejudices and superstition the top of that huge iceberg, which the electrodynamics is. But those contradictions and disagreement, which occur in the electrodynamics and today, they tell us, that not all problems are still solved. In Maxwell's equations is not contained the information about power interaction of the current carrying systems, but the Lorentz force, which defines such an interaction, it is introduced as hotel experimental postulate. Therefore electrodynamics itself consists as of two not connected together parts. From one side this of Maxwell's equations, which give the possibility to obtain wave equation for the electromagnetic waves, while another – postulate about the Lorentz force, which makes it possible to calculate power interaction of the current carrying systems. Magnetic field is also introduced not on the basis experimental facts and does not be founded upon basis. Both Maxwell and Amper considered that the magnetic field is material field, but this point of view cannot be accepted, since this field can be destroyed by the way of the selection of frame of reference. In the article it is shown that the introduction of magnetic field this altogether only the convenient mathematical device, without which it is possible to manage. In the article also is introduced the concept of the vector potential of electric field, which gives the possibility to write down the equations of induction in the symmetrical form.

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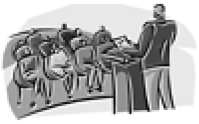

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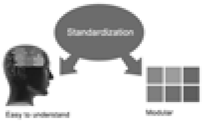


The FARSS will be eligible for a free application of standardization of their researches. Standardization of research will be subject to acceptability within stipulated norms as the next step after publishing in a journal. We shall depute a team of specialized research professionals who will render their services for elevating your researches to next higher level, which is worldwide open standardization.

The FARSS member can apply for grading and certification of standards of their educational and Institutional Degrees to Open Association of Research, Society U.S.A. Once you are designated as FARSS, you may send us a scanned copy of all of your credentials. OARS will verify, grade and certify them. This will be based on your academic records, quality of research papers published by you, and some more criteria. After certification of all your credentials by OARS, they will be published on your Fellow Profile link on website https://associationofresearch.org which will be helpful to upgrade the dignity.

The FARSS members can avail the benefits of free research podcasting in Global Research Radio with their research documents. After publishing the work, (including published elsewhere worldwide with proper authorization) you can upload your research paper with your recorded voice or you can utilize chargeable services of our professional RJs to record your paper in their voice on request.

The FARSS member also entitled to get the benefits of free research podcasting of their research documents through video clips. We can also streamline your conference videos and display your slides/ online slides and online research video clips at reasonable charges, on request.

The FARSS is eligible to earn from sales proceeds of his/her researches/reference/review Books or literature, while publishing with Global Journals. The FARSS can decide whether he/she would like to publish his/her research in a closed manner. In this case, whenever readers purchase that individual research paper for reading, maximum 60% of its profit earned as royalty by Global Journals, will be credited to his/her bank account. The entire entitled amount will be credited to his/her bank account exceeding limit of minimum fixed balance. There is no minimum time limit for collection. The FARSS member can decide its price and we can help in making the right decision.

The FARSS member is eligible to join as a paid peer reviewer at Global Journals Incorporation (USA) and can get remuneration of 15% of author fees, taken from the author of a respective paper. After reviewing 5 or more papers you can request to transfer the amount to your bank account.

MEMBER OF ASSOCIATION OF RESEARCH SOCIETY IN SCIENCE (MARSS)

The ' MARSS ' title is accorded to a selected professional after the approval of the Editor-in-Chief / Editorial Board Members/Dean.

The "MARSS" is a dignified ornament which is accorded to a person's name viz. Dr. John E. Hall, Ph.D., MARSS or William Walldroff, M.S., MARSS.

MARSS accrediting is an honor. It authenticates your research activities. After becoming MARSS, you can add 'MARSS' title with your name as you use this recognition as additional suffix to your status. This will definitely enhance and add more value and repute to your name. You may use it on your professional Counseling Materials such as CV, Resume, Visiting Card and Name Plate etc.

The following benefitscan be availed by you only for next three years from the date of certification.

MARSS designated members are entitled to avail a 25% discount while publishing their research papers (of a single author) in Global Journals Inc., if the same is accepted by our Editorial Board and Peer Reviewers. If you are a main author or co-author of a group of authors, you will get discount of 10%.

As MARSS, you will be given a renowned, secure and free professional email address with 30 GB of space e.g. johnhall@globaljournals.org. This will include Webmail, Spam Assassin, Email Forwarders,Auto-Responders, Email Delivery Route tracing, etc.

We shall provide you intimation regarding launching of e-version of journal of your stream time to time.This may be utilized in your library for the enrichment of knowledge of your students as well as it can also be helpful for the concerned faculty members.

The MARSS member can apply for approval, grading and certification of standards of their educational and Institutional Degrees to Open Association of Research, Society U.S.A.

Once you are designated as MARSS, you may send us a scanned copy of all of your credentials. OARS will verify, grade and certify them. This will be based on your academic records, quality of research papers published by you, and some more criteria.

It is mandatory to read all terms and conditions carefully.

Auxiliary Memberships

Institutional Fellow of Global Journals Incorporation (USA)-OARS (USA)

Global Journals Incorporation (USA) is accredited by Open Association of Research Society, U.S.A (OARS) and in turn, affiliates research institutions as "Institutional Fellow of Open Association of Research Society" (IFOARS).

The "FARSC" is a dignified title which is accorded to a person's name viz. Dr. John E. Hall, Ph.D., FARSC or William Walldroff, M.S., FARSC.

The IFOARS institution is entitled to form a Board comprised of one Chairperson and three to five board members preferably from different streams. The Board will be recognized as "Institutional Board of Open Association of Research Society"-(IBOARS).

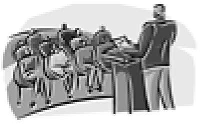
The Institute will be entitled to following benefits:

The IBOARS can initially review research papers of their institute and recommend them to publish with respective journal of Global Journals. It can also review the papers of other institutions after obtaining our consent. The second review will be done by peer reviewer of Global Journals Incorporation (USA)

The Board is at liberty to appoint a peer reviewer with the approval of chairperson after consulting us.

The author fees of such paper may be waived off up to 40%.

The Global Journals Incorporation (USA) at its discretion can also refer double blind peer reviewed paper at their end to the board for the verification and to get recommendation for final stage of acceptance of publication.

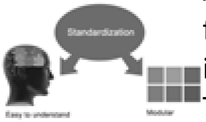


The IBOARS can organize symposium/seminar/conference in their country on behalf of Global Journals Incorporation (USA)-OARS (USA). The terms and conditions can be discussed separately.

The Board can also play vital role by exploring and giving valuable suggestions regarding the Standards of "Open Association of Research Society, U.S.A (OARS)" so that proper amendment can take place for the benefit of entire research community. We shall provide details of particular standard only on receipt of request from the Board.

The board members can also join us as Individual Fellow with 40% discount on total fees applicable to Individual Fellow. They will be entitled to avail all the benefits as declared. Please visit Individual Fellow-sub menu of GlobalJournals.org to have more relevant details.

We shall provide you intimation regarding launching of e-version of journal of your stream time to time. This may be utilized in your library for the enrichment of knowledge of your students as well as it can also be helpful for the concerned faculty members.



After nomination of your institution as “Institutional Fellow” and constantly functioning successfully for one year, we can consider giving recognition to your institute to function as Regional/Zonal office on our behalf.
The board can also take up the additional allied activities for betterment after our consultation.

The following entitlements are applicable to individual Fellows:

Open Association of Research Society, U.S.A (OARS) By-laws states that an individual Fellow may use the designations as applicable, or the corresponding initials. The Credentials of individual Fellow and Associate designations signify that the individual has gained knowledge of the fundamental concepts. One is magnanimous and proficient in an expertise course covering the professional code of conduct, and follows recognized standards of practice.

Open Association of Research Society (US)/ Global Journals Incorporation (USA), as described in Corporate Statements, are educational, research publishing and professional membership organizations. Achieving our individual Fellow or Associate status is based mainly on meeting stated educational research requirements.

Disbursement of 40% Royalty earned through Global Journals : Researcher = 50%, Peer Reviewer = 37.50%, Institution = 12.50% E.g. Out of 40%, the 20% benefit should be passed on to researcher, 15 % benefit towards remuneration should be given to a reviewer and remaining 5% is to be retained by the institution.

We shall provide print version of 12 issues of any three journals [as per your requirement] out of our 38 journals worth $ 2376 USD.

Other:

The individual Fellow and Associate designations accredited by Open Association of Research Society (US) credentials signify guarantees following achievements:

- The professional accredited with Fellow honor, is entitled to various benefits viz. name, fame, honor, regular flow of income, secured bright future, social status etc.

- In addition to above, if one is single author, then entitled to 40% discount on publishing research paper and can get 10%discount if one is co-author or main author among group of authors.
- The Fellow can organize symposium/seminar/conference on behalf of Global Journals Incorporation (USA) and he/she can also attend the same organized by other institutes on behalf of Global Journals.
- The Fellow can become member of Editorial Board Member after completing 3yrs.
- The Fellow can earn 60% of sales proceeds from the sale of reference/review books/literature/publishing of research paper.
- Fellow can also join as paid peer reviewer and earn 15% remuneration of author charges and can also get an opportunity to join as member of the Editorial Board of Global Journals Incorporation (USA)
- • This individual has learned the basic methods of applying those concepts and techniques to common challenging situations. This individual has further demonstrated an in–depth understanding of the application of suitable techniques to a particular area of research practice.

Note :

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- In future, if the board feels the necessity to change any board member, the same can be done with the consent of the chairperson along with anyone board member without our approval.
- In case, the chairperson needs to be replaced then consent of 2/3rd board members are required and they are also required to jointly pass the resolution copy of which should be sent to us. In such case, it will be compulsory to obtain our approval before replacement.
- In case of "Difference of Opinion [if any]" among the Board members, our decision will be final and binding to everyone.

"

PREFERRED AUTHOR GUIDELINES

We accept the manuscript submissions in any standard (generic) format.

We typeset manuscripts using advanced typesetting tools like Adobe In Design, CorelDraw, TeXnicCenter, and TeXStudio. We usually recommend authors submit their research using any standard format they are comfortable with, and let Global Journals do the rest.

Alternatively, you can download our basic template from https://globaljournals.org/Template.zip

Authors should submit their complete paper/article, including text illustrations, graphics, conclusions, artwork, and tables. Authors who are not able to submit manuscript using the form above can email the manuscript department at submit@globaljournals.org or get in touch with chiefeditor@globaljournals.org if they wish to send the abstract before submission.

BEFORE AND DURING SUBMISSION

Authors must ensure the information provided during the submission of a paper is authentic. Please go through the following checklist before submitting:

1. Authors must go through the complete author guideline and understand and *agree to Global Journals' ethics and code of conduct,* along with author responsibilities.
2. Authors must accept the privacy policy, terms, and conditions of Global Journals.
3. Ensure corresponding author's email address and postal address are accurate and reachable.
4. Manuscript to be submitted must include keywords, an abstract, a paper title, co-author(s') names and details (email address, name, phone number, and institution), figures and illustrations in vector format including appropriate captions, tables, including titles and footnotes, a conclusion, results, acknowledgments and references.
5. Authors should submit paper in a ZIP archive if any supplementary files are required along with the paper.
6. Proper permissions must be acquired for the use of any copyrighted material.
7. Manuscript submitted *must not have been submitted or published elsewhere* and all authors must be aware of the submission.

Declaration of Conflicts of Interest

It is required for authors to declare all financial, institutional, and personal relationships with other individuals and organizations that could influence (bias) their research.

POLICY ON PLAGIARISM

Plagiarism is not acceptable in Global Journals submissions at all.

Plagiarized content will not be considered for publication. We reserve the right to inform authors' institutions about plagiarism detected either before or after publication. If plagiarism is identified, we will follow COPE guidelines:

Authors are solely responsible for all the plagiarism that is found. The author must not fabricate, falsify or plagiarize existing research data. The following, if copied, will be considered plagiarism:

- Words (language)
- Ideas
- Findings
- Writings
- Diagrams
- Graphs
- Illustrations
- Lectures

- Printed material
- Graphic representations
- Computer programs
- Electronic material
- Any other original work

AUTHORSHIP POLICIES

Global Journals follows the definition of authorship set up by the Open Association of Research Society, USA. According to its guidelines, authorship criteria must be based on:

1. Substantial contributions to the conception and acquisition of data, analysis, and interpretation of findings.
2. Drafting the paper and revising it critically regarding important academic content.
3. Final approval of the version of the paper to be published.

Changes in Authorship

The corresponding author should mention the name and complete details of all co-authors during submission and in manuscript. We support addition, rearrangement, manipulation, and deletions in authors list till the early view publication of the journal. We expect that corresponding author will notify all co-authors of submission. We follow COPE guidelines for changes in authorship.

Copyright

During submission of the manuscript, the author is confirming an exclusive license agreement with Global Journals which gives Global Journals the authority to reproduce, reuse, and republish authors' research. We also believe in flexible copyright terms where copyright may remain with authors/employers/institutions as well. Contact your editor after acceptance to choose your copyright policy. You may follow this form for copyright transfers.

Appealing Decisions

Unless specified in the notification, the Editorial Board's decision on publication of the paper is final and cannot be appealed before making the major change in the manuscript.

Acknowledgments

Contributors to the research other than authors credited should be mentioned in Acknowledgments. The source of funding for the research can be included. Suppliers of resources may be mentioned along with their addresses.

Declaration of funding sources

Global Journals is in partnership with various universities, laboratories, and other institutions worldwide in the research domain. Authors are requested to disclose their source of funding during every stage of their research, such as making analysis, performing laboratory operations, computing data, and using institutional resources, from writing an article to its submission. This will also help authors to get reimbursements by requesting an open access publication letter from Global Journals and submitting to the respective funding source.

PREPARING YOUR MANUSCRIPT

Authors can submit papers and articles in an acceptable file format: MS Word (doc, docx), LaTeX (.tex, .zip or .rar including all of your files), Adobe PDF (.pdf), rich text format (.rtf), simple text document (.txt), Open Document Text (.odt), and Apple Pages (.pages). Our professional layout editors will format the entire paper according to our official guidelines. This is one of the highlights of publishing with Global Journals—authors should not be concerned about the formatting of their paper. Global Journals accepts articles and manuscripts in every major language, be it Spanish, Chinese, Japanese, Portuguese, Russian, French, German, Dutch, Italian, Greek, or any other national language, but the title, subtitle, and abstract should be in English. This will facilitate indexing and the pre-peer review process.

The following is the official style and template developed for publication of a research paper. Authors are not required to follow this style during the submission of the paper. It is just for reference purposes.

Manuscript Style Instruction (Optional)

- Microsoft Word Document Setting Instructions.
- Font type of all text should be Swis721 Lt BT.
- Page size: 8.27" x 11'", left margin: 0.65, right margin: 0.65, bottom margin: 0.75.
- Paper title should be in one column of font size 24.
- Author name in font size of 11 in one column.
- Abstract: font size 9 with the word "Abstract" in bold italics.
- Main text: font size 10 with two justified columns.
- Two columns with equal column width of 3.38 and spacing of 0.2.
- First character must be three lines drop-capped.
- The paragraph before spacing of 1 pt and after of 0 pt.
- Line spacing of 1 pt.
- Large images must be in one column.
- The names of first main headings (Heading 1) must be in Roman font, capital letters, and font size of 10.
- The names of second main headings (Heading 2) must not include numbers and must be in italics with a font size of 10.

Structure and Format of Manuscript

The recommended size of an original research paper is under 15,000 words and review papers under 7,000 words. Research articles should be less than 10,000 words. Research papers are usually longer than review papers. Review papers are reports of significant research (typically less than 7,000 words, including tables, figures, and references)

A research paper must include:

a) A title which should be relevant to the theme of the paper.
b) A summary, known as an abstract (less than 150 words), containing the major results and conclusions.
c) Up to 10 keywords that precisely identify the paper's subject, purpose, and focus.
d) An introduction, giving fundamental background objectives.
e) Resources and techniques with sufficient complete experimental details (wherever possible by reference) to permit repetition, sources of information must be given, and numerical methods must be specified by reference.
f) Results which should be presented concisely by well-designed tables and figures.
g) Suitable statistical data should also be given.
h) All data must have been gathered with attention to numerical detail in the planning stage.

Design has been recognized to be essential to experiments for a considerable time, and the editor has decided that any paper that appears not to have adequate numerical treatments of the data will be returned unrefereed.

i) Discussion should cover implications and consequences and not just recapitulate the results; conclusions should also be summarized.
j) There should be brief acknowledgments.
k) There ought to be references in the conventional format. Global Journals recommends APA format.

Authors should carefully consider the preparation of papers to ensure that they communicate effectively. Papers are much more likely to be accepted if they are carefully designed and laid out, contain few or no errors, are summarizing, and follow instructions. They will also be published with much fewer delays than those that require much technical and editorial correction.

The Editorial Board reserves the right to make literary corrections and suggestions to improve brevity.

FORMAT STRUCTURE

It is necessary that authors take care in submitting a manuscript that is written in simple language and adheres to published guidelines.

All manuscripts submitted to Global Journals should include:

Title

The title page must carry an informative title that reflects the content, a running title (less than 45 characters together with spaces), names of the authors and co-authors, and the place(s) where the work was carried out.

Author details

The full postal address of any related author(s) must be specified.

Abstract

The abstract is the foundation of the research paper. It should be clear and concise and must contain the objective of the paper and inferences drawn. It is advised to not include big mathematical equations or complicated jargon.

Many researchers searching for information online will use search engines such as Google, Yahoo or others. By optimizing your paper for search engines, you will amplify the chance of someone finding it. In turn, this will make it more likely to be viewed and cited in further works. Global Journals has compiled these guidelines to facilitate you to maximize the web-friendliness of the most public part of your paper.

Keywords

A major lynchpin of research work for the writing of research papers is the keyword search, which one will employ to find both library and internet resources. Up to eleven keywords or very brief phrases have to be given to help data retrieval, mining, and indexing.

One must be persistent and creative in using keywords. An effective keyword search requires a strategy: planning of a list of possible keywords and phrases to try.

Choice of the main keywords is the first tool of writing a research paper. Research paper writing is an art. Keyword search should be as strategic as possible.

One should start brainstorming lists of potential keywords before even beginning searching. Think about the most important concepts related to research work. Ask, “What words would a source have to include to be truly valuable in a research paper?” Then consider synonyms for the important words.

It may take the discovery of only one important paper to steer in the right keyword direction because, in most databases, the keywords under which a research paper is abstracted are listed with the paper.

Numerical Methods

Numerical methods used should be transparent and, where appropriate, supported by references.

Abbreviations

Authors must list all the abbreviations used in the paper at the end of the paper or in a separate table before using them.

Formulas and equations

Authors are advised to submit any mathematical equation using either MathJax, KaTeX, or LaTeX, or in a very high-quality image.

Tables, Figures, and Figure Legends

Tables: Tables should be cautiously designed, uncrowned, and include only essential data. Each must have an Arabic number, e.g., Table 4, a self-explanatory caption, and be on a separate sheet. Authors must submit tables in an editable format and not as images. References to these tables (if any) must be mentioned accurately.

Figures

Figures are supposed to be submitted as separate files. Always include a citation in the text for each figure using Arabic numbers, e.g., Fig. 4. Artwork must be submitted online in vector electronic form or by emailing it.

PREPARATION OF ELETRONIC FIGURES FOR PUBLICATION

Although low-quality images are sufficient for review purposes, print publication requires high-quality images to prevent the final product being blurred or fuzzy. Submit (possibly by e-mail) EPS (line art) or TIFF (halftone/ photographs) files only. MS PowerPoint and Word Graphics are unsuitable for printed pictures. Avoid using pixel-oriented software. Scans (TIFF only) should have a resolution of at least 350 dpi (halftone) or 700 to 1100 dpi (line drawings). Please give the data for figures in black and white or submit a Color Work Agreement form. EPS files must be saved with fonts embedded (and with a TIFF preview, if possible).

For scanned images, the scanning resolution at final image size ought to be as follows to ensure good reproduction: line art: >650 dpi; halftones (including gel photographs): >350 dpi; figures containing both halftone and line images: >650 dpi.

Color charges: Authors are advised to pay the full cost for the reproduction of their color artwork. Hence, please note that if there is color artwork in your manuscript when it is accepted for publication, we would require you to complete and return a Color Work Agreement form before your paper can be published. Also, you can email your editor to remove the color fee after acceptance of the paper.

TIPS FOR WRITING A GOOD QUALITY SCIENCE FRONTIER RESEARCH PAPER

Techniques for writing a good quality Science Frontier Research paper:

1. Choosing the topic: In most cases, the topic is selected by the interests of the author, but it can also be suggested by the guides. You can have several topics, and then judge which you are most comfortable with. This may be done by asking several questions of yourself, like "Will I be able to carry out a search in this area? Will I find all necessary resources to accomplish the search? Will I be able to find all information in this field area?" If the answer to this type of question is "yes," then you ought to choose that topic. In most cases, you may have to conduct surveys and visit several places. Also, you might have to do a lot of work to find all the rises and falls of the various data on that subject. Sometimes, detailed information plays a vital role, instead of short information. Evaluators are human: The first thing to remember is that evaluators are also human beings. They are not only meant for rejecting a paper. They are here to evaluate your paper. So present your best aspect.

2. Think like evaluators: If you are in confusion or getting demotivated because your paper may not be accepted by the evaluators, then think, and try to evaluate your paper like an evaluator. Try to understand what an evaluator wants in your research paper, and you will automatically have your answer. Make blueprints of paper: The outline is the plan or framework that will help you to arrange your thoughts. It will make your paper logical. But remember that all points of your outline must be related to the topic you have chosen.

3. Ask your guides: If you are having any difficulty with your research, then do not hesitate to share your difficulty with your guide (if you have one). They will surely help you out and resolve your doubts. If you can't clarify what exactly you require for your work, then ask your supervisor to help you with an alternative. He or she might also provide you with a list of essential readings.

4. Use of computer is recommended: As you are doing research in the field of science frontier then this point is quite obvious. Use right software: Always use good quality software packages. If you are not capable of judging good software, then you can lose the quality of your paper unknowingly. There are various programs available to help you which you can get through the internet.

5. Use the internet for help: An excellent start for your paper is using Google. It is a wondrous search engine, where you can have your doubts resolved. You may also read some answers for the frequent question of how to write your research paper or find a model research paper. You can download books from the internet. If you have all the required books, place importance on reading, selecting, and analyzing the specified information. Then sketch out your research paper. Use big pictures: You may use encyclopedias like Wikipedia to get pictures with the best resolution. At Global Journals, you should strictly follow here.

6. Bookmarks are useful: When you read any book or magazine, you generally use bookmarks, right? It is a good habit which helps to not lose your continuity. You should always use bookmarks while searching on the internet also, which will make your search easier.

7. Revise what you wrote: When you write anything, always read it, summarize it, and then finalize it.

8. Make every effort: Make every effort to mention what you are going to write in your paper. That means always have a good start. Try to mention everything in the introduction—what is the need for a particular research paper. Polish your work with good writing skills and always give an evaluator what he wants. Make backups: When you are going to do any important thing like making a research paper, you should always have backup copies of it either on your computer or on paper. This protects you from losing any portion of your important data.

9. Produce good diagrams of your own: Always try to include good charts or diagrams in your paper to improve quality. Using several unnecessary diagrams will degrade the quality of your paper by creating a hodgepodge. So always try to include diagrams which were made by you to improve the readability of your paper. Use of direct quotes: When you do research relevant to literature, history, or current affairs, then use of quotes becomes essential, but if the study is relevant to science, use of quotes is not preferable.

10. Use proper verb tense: Use proper verb tenses in your paper. Use past tense to present those events that have happened. Use present tense to indicate events that are going on. Use future tense to indicate events that will happen in the future. Use of wrong tenses will confuse the evaluator. Avoid sentences that are incomplete.

11. Pick a good study spot: Always try to pick a spot for your research which is quiet. Not every spot is good for studying.

12. Know what you know: Always try to know what you know by making objectives, otherwise you will be confused and unable to achieve your target.

13. Use good grammar: Always use good grammar and words that will have a positive impact on the evaluator; use of good vocabulary does not mean using tough words which the evaluator has to find in a dictionary. Do not fragment sentences. Eliminate one-word sentences. Do not ever use a big word when a smaller one would suffice.

Verbs have to be in agreement with their subjects. In a research paper, do not start sentences with conjunctions or finish them with prepositions. When writing formally, it is advisable to never split an infinitive because someone will (wrongly) complain. Avoid clichés like a disease. Always shun irritating alliteration. Use language which is simple and straightforward. Put together a neat summary.

14. Arrangement of information: Each section of the main body should start with an opening sentence, and there should be a changeover at the end of the section. Give only valid and powerful arguments for your topic. You may also maintain your arguments with records.

15. Never start at the last minute: Always allow enough time for research work. Leaving everything to the last minute will degrade your paper and spoil your work.

16. Multitasking in research is not good: Doing several things at the same time is a bad habit in the case of research activity. Research is an area where everything has a particular time slot. Divide your research work into parts, and do a particular part in a particular time slot.

17. Never copy others' work: Never copy others' work and give it your name because if the evaluator has seen it anywhere, you will be in trouble. Take proper rest and food: No matter how many hours you spend on your research activity, if you are not taking care of your health, then all your efforts will have been in vain. For quality research, take proper rest and food.

18. Go to seminars: Attend seminars if the topic is relevant to your research area. Utilize all your resources.

19. Refresh your mind after intervals: Try to give your mind a rest by listening to soft music or sleeping in intervals. This will also improve your memory. Acquire colleagues: Always try to acquire colleagues. No matter how sharp you are, if you acquire colleagues, they can give you ideas which will be helpful to your research.

20. Think technically: Always think technically. If anything happens, search for its reasons, benefits, and demerits. Think and then print: When you go to print your paper, check that tables are not split, headings are not detached from their descriptions, and page sequence is maintained.

21. Adding unnecessary information: Do not add unnecessary information like "I have used MS Excel to draw graphs." Irrelevant and inappropriate material is superfluous. Foreign terminology and phrases are not apropos. One should never take a broad view. Analogy is like feathers on a snake. Use words properly, regardless of how others use them. Remove quotations. Puns are for kids, not grunt readers. Never oversimplify: When adding material to your research paper, never go for oversimplification; this will definitely irritate the evaluator. Be specific. Never use rhythmic redundancies. Contractions shouldn't be used in a research paper. Comparisons are as terrible as clichés. Give up ampersands, abbreviations, and so on. Remove commas that are not necessary. Parenthetical words should be between brackets or commas. Understatement is always the best way to put forward earth-shaking thoughts. Give a detailed literary review.

22. Report concluded results: Use concluded results. From raw data, filter the results, and then conclude your studies based on measurements and observations taken. An appropriate number of decimal places should be used. Parenthetical remarks are prohibited here. Proofread carefully at the final stage. At the end, give an outline to your arguments. Spot perspectives of further study of the subject. Justify your conclusion at the bottom sufficiently, which will probably include examples.

23. Upon conclusion: Once you have concluded your research, the next most important step is to present your findings. Presentation is extremely important as it is the definite medium though which your research is going to be in print for the rest of the crowd. Care should be taken to categorize your thoughts well and present them in a logical and neat manner. A good quality research paper format is essential because it serves to highlight your research paper and bring to light all necessary aspects of your research.

Informal Guidelines of Research Paper Writing

Key points to remember:

- Submit all work in its final form.
- Write your paper in the form which is presented in the guidelines using the template.
- Please note the criteria peer reviewers will use for grading the final paper.

Final points:

One purpose of organizing a research paper is to let people interpret your efforts selectively. The journal requires the following sections, submitted in the order listed, with each section starting on a new page:

The introduction: This will be compiled from reference matter and reflect the design processes or outline of basis that directed you to make a study. As you carry out the process of study, the method and process section will be constructed like that. The results segment will show related statistics in nearly sequential order and direct reviewers to similar intellectual paths throughout the data that you gathered to carry out your study.

The discussion section:

This will provide understanding of the data and projections as to the implications of the results. The use of good quality references throughout the paper will give the effort trustworthiness by representing an alertness to prior workings.

Writing a research paper is not an easy job, no matter how trouble-free the actual research or concept. Practice, excellent preparation, and controlled record-keeping are the only means to make straightforward progression.

General style:

Specific editorial column necessities for compliance of a manuscript will always take over from directions in these general guidelines.

To make a paper clear: Adhere to recommended page limits.

Mistakes to avoid:

- Insertion of a title at the foot of a page with subsequent text on the next page.
- Separating a table, chart, or figure—confine each to a single page.
- Submitting a manuscript with pages out of sequence.
- In every section of your document, use standard writing style, including articles ("a" and "the").
- Keep paying attention to the topic of the paper.
- Use paragraphs to split each significant point (excluding the abstract).
- Align the primary line of each section.
- Present your points in sound order.
- Use present tense to report well-accepted matters.
- Use past tense to describe specific results.
- Do not use familiar wording; don't address the reviewer directly. Don't use slang or superlatives.
- Avoid use of extra pictures—include only those figures essential to presenting results.

Title page:

Choose a revealing title. It should be short and include the name(s) and address(es) of all authors. It should not have acronyms or abbreviations or exceed two printed lines.

Abstract: This summary should be two hundred words or less. It should clearly and briefly explain the key findings reported in the manuscript and must have precise statistics. It should not have acronyms or abbreviations. It should be logical in itself. Do not cite references at this point.

An abstract is a brief, distinct paragraph summary of finished work or work in development. In a minute or less, a reviewer can be taught the foundation behind the study, common approaches to the problem, relevant results, and significant conclusions or new questions.

Write your summary when your paper is completed because how can you write the summary of anything which is not yet written? Wealth of terminology is very essential in abstract. Use comprehensive sentences, and do not sacrifice readability for brevity; you can maintain it succinctly by phrasing sentences so that they provide more than a lone rationale. The author can at this moment go straight to shortening the outcome. Sum up the study with the subsequent elements in any summary. Try to limit the initial two items to no more than one line each.

Reason for writing the article—theory, overall issue, purpose.

- Fundamental goal.
- To-the-point depiction of the research.
- Consequences, including definite statistics—if the consequences are quantitative in nature, account for this; results of any numerical analysis should be reported. Significant conclusions or questions that emerge from the research.

Approach:

- o Single section and succinct.
- o An outline of the job done is always written in past tense.
- o Concentrate on shortening results—limit background information to a verdict or two.
- o Exact spelling, clarity of sentences and phrases, and appropriate reporting of quantities (proper units, important statistics) are just as significant in an abstract as they are anywhere else.

Introduction:

The introduction should "introduce" the manuscript. The reviewer should be presented with sufficient background information to be capable of comprehending and calculating the purpose of your study without having to refer to other works. The basis for the study should be offered. Give the most important references, but avoid making a comprehensive appraisal of the topic. Describe the problem visibly. If the problem is not acknowledged in a logical, reasonable way, the reviewer will give no attention to your results. Speak in common terms about techniques used to explain the problem, if needed, but do not present any particulars about the protocols here.

The following approach can create a valuable beginning:

- Explain the value (significance) of the study.
- Defend the model—why did you employ this particular system or method? What is its compensation? Remark upon its appropriateness from an abstract point of view as well as pointing out sensible reasons for using it.
- Present a justification. State your particular theory(-ies) or aim(s), and describe the logic that led you to choose them.
- Briefly explain the study's tentative purpose and how it meets the declared objectives.

Approach:

Use past tense except for when referring to recognized facts. After all, the manuscript will be submitted after the entire job is done. Sort out your thoughts; manufacture one key point for every section. If you make the four points listed above, you will need at least four paragraphs. Present surrounding information only when it is necessary to support a situation. The reviewer does not desire to read everything you know about a topic. Shape the theory specifically—do not take a broad view.

As always, give awareness to spelling, simplicity, and correctness of sentences and phrases.

Procedures (methods and materials):

This part is supposed to be the easiest to carve if you have good skills. A soundly written procedures segment allows a capable scientist to replicate your results. Present precise information about your supplies. The suppliers and clarity of reagents can be helpful bits of information. Present methods in sequential order, but linked methodologies can be grouped as a segment. Be concise when relating the protocols. Attempt to give the least amount of information that would permit another capable scientist to replicate your outcome, but be cautious that vital information is integrated. The use of subheadings is suggested and ought to be synchronized with the results section.

When a technique is used that has been well-described in another section, mention the specific item describing the way, but draw the basic principle while stating the situation. The purpose is to show all particular resources and broad procedures so that another person may use some or all of the methods in one more study or referee the scientific value of your work. It is not to be a step-by-step report of the whole thing you did, nor is a methods section a set of orders.

Materials:

Materials may be reported in part of a section or else they may be recognized along with your measures.

Methods:

- Report the method and not the particulars of each process that engaged the same methodology.
- Describe the method entirely.
- To be succinct, present methods under headings dedicated to specific dealings or groups of measures.
- Simplify—detail how procedures were completed, not how they were performed on a particular day.
- If well-known procedures were used, account for the procedure by name, possibly with a reference, and that's all.

Approach:

It is embarrassing to use vigorous voice when documenting methods without using first person, which would focus the reviewer's interest on the researcher rather than the job. As a result, when writing up the methods, most authors use third person passive voice.

Use standard style in this and every other part of the paper—avoid familiar lists, and use full sentences.

What to keep away from:

- Resources and methods are not a set of information.
- Skip all descriptive information and surroundings—save it for the argument.
- Leave out information that is immaterial to a third party.

Results:

The principle of a results segment is to present and demonstrate your conclusion. Create this part as entirely objective details of the outcome, and save all understanding for the discussion.

The page length of this segment is set by the sum and types of data to be reported. Use statistics and tables, if suitable, to present consequences most efficiently.

You must clearly differentiate material which would usually be incorporated in a study editorial from any unprocessed data or additional appendix matter that would not be available. In fact, such matters should not be submitted at all except if requested by the instructor.

Content:

- Sum up your conclusions in text and demonstrate them, if suitable, with figures and tables.
- In the manuscript, explain each of your consequences, and point the reader to remarks that are most appropriate.
- Present a background, such as by describing the question that was addressed by creation of an exacting study.
- Explain results of control experiments and give remarks that are not accessible in a prescribed figure or table, if appropriate.
- Examine your data, then prepare the analyzed (transformed) data in the form of a figure (graph), table, or manuscript.

What to stay away from:

- Do not discuss or infer your outcome, report surrounding information, or try to explain anything.
- Do not include raw data or intermediate calculations in a research manuscript.
- Do not present similar data more than once.
- A manuscript should complement any figures or tables, not duplicate information.
- Never confuse figures with tables—there is a difference.

Approach:

As always, use past tense when you submit your results, and put the whole thing in a reasonable order.

Put figures and tables, appropriately numbered, in order at the end of the report.

If you desire, you may place your figures and tables properly within the text of your results section.

Figures and tables:

If you put figures and tables at the end of some details, make certain that they are visibly distinguished from any attached appendix materials, such as raw facts. Whatever the position, each table must be titled, numbered one after the other, and include a heading. All figures and tables must be divided from the text.

Discussion:

The discussion is expected to be the trickiest segment to write. A lot of papers submitted to the journal are discarded based on problems with the discussion. There is no rule for how long an argument should be.

Position your understanding of the outcome visibly to lead the reviewer through your conclusions, and then finish the paper with a summing up of the implications of the study. The purpose here is to offer an understanding of your results and support all of your conclusions, using facts from your research and generally accepted information, if suitable. The implication of results should be fully described.

Infer your data in the conversation in suitable depth. This means that when you clarify an observable fact, you must explain mechanisms that may account for the observation. If your results vary from your prospect, make clear why that may have happened. If your results agree, then explain the theory that the proof supported. It is never suitable to just state that the data approved the prospect, and let it drop at that. Make a decision as to whether each premise is supported or discarded or if you cannot make a conclusion with assurance. Do not just dismiss a study or part of a study as "uncertain."

Research papers are not acknowledged if the work is imperfect. Draw what conclusions you can based upon the results that you have, and take care of the study as a finished work.

- You may propose future guidelines, such as how an experiment might be personalized to accomplish a new idea.
- Give details of all of your remarks as much as possible, focusing on mechanisms.
- Make a decision as to whether the tentative design sufficiently addressed the theory and whether or not it was correctly restricted. Try to present substitute explanations if they are sensible alternatives.
- One piece of research will not counter an overall question, so maintain the large picture in mind. Where do you go next? The best studies unlock new avenues of study. What questions remain?
- Recommendations for detailed papers will offer supplementary suggestions.

Approach:

When you refer to information, differentiate data generated by your own studies from other available information. Present work done by specific persons (including you) in past tense.

Describe generally acknowledged facts and main beliefs in present tense.

The Administration Rules

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Topics	Grades		
	A-B	**C-D**	**E-F**
Abstract	Clear and concise with appropriate content, Correct format. 200 words or below	Unclear summary and no specific data, Incorrect form Above 200 words	No specific data with ambiguous information Above 250 words
Introduction	Containing all background details with clear goal and appropriate details, flow specification, no grammar and spelling mistake, well organized sentence and paragraph, reference cited	Unclear and confusing data, appropriate format, grammar and spelling errors with unorganized matter	Out of place depth and content, hazy format
Methods and Procedures	Clear and to the point with well arranged paragraph, precision and accuracy of facts and figures, well organized subheads	Difficult to comprehend with embarrassed text, too much explanation but completed	Incorrect and unorganized structure with hazy meaning
Result	Well organized, Clear and specific, Correct units with precision, correct data, well structuring of paragraph, no grammar and spelling mistake	Complete and embarrassed text, difficult to comprehend	Irregular format with wrong facts and figures
Discussion	Well organized, meaningful specification, sound conclusion, logical and concise explanation, highly structured paragraph reference cited	Wordy, unclear conclusion, spurious	Conclusion is not cited, unorganized, difficult to comprehend
References	Complete and correct format, well organized	Beside the point, Incomplete	Wrong format and structuring

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