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Further Studies on Cosmic Rays from Inter-Electronic Structure of the Electron

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Abstract

In a previous paper by Nandedkar, an analysis of cosmic rays from inter-electronic structure of the electron is considered, where electromagnetic nature of cosmic rays is analyzed along with complex charge and complex mass of an electron. In the present paper, radius of the electron, velocity of the electron, angular velocity of the electron, moving mass of the electron, frequency of electromagnetic radiation from the electron, wavelength of electromagnetic radiation from the electron and strength of magnetic flux density required for reversal of spin angular momentum are re-calculated. Here it is interesting to note that the moving mass of the electron inside and/ on periphery of the electron has a velocity of $4.242(6)$ x 10^8 m/ sc which is greater than velocity of light in free space. Thus a world of Tachyon (where particle velocity can exceed velocity of light in free space) exit inside and/ on periphery of the electron. Here strength of magnetic flux density required for reversal of spin angular momentum is given in two cases, viz., Case (i) with real part of complex charge neglecting its inherent complexity, and Case (ii) with real part of complex charge retaining its inherent complexity, of the moving electron along periphery of the circle of electron radius, illustrating spin of the electron diagrammatically. Strength of magnetic flux density required for reversal of spin angular momentum in previous Case (i) is $1.895(4)$ x 10^{14} Wb/ m^2 of first order approximation, while in later Case (ii) it is 7.1078 x 10^{13} Wb/ m^2 of second order approximation. Sudden alternate reversals of magnetic flux densities in these cases of equal to or greater than these above values, generate continuous waves of cosmic rays of frequency ~ 1.803(8) x 10^{22} Hz by complex mass/ complex charge inter-electronic structure given herewith is re-considered.

Keywords

Cosmic-Rays, Electron, Complex-Mass, Complex-Charge

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1. Introduction

Cosmic rays are extremely penetrating radiations/ charged particles, coming from where we do not know for certain as yet, but doubtless from regions far away from earth, and continually bombarding it on all sides with more or less of uniform intensity.

It is considered that the cosmic rays have terrestrial origin. As regards nature of charged particles of which cosmic rays are composed of, whether positive or negative, protons or electrons, study of the latitude effect on earth, by itself, gives no indication whatever; nor does it excludes the possibility of the presence of photons or neutrons, [1], [2], [3], [4, 5, 6].

Assuming that, the cosmic rays are electrically charged & they are deflected by magnetic fields, and their directions have been randomized, making it impossible to tell where they originated. However, cosmic rays in other regions of the Galaxy can be traced by the electromagnetic radiation they produce [7]. Supernova remnants such as the Crab Nebula are known to be a source of cosmic rays from the radio synchrotron radiation emitted by cosmic ray electrons spiralling in the magnetic fields of the remnant.

In addition, observations of high energy (10 MeV - 1000 MeV) gamma rays resulting from cosmic ray collisions with

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interstellar gas show that most cosmic rays are confined to the disk of the Galaxy, presumably by its magnetic field. Similar collisions of cosmic ray nuclei produce lighter nuclear fragments, including radioactive isotopes such as ^{10}Be, which has a half-life of 1.6 million years. The measured amount of ^{10}Be in cosmic rays implies that, on average, cosmic rays spend about 10 million years in the Galaxy before escaping into inter-galactic space.

In a previous paper by Nandedkar [8], an analysis of cosmic rays from inter-electronic structure of the electron is considered, where electromagnetic nature of cosmic rays is analyzed along with complex charge and complex mass of an electron. In the present paper, radius of the electron, velocity of the electron, angular velocity of the electron, moving mass of the electron, frequency of electromagnetic radiation from the electron, wavelength of electromagnetic radiation from the electron and strength of magnetic flux density required for reversal of spin angular momentum are re-calculated. Here it is interesting to note that the moving mass of the electron inside and/ on periphery of the electron has a velocity of 4.242(6) x 10^8 m/ sc which is greater than velocity of light in free space. Thus a world of Tachyon [9] (where particle velocity can exceed velocity of light in free space) exit inside and/ on periphery of the electron. In this paper strength of magnetic flux density required for reversal of spin angular momentum is given in two cases, viz., Case (i) with real part of complex charge neglecting its inherent complexity, and Case (ii) with real part of complex charge retaining its inherent complexity, of the moving electron along periphery of the circle of electron radius, illustrating spin of the electron diagrammatically. Strength of magnetic flux density required for reversal of spin angular momentum in previous Case (i) is 1.895(4) x 10^{14} Wb/ m^2 of first order approximation, while in later Case (ii) it is 7.1078 x 10^{13} Wb/ m^2 of second order approximation. Sudden alternate reversals of magnetic flux densities in these cases of equal to or greater than these above values, generate continuous waves of cosmic rays of frequency ~ 1.803(8) x 10^{22} Hz by complex mass/ complex charge inter-electronic structure given herewith is re-considered.

Frequencies higher than about 10^{21} Hz of Electromagnetic Waves are classified in Cosmic Rays. In this research-paper, aspect of electromagnetic nature of the cosmic rays is re-considered in detail incorporating some additional data.

Figures in this article are in, Plane of Paper for hard-copy version/ Plane of Flat Monitor of Computer for soft-copy version, unless otherwise specified.

The article is developed in following Sections:

1. Introduction
2. Radius of an Electron
3. Complex Charge and Complex mass of an Electron
4. Electromagnetic Radiation Generation by the Electron and
5. Numerical Analysis and Conclusions

2. Radius of an Electron

Let a small uniformly charged sphere O i.e. the electron of radius r_e and charge e moves along the X-axis with a steady velocity u. If this velocity is not large, it may be assumed that the sphere carriers its Faradays tubes along with it, undisturbed as the electromagnetic induction that tends to distort the tubes of force, depends on the velocity of motion - (Fig 1).

As the moving charge O is equivalent to a current i of strength i = eu, the magnetic field H due to it at a point P, distant r from O is given by Biot (Ampere) Law as follows,

$$\mathrm{H} = \frac{\mathrm{eu}\sin\theta}{4\pi r^2}, \quad (1)$$

where θ is the angle between r and X-axis. Therefore energy density w of magnetic field [10] at P, is given by,

$$\mathrm{w} = \frac{1}{2}\mu_0 \mathrm{H}^2. \quad (2)$$

where μ_0 is permeability of free space.

Now consider a small element PQRS at P (Fig. 1) with PQ = dr and PS subtending at O an angle dθ, so that PS = r dθ. The area of the element PQRS (in the plane of the Fig. 1) = r dθ x dr. Dropping a perpendicular PN = r sin θ on the X-axis from P, if the small area PQRS considered above at P, be revolved about OX-axis then it will enclose a ring, every bit of which lies upon the circumference of the circle whose radius is PN = r sin θ and whose plane is perpendicular to OX and hence has the same value for H.

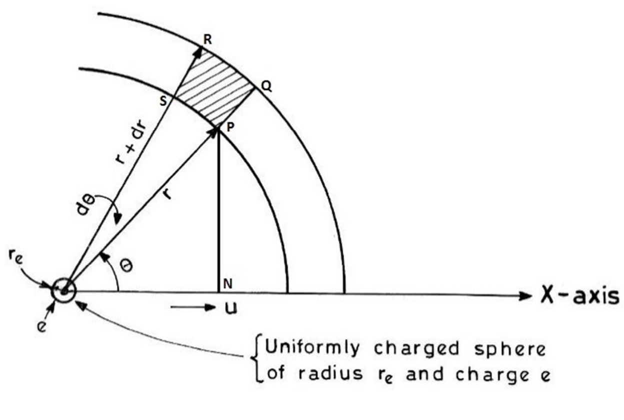

Fig. 1. Diagram for considering of magnetic field energy of a moving electron of finite size with velocity u along X-axis.

The volume of this ring is dv′, where

$$dv' = (r d\theta \times dr)[2\pi \times (PN = r\sin\theta)]$$

which gives,

$$dv' = 2\pi r^2 \sin\theta \, d\theta \, dr. \tag{3}$$

The contribution to the differential energy of the magnetic field dw at dv' is given, using eqns. (1), (2) and (3), by

$$dw = w dv' = \frac{\mu_o}{16\pi} \frac{e^2 u^2 \sin^3\theta}{r^2} d\theta \, dr. \tag{4}$$

Integrating (Fig. 1) the above quantity given by eqn. (4), for all values r i.e. from OP = r_e to ∞ (where r_e is the radius of electron), and for all values of θ, i.e. from 0 to π, total energy due to the moving charged sphere i.e. the electron, is given by,

$$W = \frac{\mu_o}{16\pi} e^2 u^2 \int_0^{\pi} \sin^3\theta \, d\theta \int_{r_e}^{\infty} \frac{dr}{r^2} = \frac{\mu_o e^2 u^2}{12\pi r_e}. \tag{5}$$

The above energy, is also the kinetic energy E of electron, given by,

$$E = \frac{1}{2} m_o u^2, \tag{6}$$

here m_o is rest mass of electron, assuming,

$$u \ll c, \tag{7}$$

where c is the velocity of an electromagnetic wave in free space.

Equating eqns. (5) and (6) gives,

$$m_o = \frac{\mu_o e^2}{6\pi r_e}, \tag{8}$$

here the mass m_o is due to motion where eqn. (7) holds good and, energy associated with the field is given by eqn. (6), in Newtonian World.

Now [10],

$$c = \frac{1}{\sqrt{\mu_o \epsilon_o}}, \tag{9}$$

so,

$$r_e = \frac{(\frac{2}{3})e^2}{4\pi\epsilon_o m_o c^2}, \tag{10}$$

using eqns. (8) and (9). Eqn. (10) gives radius of an electron. Here ϵ_o is permittivity of free space. Now classical radius of electron r_{ec} is given [11] by,

$$r_{ec} = \frac{e^2}{4\pi\epsilon_o m_o c^2}. \tag{11}$$

From eqns. (10) and (11),

$$r_e / r_{ec} = 2/3. \tag{12}$$

In view of eqn. (12), r_e of eqn. (10) is called "reduced radius" of the electron, whereas eqn. (11) gives "classical radius" of the electron. In this analysis "radius" word is used for "reduced radius" of the electron.

3. Complex Charge and Complex Mass of an Electron

From eqn. (10),

$$m_o c^2 = \frac{(\frac{2}{3})e^2}{4\pi\epsilon_o r_e}. \tag{13}$$

In eqn. (13), $m_o c^2$ is the total energy associated with rest mass m_o of the electron [12]. Here $\frac{(\frac{2}{3})e^2}{4\pi\epsilon_o r_e}$ gives Potential Energy of either charges e_1 or e_2 due to e_2 or e_1 separated by a distance r_e - (here also refer to Secn. 4), such that,

$$e_1 + e_2 = e, \tag{14}$$

and,

$$e_1 e_2 = \left(\frac{2}{3}\right) e^2. \tag{15}$$

The solution of simultaneous equations denoted by eqns. (14) and (15) in e_1 and e_2, gives that,

$$e_1 = \frac{e}{2}\left(1 + i\sqrt{5/3}\right), \tag{16}$$

and,

$$e_2 = \frac{e}{2}\left(1 - i\sqrt{5/3}\right), \tag{17}$$

where $i = \sqrt{-1}$.

Let $(m_o - im'_o)$ be the rest mass of charge e_1 and im'_o be the rest mass of charge e_2, such that total rest mass of charges e_1 and e_2 is $(m_o - im'_o) + im'_o = m_o$ and total rest mass energy of them is,

$$[(m_o - im'_o) + im'_o]c^2 = m_o c^2. \tag{18}$$

And then eqn. (13) can be rewritten as follows:

$$\frac{\{\frac{e}{2}(1+i\sqrt{5/3})\}\{\frac{e}{2}(1-i\sqrt{5/3})\}}{4\pi\epsilon_o r_e} = \{(m_o - im'_o) + im'_o\} c^2, \tag{19}$$

where, $(m_o - im'_o)$ is rest mass of charge $e_1 = \frac{e}{2}\left(1 + i\sqrt{5/3}\right)$, and im'_o is rest mass of charge $e_2 = \frac{e}{2}\left(1 - i\sqrt{5/3}\right)$, using eqns. (15), (16), (17) and (18).

4. Electromagnetic Radiation Generation by the Electron

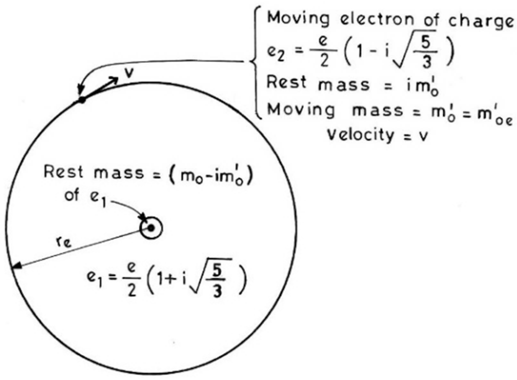

Fig. 2. Complex charge and complex mass structure of electron of radius r_e in (p, ϕ)-plane of a system of polar co-ordinates. Here imaginary-axis is not shown in above Figure. Entities associated with a factor $i = \sqrt{-1}$ are mathematical operators only.

In this model of electron, the charge e_1 with rest mass $(m_o - im'_o)$ is present at origin O of a system of polar co-ordinates (p, ϕ). And charge e_2 rotate along circle of radius r_e with charge e_1 hinged at O - (Fig. 2), forming a stable system, *is the assumption*. The plane of Fig. 2 is Plane of Paper.

Now potential energy of charge e_2 on circumference of circle of radius r_e due to potential of charge e_1 at O (Fig. 2) is $[e_2 (\frac{e_1}{4\pi\epsilon_o r_e})] = \frac{(\frac{2}{3})e^2}{4\pi\epsilon_o r_e} = m_o c^2$ [refer to eqns. (13) and (15)]. Similarly potential energy of charge e_1 at center O due to potential of charge e_2 on circumference of circle of radius r_e (Fig. 2) is $\left[e_1 \left(\frac{e_2}{4\pi\epsilon_o r_e}\right)\right] = \frac{(\frac{2}{3})e^2}{4\pi\epsilon_o r_e} = m_o c^2$ [refer to eqns. (13) and (15)]. So this rest mass energy of the electron $m_o c^2$ is also effective pair potential energy that describes the interaction which acts along the line of length equal to the radius r_e of electron connecting the (two point) charges e_1 and e_2.

Let m'_{oe} be the moving mass of charge e_2. This charge moves with uniform velocity v along the circumference of the circle of radius r_e (Fig. 2)*, is the assumption*. Then,

$$m'_{oe} = \frac{im'_o}{\sqrt{1-\frac{v^2}{c^2}}}, \tag{20}$$

by Einstein theory of relativity[12].

If I is the moment of Inertia of the spinning electron about O, then

$$I = m'_{oe} r_e^2. \tag{21}$$

And spinning energy associated with this charge e_2 is then,

$$E_s = \frac{1}{2} I\omega^2 = \frac{1}{2} m'_{oe} r_e^2 \omega^2, \tag{22}$$

where ω is the angular velocity of the spinning/rotating electron in the circle of radius r_e.

Further energy associated with moving charge of mass m'_{oe}, by Einstein theory of relativity [12], is given as follows:

$$E_m = m'_{oe} c^2. \tag{23}$$

Here E_s of eqn. (22) and, E_m of eqn. (23) are same. Hence equating the two, the result is.

$$\omega = \sqrt{2} \frac{c}{r_e}. \tag{24}$$

But spin angular momentum of charge e_2 is,

$$M_s = I\omega = m'_{oe} r_e^2 \omega, \tag{25}$$

using eqn. (21).

Further, the spin angular momentum of the electron is considered to be given by,

$$M_s = \pm\frac{1}{2}\left(\frac{h}{2\pi}\right), \tag{26}$$

where, ±1/2 is spin quantum number, say +1/2 for clockwise spin & -1/2 for anti-clockwise spin of the electron and, h is Plank constant, in analogy with Uhlenbeck and Goudschmidt (1925-1926) model of spinning electron [13], *is the assumption* of this analysis.

From eqn. (26) choosing +1/2 spin quantum number, eqn. (25) gives,

$$m'_{oe} = \frac{1}{2}\left(\frac{h}{2\pi}\right)\frac{1}{r_e^2 \omega}. \tag{27}$$

Substituting the value of ω from eqn. (24) in eqn. (27), eqn. (27) gives,

$$m'_{oe} = \frac{1}{2\sqrt{2}}\left(\frac{\hbar}{c r_e}\right), \tag{28}$$

where,

$$\hbar = h/2\pi, \quad (29)$$

is reduced Planck constant.

Further, since

$$m'_{oe} = \frac{i m'_o}{\sqrt{1-\frac{v^2}{c^2}}},$$

which is eqn. (20) and,

$$r_e\,\omega = v = \sqrt{2}\,c, \quad (30)$$

using eqn. (24), hence eqn. (20) using eqn. (30), gives,

$$m'_{oe} = m'_o = \frac{1}{2\sqrt{2}}\left(\frac{\hbar}{c\,r_e}\right), \quad (31)$$

using eqn. (28).

Energy associated with spin angular momentum + (1/2) $\hbar$ [refer to eqn. (26) and eqn. (29)] is $m'_{oe}\,c^2$, say in clockwise spin of the electron [refer to eqn. (23)]. Similarly, energy associated with spin angular momentum − (1/2) $\hbar$ [refer to eqn. (26) and eqn. (29)] is - $m'_{oe}\,c^2$, say in anticlockwise spin of the electron [refer to eqn. (23)]. So change of energy of the electron when its spin momentum changes from + (1/2) $\hbar$ to − (1/2) $\hbar$ is given by,

$$[m'_{oe}\,c^2 - (-m'_{oe}\,c^2)] = 2\,m'_{oe}\,c^2. \quad (32)$$

The above difference of energy of the electron is radiated with a photon of frequency ν of energy hν, by Planck hypothesis. Whence Eqn. (32) gives,

$$h\nu = 2\,m'_{oe}\,c^2. \quad (33)$$

Using eqn. (31), eqn. (33) gives,

$$\nu = \frac{1}{2\,\pi\sqrt{2}}\left(\frac{c}{r_e}\right). \quad (34)$$

Equation (34) gives frequency of electromagnetic radiation from the electron as its spin angular momentum changes from + (1/2) $\hbar$ to − (1/2)$\hbar$.

5. Numerical Analysis and Conclusions

[A]. Numerical Analysis →

Here numerical values of various entities with reference to previous paper by Nandedkar [8] are re-calculated, using 'Computational Values' of "Some Fundamental Constants of Physics" in Appendix B [14]:

[1]. Radius of the electron (r_e):

The radius of electron is given by, eqn. (10),

$$r_e = \frac{(\frac{2}{3})e^2}{4\,\pi\epsilon_o m_o c^2} = 1.871(7) \text{ x } 10^{-15} \text{ m}. \quad (35)$$

[2]. Velocity of the electron (v):

Velocity of the electron is given by eqn. (30),

$$v = \sqrt{2}\;c = 4.242(6) \text{ x } 10^{8} \text{ m/ sc}. \quad (36)$$

This velocity is greater than velocity of electromagnetic radiation in free space, which can happen in Tachyon world [9].

[3]. Angular velocity of the electron (ω):

Angular velocity of the electron is given by using eqn. (30),

$$\omega = \sqrt{2}\;c/\,r_e = 2.266(7) \text{ x } 10^{23} \text{ rad/ sc}. \quad (37)$$

[4]. Moving mass of the electron (m'_{oe}):

Moving mass of the electron is given by using eqn. (31),

$$m'_{oe} = \frac{1}{2\sqrt{2}}\left(\frac{\hbar}{c\,r_e}\right) = 6.644(0) \text{ x } 10^{-29} \text{ Kgm}. \quad (38)$$

[5]. Frequency of electromagnetic radiation from the electron (ν):

Frequency of electromagnetic radiation from the electron is given by using eqn. (34),

$$\nu = \frac{1}{2\,\pi\sqrt{2}}\left(\frac{c}{r_e}\right) = 1.803(8) \text{ x } 10^{22} \text{ Hz} \quad (39)$$

which is due to reversal of spin momentum of the electron. ν is in the range of cosmic rays.

[6]. Wavelength of electromagnetic radiation from the electron (λ):

Wavelength of electromagnetic radiation from the electron is given by using eqn. (39),

$$\lambda = \frac{c}{\nu} = 2\,\pi\sqrt{2}\;r_e = 1.663(2) \text{ x } 10^{-14} \text{ m}, \quad (40)$$

which is due to reversal of spin momentum of the electron. λ is in the range of cosmic rays.

[7]. Strength of magnetic field required for reversal of spin angular momentum (B/ B_r):

Here, the moving charge in the circle of radius r_e is,

$$\text{Charge (moving), } e_2 = \frac{e}{2}\left(1 - i\sqrt{5/3}\right), \quad (41)$$

with its rest mass as,

$$\text{Rest mass} = i m'_o, \quad (42)$$

and moving mass as,

$$\text{Moving mass} = m'_o = m'_{oe}. \quad (43)$$

Apart from the above, there is a stationary charge at center of the circle of radius r_e viz.,

$$\text{Charge (stationary), } e_1 = \frac{e}{2}\left(1 + i\sqrt{5/3}\right), \quad (44)$$

with its stationary mass at center of the circle of radius r_e is,

$$\text{Rest mass} = (m_o - im'_o), \quad (45)$$

refer to Fig. 2 for the above cases.

Case (i). Considering Real Part of Complex Moving Charge of e_2 neglecting its inherent complexity:

Here, value of magnetic flux density due to circulation of complex electronic current giving Real part of current due to Real charge neglecting its inherent complexity along positive Y-axis (Fig. 3) is carried out in following steps. Here note that charge e of electron is negative.

Now magnetic flux density B (Fig. 3) developed normal to and entering along negative Z-axis towards O and in the XY-plane of circular motion of the moving (say, clockwise) real charge $\frac{e}{2}$ of Complex Charge (moving), $e_2 = \frac{e}{2}\left(1 - i\sqrt{5/3}\right)$ of eqn. (41) with velocity v of the electron which is in XY-plane of the paper, of the Fig. 3 produces Lorentz Force F_B *(assumed to hold good)* acting radially towards Centre O (Fig. 3) and along negative X-axis in XY-plane of paper of the Fig. 3, that is given by following relationship:

$$F_B = B\,\frac{e}{2}\,v. \quad (46)$$

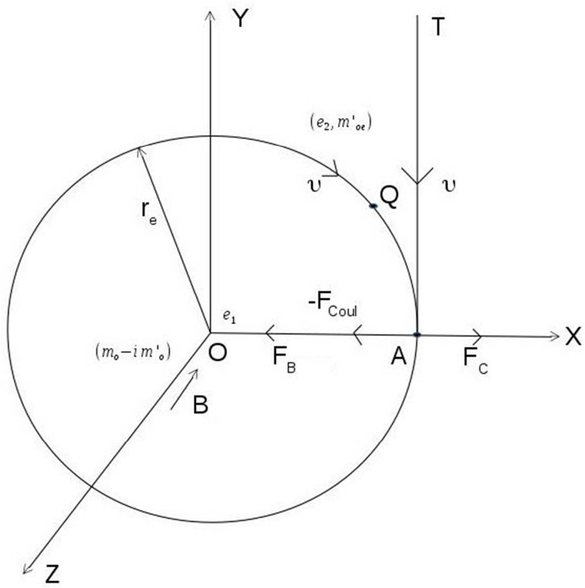

Fig. 3. Charge e_2 = (e/2) $\left(1 - i\sqrt{5/3}\right)$ of electron rotating clockwise in a circle of electron radius r_e with moving mass m'_{oe} and velocity v in XY- plane, where imaginary-axis is not shown in above Figure. Entities associated with a factor i = $\sqrt{-1}$ are mathematical operators only. Charge e_1 = (e/2) $\left(1 + i\sqrt{5/3}\right)$ of electron with its rest mass $(m_o - im'_o)$ is at Center O of the circle of electron radius r_e. Here B = magnetic flux density developed *(due to circulation of Real part of current due to Real charge neglecting its inherent complexity along positive Y-axis is assumption. Here note that charge e of electron is negative)*, acting along negative Z-axis towards O, F_B = Lorentz Force acting towards O along negative X-axis in XY-plane, $-F_{Coul}$ = Coulomb Force of Repulsion acting towards O along negative X-axis in XY-plane, and F_C = Centrifugal Force acting away from O along positive X-axis in XY-plane. Orientation of X-axis in XY-plane is to be chosen such that v is always instantaneously tangential to path of circular motion of electron in XY-plane (say at A) and OX is normal to v along the tangent TA at A. Here Q denotes an arbitrary point on circular orbit of the electron of Fig. 3. Origin O of the system of Polar co-ordinates (p, ϕ) with (p, ϕ) - plane of Fig. 2, is same as origin O of the system of Cartesian co-ordinates (X, Y) with (X, Y) – plane of Fig. 3. Plane of Fig. 2 is same as plane of Fig. 3, which is the plane of paper. Radius of electron r_e is same in circles of the radius r_e (Fig. 2 & Fig. 3) and Center O of Fig. 2 coincides with Center O of Fig. 3, although both Figures are drawn with different scales.

Whereas Coulomb Force F_{Coul} *(assumed to hold good)* of repulsion between Charge (stationary), $e_1 = \frac{e}{2}\left(1 + i\sqrt{5/3}\right)$ of eqn. (44) and Charge (moving), $e_2 = \frac{e}{2}\left(1 - i\sqrt{5/3}\right)$ of eqn. (41), separated by distance of r_e of electron radius (Fig. 3), is given by Coulomb Law, viz.,

$$F_{Coul} = \left(\frac{2}{3}\right) e^2/4\,\pi\epsilon_o\, r_e^2, \quad (47)$$

where,

$$\left\{\frac{e}{2}\left(1 + i\sqrt{\frac{5}{3}}\right)\right\}\left\{\frac{e}{2}\left(1 - i\sqrt{\frac{5}{3}}\right)\right\} = \left(\frac{2}{3}\right) e^2, \quad (48)$$

and here e_1 and e_2 are also given by eqns. (16) and (17) respectively, [here refer also to eqn. (15)]. And here r_e is given by eqn. (10). - F_{Coul} acts radially towards Centre O along negative X-axis in XY-plane of the paper of Fig. 3.

Thus a force due to difference of Lorentz and Coulomb forces, viz.,

$$F_B - F_{Coul}, \tag{49}$$

acts towards Center O of circular path of electron of Fig. 3 along negative X-axis in XY-plane of the paper.

Further Centrifugal Force F_C *(assumed to hold good)* acting on the above electron in the XY-plane of the paper of Fig. 3, and radially away from Centre O along positive X-axis in XY-plane of the paper (Fig. 3) due to circular motion of the electron, is given by,

$$F_C = \left(\frac{m'_{oe}v^2}{r_e}\right), \tag{50}$$

where m'_{oe}, v and r_e are given by eqns. (28), (30) and (10) respectively.

Expressions given by eqns. (49) and (50) are the same. Whence equating them gives,

$$F_B - F_{Coul} = F_C. \tag{51}$$

Eqn. (51) using eqns. (46), (47) and (50), gives,

$$B = \left(\frac{\left(\frac{m'_{oe}v^2}{r_e} + \left(\frac{2}{3}\right) e^2/4\,\pi\epsilon_o\, r_e^2\right)}{ev/2}\right) = 1.895(4) \times 10^{14}\ \text{Wb/ m}^2. \tag{52}$$

Case (ii). Considering Real Part of Complex Moving Charge of e_2 retaining its inherent complexity:

In an analogous way as in Case (i), value of magnetic flux density due to circulation of complex electronic current giving Real part of current due to Real charge retaining its inherent complexity along positive Y-axis (Fig. 4) is carried out in following steps. Here note that charge e of electron is negative.

Now (complex) magnetic flux density $B = (B_r + i\,B_i)$, [where B_r is real part of complex magnetic flux density B with B_i as imaginary part of complex magnetic flux density B], and here B_r (Fig. 4) developed normal to and entering in the XY-plane along negative Z-axis towards O *(is the assumption)* of circular motion of the moving (say, clockwise) Complex Charge (moving), $e_2 = \frac{e}{2}\left(1 - i\sqrt{5/3}\right)$ of eqn. (41) with velocity v of the electron which is in XY-plane of the paper, of the Fig. 4, produces (complex) Lorentz Force F_B which is *assumed to hold good,* [where $F_B = F_{B(real)} + i\ F_{B(imaginary)}$ of which real part is $F_{B(real)}$ and imaginary part is $F_{B(imaginary)}$] and $F_{B(real)}$ of F_B acting radially towards Centre O (Fig. 4) and in XY-plane of paper of the Fig. 4 along negative X-axis, that is given by following relationship:

$$F_B = B\,\frac{e}{2}\left(1 - i\sqrt{5/3}\right)v, \tag{53}$$

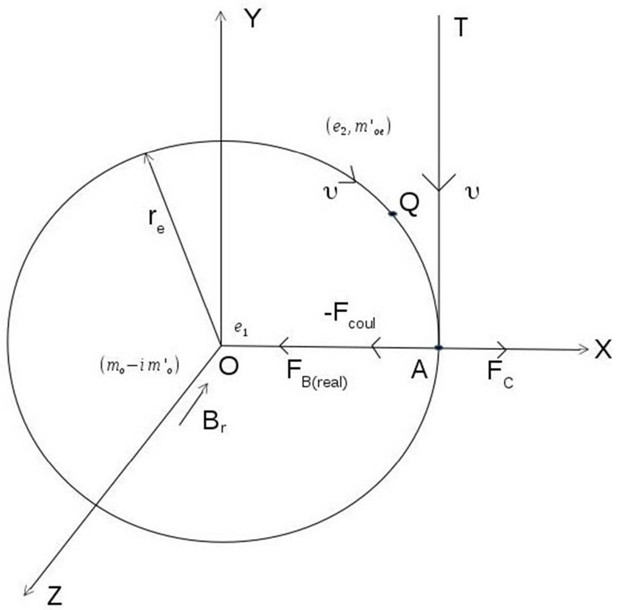

Fig. 4. Charge e_2 = (e/2) $\left(1 - i\sqrt{5/3}\right)$ of electron rotating clockwise in a circle of electron radius r_e with moving mass m'_{oe} and velocity v in XY-plane, where imaginary-axis is not shown in above Figure. Entities associated with a factor $i = \sqrt{-1}$ are mathematical operators only. Charge e_1 = (e/2) $\left(1 + i\sqrt{5/3}\right)$ of electron with its rest mass $(m_o - im'_o)$ is at Center O of the circle of electron radius r_e. Here B_r = real magnetic flux density developed *(due to circulation of complex electronic current giving Real part of current due to Real charge retaining its inherent complexity along positive Y-axis is assumption. Here note that charge e of electron is negative)*, acting along negative Z-axis towards O, $F_{B(real)}$ = real Lorentz Force acting towards O along negative X-axis in XY-plane, $-F_{coul}$ = Coulomb Force of Repulsion acting towards O along negative X-axis in XY-plane and F_C = Centrifugal Force acting away from O along positive X-axis in XY-plane. Orientation of X-axis in XY-plane is to be chosen such that v is always instantaneously tangential to path of circular motion of electron in XY-plane (say at A) and OX is normal to v along the tangent TA at A. Here Q denotes an arbitrary point on circular orbit of the electron of Fig. 4. Origin O of the system of Polar co-ordinates (p, ϕ) with (p, ϕ) - plane of Fig. 2, is same as origin O of the system of Cartesian co-ordinates (X, Y) with (X, Y) – plane of Fig. 4. Plane of Fig. 2 is same as plane of Fig. 4, which is the plane of paper. Radius of electron r_e is same in circles of the radius r_e (Fig. 2 & Fig. 4) and Center O of Fig. 2 coincides with Center O of Fig. 4, although both Figures are drawn with different scales.

with,

$$B = (B_r + i\,B_i), \tag{54}$$

due to moving complex charge $e_2 = \frac{e}{2}\left(1 - i\sqrt{5/3}\right)$ of eqn. (41) and with velocity v of eqn. (30), *is the assumption*.

Whereas Coulomb Force F_{coul} of repulsion between Charge (stationary), $e_1 = \frac{e}{2}\left(1 + i\sqrt{5/3}\right)$ of eqn. (44) and Charge (moving), $e_2 = \frac{e}{2}\left(1 - i\sqrt{5/3}\right)$ of eqn. (41), separated by distance of r_e of electron radius (Fig. 4), is given by Coulomb Law, viz.,

$$F_{coul} = \left(\frac{2}{3}\right) e^2/4\,\pi\epsilon_o\, r_e^2, \tag{55}$$

where,

$$\{\frac{e}{2}\left(1+i\sqrt{\frac{5}{3}}\right)\}\{\frac{e}{2}\left(1-i\sqrt{\frac{5}{3}}\right)\} = \left(\frac{2}{3}\right) e^2, \quad (56)$$

and here e_1 and e_2 are also given by eqns. (16) and (17) respectively, [here refer also to eqn. (15)]. And here r_e is given by eqn. (10). - F_{coul} acts radially towards Centre O along negative X-axis in XY-plane of the paper of Fig. 4 *is the assumption.*

Thus a force due to difference of Lorentz and Coulomb forces, viz.,

$$F_B - F_{coul}, \quad (57)$$

acts towards Center O of circular path of electron of Fig. 4 in XY-plane of the paper, along negative X-axis *[where it is intrinsically assumed that in eqn. (57) real part of F_B is coming into picture*].

Further Centrifugal Force F_C acting on the above electron in the XY-plane of the paper of Fig. 4, and radially away from Centre O in XY-plane of the paper along positive X-axis (Fig. 4) due to circular motion of the electron, is given by,

$$F_C = \left(\frac{m'_{oe}v^2}{r_e}\right), \quad (58)$$

is assumed to hold good. Here m'_{oe}, v and r_e are given by eqns. (28), (30) and (10) respectively.

Expressions given by eqns. (57) and (58) are the same. Whence equating them gives,

$$F_B - F_{coul} = F_C. \quad (59)$$

Eqn. (59) using eqns. (53), (54), (55) and (58), gives,

$$(B_r + i B_i)\{\frac{e}{2}\left(1-i\sqrt{\frac{5}{3}}\right)\} v - \left(\frac{2}{3}\right) e^2/4\pi\epsilon_o r_e^2 = \left(\frac{m'_{oe}v^2}{r_e}\right) \quad (60)$$

which gives,

$$F_{B(real)} \equiv (B_r + \sqrt{\frac{5}{3}} B_i)\frac{e}{2} v = \left(\frac{2}{3}\right) e^2/4\pi\epsilon_o r_e^2 + \left(\frac{m'_{oe}v^2}{r_e}\right), \quad (61)$$

where $F_{B(real)}$ is real part of Lorentz Force F_B, and

$$F_{B(imaginary)} \equiv (B_i - \sqrt{\frac{5}{3}} B_r)\frac{e}{2} v = 0, \quad (62)$$

where $F_{B(imaginary)}$ is imaginary part of Lorentz Force F_B (which is a mathematical operator only), which is zero, *is the assumption*. And here, total Lorentz Force F_B is given by,

$$F_B = F_{B(real)} + i F_{B(imaginary)}. \quad (63)$$

Eqn. (62) gives,

$$B_i = \sqrt{\frac{5}{3}} B_r, \quad (64)$$

if e or v is not zero.

Eliminating B_i between eqns. (61) and (64), eqn. (61) gives,

$$B_r = \left(\frac{3}{8}\right)\left(\frac{\left(\frac{m'_{oe}v^2}{r_e} + \left(\frac{2}{3}\right) e^2/4\pi\epsilon_o r_e^2\right)}{ev/2}\right) = 7.107(8) \times 10^{13}\ \text{Wb/m}^2, \quad (65)$$

corresponding to Real part of Lorentz Force F_B of eqn. (61) [using eqn. (64)], contributing to spin of electron.

[B]. Conclusions →

Thus if spin angular momentum is to be reversed in the circular orbit (Fig. 3/ Fig. 4), external magnetic flux density $\geq 1.895(4) \times 10^{14}$ Wb/ m^2 for Case (i)/ 7.107(8) x 10^{13} Wb/ m^2 for Case (ii), to be applied and removed suddenly in opposite direction of B/ B_r which is normal to plane of paper and entering in XY-plane of the paper along negative Z-axis towards O (Fig. 3 / Fig. 4) of above illustration, when electromagnetic radiation of frequency ν = 1.803(8) x 10^{22} Hz of eqn. (39) or wavelength λ = 1.663(2) x 10^{-14} m of eqn. (40) gets generated. A sequence of alternate applications and removals of sudden external magnetic flux density $\geq 1.895(4) \times 10^{14}$ Wb/ m^2 for Case (i)/ 7.107(8) x 10^{13} Wb/ m^2 for Case (ii) that may exit in our/ other galaxy, results in generation of continuous waves of cosmic rays of the frequency of ν = 1.803(8)) x 10^{22} Hz.

In the present analysis, considering electromagnetic nature of cosmic rays, the radius of electron viz., 1.8717 x 10^{-15} m is got. Then complex charge and complex mass of an electron are analysed. Furthermore electromagnetic radiation generation by the electron is discussed. The work in this article can provide radius of electron, velocity of the electron viz., 4.242(6) x 10^8 m/ sc, angular velocity of the electron viz., 2.266(7) x 10^{23} rad/ sc, moving mass of the electron viz., $6.644(0) \times 10^{-29}$ Kgm, frequency of electromagnetic radiation from the electron viz., 1.803(8)) x 10^{22} Hz, wavelength of electromagnetic radiation from the electron viz., 1.663(2)) x 10^{-14} m and strength of magnetic flux density required for reversal of spin angular momentum viz., $1.895(4) \times 10^{14}$ Wb/ m^2 for Case (i)/ 7.107(8) x 10^{13} Wb/ m^2 for Case (ii), which are of considerable significance. It is interesting to note that the moving mass of the electron given by eqn. (28) of Fig. 2/ Fig. 3/ Fig. 4, inside/ on periphery of the electron has a velocity of 4.242(6) x 10^8 m/ sc which is greater than velocity of light in free space. Thus a world of Tachyon [9] exit inside/ on periphery of electron.

The present paper gives strength of magnetic flux density required for reversal of spin angular momentum in two cases, viz., for Case (i), with real part of complex charge neglecting its inherent complexity which is $1.895(4) \times 10^{14}$ Wb/ m^2 (Fig. 3) of first order approximation and, for Case (ii) with real part of complex charge retaining its inherent complexity which is 7.107(8) x 10^{13} Wb/ m^2 (Fig. 4) of second order approximation, of the moving electron along periphery of the circle of electron radius, illustrating spin of the electron diagrammatically.

This research-paper illustrates diagrammatically spin of electron [Fig. 3 for Case (i)/ Fig. 4 for Case (ii)] with all entities associated therein with a factor $i = \sqrt{-1}$ as mathematical operators only, in Tachyon world [9] for the electron of charge e and rest mass m_o of Newtonian world.

For Case (i), present analysis assumes that, (i) validity of eqn. (26) for the spin angular momentum $M_s = \pm\frac{1}{2}\left(\frac{h}{2\pi}\right)$ of the electron holds good, (ii) validity of eqn. (46) for Lorentz Force $F_B = B\frac{e}{2}v$, for magnetic flux density $B = \left(\frac{\left(\frac{m'_{oe}v^2}{r_e} + \left(\frac{2}{3}\right)e^2/4\,\pi\epsilon_o r_e^2\right)}{ev/2}\right)$ of eqn. (52) holds good, (iii) validity of eqn. (47) for Coulomb Law of Force of Repulsion $F_{Coul} = \left(\frac{2}{3}\right)e^2/4\,\pi\epsilon_o r_e^2$ holds good, (iv) validity of eqn. (50) for Centrifugal Force $F_C = \left(\frac{m'_{oe}v^2}{r_e}\right)$ for real charge $\frac{e}{2}$ neglecting its inherent complexity of complex moving charge $e_2 = \frac{e}{2}\left(1 - i\sqrt{5/3}\right)$ of (Fig.2/ Fig. 3) with velocity $v = \sqrt{2}$ c of eq. (30) of the electron of moving mass $m'_{oe} = \frac{1}{2\sqrt{2}}\left(\frac{\hbar}{c\,r_e}\right)$ of eqn. (28) hold good, (v) validity of diagrammatic representation of various entities in Fig. 2 and Fig. 3, are valid and, (vi) here all entities associated with a factor $i = \sqrt{-1}$ denote mathematical operators only.

Whereas for Case (ii), present analysis assumes that, (i) validity of eqn. (26) for the spin angular momentum $M_s = \pm\frac{1}{2}\left(\frac{h}{2\pi}\right)$ of the electron holds good, (ii) validity of eqns. (53) and (63) for complex Lorentz Force $F_B = F_{B(real)} + i\, F_{B(imaginary)}$ for real magnetic flux density $B_r = \left(\frac{3}{8}\right)\left(\frac{\left(\frac{m'_{oe}v^2}{r_e} + \left(\frac{2}{3}\right)e^2/4\,\pi\epsilon_o r_e^2\right)}{ev/2}\right)$ of eqn. (65) hold good, (iii) validity of eqn. (55) for Coulomb Law of Force of Repulsion $F_{coul} = \left(\frac{2}{3}\right)e^2/4\,\pi\epsilon_o r_e^2$ holds good, (iv) validity of eqn. (58) for Centrifugal Force $F_C = \left(\frac{m'_{oe}v^2}{r_e}\right)$ for real charge $\frac{e}{2}$ retaining its inherent complexity of complex moving charge $e_2 = \frac{e}{2}\left(1 - i\sqrt{5/3}\right)$ of (Fig. 2/ Fig. 4) with velocity $v = \sqrt{2}$ c of eq. (30) of the electron of moving mass $m'_{oe} = \frac{1}{2\sqrt{2}}\left(\frac{\hbar}{c\,r_e}\right)$ of eqn. (28) along with eqn. (54) for complex magnetic flux density $B = (B_r + i\,B_i)$, hold good, (v) validity of eqn. (62) viz., $F_{B(imaginary)} \equiv (B_i - \sqrt{\frac{5}{3}}\,B_r)\frac{e}{2}v = 0$ holds good, (vi) validity of diagrammatic representation of various entities in Fig. 2 and Fig. 4, are valid and, (vii) here all entities associated with a factor $i = \sqrt{-1}$ denote mathematical operators only.

If different species of electrons with different charge/ mass ratios and hence different radii be considered to exit in this vast universe, then a continuous/ desecrate band of cosmic rays of various frequencies may be generated, depending upon what different species of electrons with different charge/ mass ratios and hence different radii are available in this vast universe. Data on energy spectra of cosmic ray (photons) at Cosmic Ray Observatory corresponding to Wikipedia, the free encyclopaedia, can also considered to be due to production of cosmic rays mentioned in this article.

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