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Analysis of Cosmic Rays from Inter-Electronic Structure of the Electron

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Abstract

Considering electromagnetic nature of cosmic rays, the radius of electron 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., 4.239(4) x 10^8 m/sc, angular velocity of the electron, moving mass of the electron viz., 6.618(0)x 10^{-29} Kgm, frequency of electromagnetic radiation from the electron viz., 1.795(6) x 10^{22} Hz, wavelength of electromagnetic radiation from the electron and strength of magnetic flux density required for reversal of spin angular momentum viz., 1.877(1) x10^{14} Wb/m^2, which are of considerable significance. It is interesting to note that the moving mass of the electron inside and/on periphery of the electron has a velocity of 4.239(4) x 10^8 m/sc which is greater than velocity of light in free space. Thus a world of Tachyon exit inside and/on periphery of the electron. The present research-paper deals with, electromagnetic nature of cosmic rays. A sequence of alternate applications and removals of external magnetic flux density $\geq$ 1.877(1) x10^{14} Wb/m^2, that may exit in our/other galaxy, results in generation of continuous waves of cosmic rays of frequency ~ 1.795(6) x 10^{22} Hz by complex mass/complex charge inter-electronic structure given herewith.

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–(refer to Rajam 1960 [1], Ringuet 1950 [2], Dauvillier 1954 [3], Wilson 1952, 1954, 1956 [4], [5], [6].

Considering 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 (refer to Mewaldt, 1996) [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 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

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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.

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 considered.

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.

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,

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

where θ is the angle between r and X-axis. Therefore energy density w of magnetic field (Ramo, Whinnery, and Van Duzer 1970 [8]) at P, is given by,

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

where μ_0 is permeability of free space.

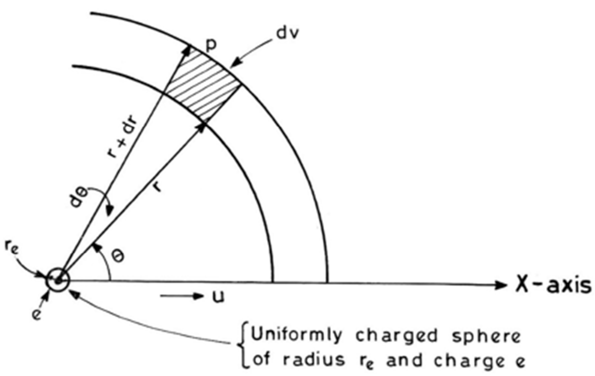

Fig. 1. Diagram for considering of magnetic field energy of a moving electron of finite size with velocity u along X-axis.

The volume element dv (Fig.1), between (r, θ) and (r + dr, θ + dθ) is given by,

$$dv = 2\pi r^2 \sin\theta \, d\theta \, dr. \quad (3)$$

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

$$dw = \frac{\mu_0}{16\pi}\frac{e^2u^2\sin^3\theta}{r^2}\, d\theta \, dr. \quad (4)$$

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 classical 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,

$$W = \frac{\mu_0}{16\pi} e^2u^2 \int_0^{\pi}\sin^3\theta \, d\theta \int_{r_e}^{\infty}\frac{dr}{r^2} = \frac{\mu_0 e^2u^2}{12\,\pi\, r_e}. \quad (5)$$

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

$$E = \frac{1}{2} m_o u^2, \quad (6)$$

here m_o is rest mass of electron, assuming,

$$u \ll c, \quad (7)$$

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

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

$$m_o = \frac{\mu_0 e^2}{6\,\pi\, r_e}, \quad (8)$$

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 (refer to Ramo, Whinnery and Van Duzer, 1970) [8],

$$c = \frac{1}{\sqrt{\mu_0\epsilon_0}}, \quad (9)$$

so,

$$r_e = \frac{(\frac{2}{3})e^2}{4\,\pi\epsilon_0 m_o c^2}, \quad (10)$$

using eqns. (8) and (9). Eqn. (10) gives classical radius of an electron. Here ϵ_o is permittivity of free space.

3. Complex Charge and Complex Mass of an Electron

From eqn. (10),

$$m_o c^2 = \frac{(\frac{2}{3})e^2}{4\,\pi\epsilon_0\, r_e}. \quad (11)$$

In eqn. (11), $m_o c^2$ is the total energy associated with rest mass m_o of the electron. (for instance, refer to Richtmyer, Kennard and Lauristen, 1955) [9]. Here $\frac{(\frac{2}{3})e^2}{4\,\pi\epsilon_0\, r_e}$ gives

Potential Energy of two charges e_1 and e_2, separated by a distance r_e such that,

$$e_1 + e_2 = e, \tag{12}$$

and,

$$e_1 e_2 = \left(\frac{2}{3}\right) e^2. \tag{13}$$

The solution of simultaneous equations denoted by eqns. (12) and (13) in e_1 and e_2, gives that,

$$e_1 = \frac{e}{2}\left(1 + i\sqrt{5/3}\right), \tag{14}$$

and,

$$e_2 = \frac{e}{2}\left(1 - i\sqrt{5/3}\right), \tag{15}$$

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,

$$[(m_o - im_o') + im_o']c^2 = m_o c^2. \tag{16}$$

And then eqn. (11) can be rewritten as follows:

$$\frac{\{\frac{e}{2}(1+i\sqrt{5/3})\}\{\frac{e}{2}(1-i\sqrt{5/3})\}}{4\pi\epsilon_o r_e} = \{(m_o - im_o') + im_o'\}c^2, \tag{17}$$

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

4. Electromagnetic Radiation Generation by the Electron

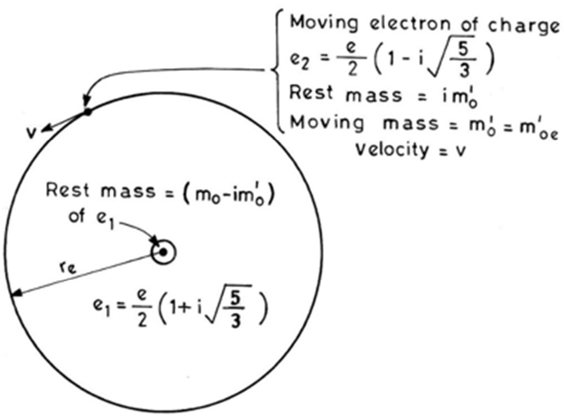

Fig. 2. Complex charge and mass structure of electron of radius r_e.

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. The plane of Fig. 2 is Plane of Paper.

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. Then,

$$m_{oe}' = \frac{im_o'}{\sqrt{1-\frac{v^2}{c^2}}}, \tag{18}$$

by Einstein theory of relativity (for instance, refer to Richtmyer, Kennard and Lauristen, 1955) [9].

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

$$I = m_{oe}' r_e^2. \tag{19}$$

And spinning energy associated with this charge e_2 is then,

$$E_s = \frac{1}{2} I\omega^2 = \frac{1}{2} m_{oe}' r_e^2 \omega^2, \tag{20}$$

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 (for instance, refer to Richtmyer, Kennard and Lauritsen, 1955) [9], is given as follows:

$$E_m = m_{oe}' c^2. \tag{21}$$

Here E_s of eqn. (20) and, E_m of eqn. (21) are same. Hence equating the two, the result is.

$$\omega = \sqrt{2}\,\frac{c}{r_e}. \tag{22}$$

But spin angular momentum of charge e_2 is,

$$M_s = I\omega = m_{oe}' r_e^2 \omega, \tag{23}$$

using eqn. (19).

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

$$M_s = \pm\frac{1}{2}\left(\frac{h}{2\pi}\right), \tag{24}$$

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 (Jain, 1967) [10], is the assumption of this analysis.

From eqn. (24) choosing +1/2 spin quantum number, eqn. (23) gives,

$$m_{oe}' = \frac{1}{2}\left(\frac{h}{2\pi}\right)\frac{1}{r_e^2\,\omega}. \tag{25}$$

Substituting the value of ω from eqn. (22) in eqn. (25), eqn.

(25) gives,

$$m'_{oe} = \frac{1}{2\sqrt{2}}\left(\frac{\hbar}{c\, r_e}\right), \qquad (26)$$

where,

$$\hbar = h/2\pi\,. \qquad (27)$$

Further, since

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

which is eqn. (18) and,

$$r_e\, \omega = v = \sqrt{2}\, c, \qquad (28)$$

using eqn. (22), hence eqn. (18) using eqn. (28), gives,

$$m'_{oe} = m'_o = \frac{1}{2\sqrt{2}}\left(\frac{\hbar}{c\, r_e}\right), \qquad (29)$$

using eqn. (26).

Energy associated with spin angular momentum + (1/2) $\hbar$ [- refer to eqn. (24)] is, $m'_{oe}\, c^2$, say in clockwise spin of the electron. Similarly, energy associated with spin angular momentum $-$ (1/2) $\hbar$ [- refer to eqn. (24)] is, - $m'_{oe}\, c^2$, say in anticlockwise spin of the electron. So change of energy of the electron when its spin momentum changes from + (1/2) $\hbar$ to $-$ (1/2) $\hbar$ is given by,

$$[m'_{oe}\, c^2 - (-m'_{oe}\, c^2)] = 2\, m'_{oe}\, c^2. \qquad (30)$$

The above difference of energy of the electron is radiated with a photon of frequency ν of energy hν, by Planck hypothesis. Whence Eqn. (30) gives,

$$h\nu = 2\, m'_{oe}\, c^2\,. \qquad (31)$$

Using eqn. (29), eqn. (31) gives,

$$\nu = \frac{1}{2\,\pi\sqrt{2}}\left(\frac{c}{r_e}\right). \qquad (32)$$

Equation (32) 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

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

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

$$r_e = \frac{(\frac{2}{3})e^2}{4\,\pi\epsilon_o m_o c^2} = 1.878(8)\ \text{x}\ 10^{-15}\ \text{m}. \qquad (33)$$

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

Velocity of the electron is given by eqn. (28),

$$v = \sqrt{2}\ c = 4.239(4)\ \text{x}\ 10^{8}\ \text{m/sc}. \qquad (34)$$

This velocity is greater than velocity of electromagnetic radiation in free space, which can happen in Tachyon world. For Tachyon refer to Feinberg 1967) [11].

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

Angular velocity of the electron is given by using eqn. (28),

$$\omega = \sqrt{2}\ c/\ r_e = 2.256(4)\ \text{x}\ 10^{23}\ \text{rad/sc}. \qquad (35)$$

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

Moving mass of the electron is given by using eqn. (29),

$$m'_{oe} = \frac{1}{2\sqrt{2}}\left(\frac{\hbar}{c\, r_e}\right) = 6.618(0)\text{x}\ 10^{-29}\ \text{Kgm}. \qquad (36)$$

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

Frequency of electromagnetic radiation from the electron is given by using eqn. (32),

$$\nu = \frac{1}{2\,\pi\sqrt{2}}\left(\frac{c}{r_e}\right) = 1.795(6)\ \text{x}\ 10^{22}\ \text{Hz} \qquad (37)$$

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. (37),

$$\lambda = \frac{c}{\nu} = 2\,\pi\sqrt{2}\ r_e = 1.669(5)\ \text{x}\ 10^{-14}\ \text{m}, \qquad (38)$$

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):

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

$$\text{Charge (moving)},\ e_2 = \frac{e}{2}\left(1 - i\sqrt{5/3}\right), \qquad (39)$$

with its rest mass as,

$$\text{Rest mass} = i m'_o, \qquad (40)$$

and moving mass as,

$$\text{Moving mass} = m'_o = m'_{oe}. \qquad (41)$$

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

$$\text{Charge (stationary)},\ e_1 = \frac{e}{2}\left(1 + i\sqrt{5/3}\right), \qquad (42)$$

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

$$\text{Rest mass} = (m_o - im'_o), \quad (43)$$

refer to Fig. 2 for the above cases.

Now magnetic flux density B developed normal to and entering in the 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. (39) with velocity v of the electron which is in plane of the paper, of the Fig. 2, produces Lorentz Force F_B acting radially towards Centre O (Fig. 2) and in plane of paper of the Fig. 2, that is given by following relationship:

$$F_B = B\,\frac{e}{2}\,v. \quad (44)$$

Whereas Coulomb Force F_{Coul} of repulsion between Charge (stationary), $e_1 = \frac{e}{2}\left(1 + i\sqrt{5/3}\right)$ of eqn. (42) and Charge (moving), $e_2 = \frac{e}{2}\left(1 - i\sqrt{5/3}\right)$ of eqn. (39), separated by distance of r_e of electron radius (Fig. 2), is given by Coulomb Law, viz.,

$$F_{Coul} = \left(\frac{2}{3}\right) e^2/4\,\pi\epsilon_o\, r_e^2, \quad (45)$$

where,

$$\{\frac{e}{2}\left(1 + i\sqrt{\frac{5}{3}}\right)\}\{\frac{e}{2}\left(1 - i\sqrt{\frac{5}{3}}\right)\} = \left(\frac{2}{3}\right) e^2, \quad (46)$$

and here e_1 and e_2 are also given by eqns. (14) and (15) respectively-[Here refer also to eqn. (13)]. F_{Coul} acts radially away from Centre O in plane of the paper of Fig. 2.

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

$$F_B - F_{Coul}, \quad (47)$$

acts towards Center O of circular path of electron of Fig. 2 in plane of the paper.

Further Centrifugal Force F_C acting on the above electron in the plane of the paper of Fig. 2, and radially away from Centre O in plane of the paper (Fig. 2) due to circular motion of the electron, is given by,

$$F_C = \left(\frac{m'_{oe} v^2}{r_e}\right). \quad (48)$$

Expressions given by eqns. (47) and (48) are the same. Whence equating them gives,

$$F_B - F_{Coul} = F_C. \quad (49)$$

Eqn. (49) using eqns. (44), (45) and (48), gives

$$B = \left(\frac{\left(\frac{m'_{oe} v^2}{r_e} + \left(\frac{2}{3}\right) e^2/4\,\pi\epsilon_o\, r_e^2\right)}{ev/2}\right)$$

$$= 1.877(1)\, x10^{14}\ .\text{Wb/m}^2. \quad (50)$$

Thus if spin angular momentum is to be reversed in the circular orbit (Fig. 2), external magnetic flux density $\geq 1.877(1)\, x10^{14}$ Wb/ m^2 to be applied and removed suddenly in opposite direction of B which is normal to plane of paper and entering in plane of the paper of above illustration, when electromagnetic radiation of frequency ν = 1.795(6) x 10^{22} Hz of eqn. (37) or wavelength λ = 1.669(5) x 10^{-14} m of eqn. (38) gets generated. A sequence of alternate applications and removals of sudden external magnetic flux density $\geq 1.877(1)\, x10^{14}$ Wb/m^2, that may exit in our/other galaxy, results in generation of continuous waves of cosmic rays of the frequency of ν = 1.795(6) x 10^{22} Hz.

In the present analysis, considering electromagnetic nature of cosmic rays, the radius of electron viz., 1.878(8) 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., 4.239(4) x 10^8 m/sc, angular velocity of the electron viz., 2.256(4) x 10^{23} rad/sc, moving mass of the electron viz., 6.618(0)x 10^{-29} Kgm, frequency of electromagnetic radiation from the electron viz., 1.795(6) x 10^{22} Hz, wavelength of electromagnetic radiation from the electron viz., 1.669(5) x 10^{-14} m and strength of magnetic flux density required for reversal of spin angular momentum viz., 1.877(1) x 10^{14} Wb/ m^2, which are of considerable significance. It is interesting to note that the moving mass of the electron given by eqn. (26) of Fig. 2, ~~i~~nside/on periphery of the electron has a velocity of 4.239(4) x 10^8 m/sc which is greater than velocity of light in free space. Thus a world of Tachyon exit inside/on periphery of electron. For Tachyon refer to Feinberg 1967) [11].

Present analysis assumes that, (i) validity of eqn. (24) 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. (44) for Lorentz Force $F_B = B\,\frac{e}{2}\,v$ for real 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. (50) and (iii) validity of eqn. (48) for Centrifugal Force $F_C = \left(\frac{m'_{oe} v^2}{r_e}\right)$ for real charge $\frac{e}{2}$ of complex moving charge $e_2 = \frac{e}{2}\left(1 - i\sqrt{5/3}\right)$ (Fig. 2) with velocity $v = \sqrt{2}$ c of eq. (28) of the electron of moving mass $m'_{oe} = \frac{1}{2\sqrt{2}}\left(\frac{\hbar}{c\, r_e}\right)$ of eqn. (26) hold good.

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 comic rays mentioned in this article.

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