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The Inner Structure of the Intrinsic Electron and the Origin of Self-Mass

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Abstract

A brief review and analysis of two historical models of the electron, the charged spinning sphere and Goudsmit and Uhlenbeck's concept, is presented. It is shown that the enormous potential of classical electrodynamics has been underutilized in particle physics. Such observation leads to discovery of a principal component in the electron inner structure—*the charged c-ring*. The intrinsic (fundamental) electron model based on the charged c-ring successfully explains the ontology of the charge fractionation in quantum chromodynamics and the formation of Cooper pairs in superconductivity. The c-ring properties are explained on the basis of the General Compton Conditions as defined. Properties of the charged c-ring include the explanation of the boundary conditions, electro-magnetostatic field configuration, self-mass, spin, magnetic moment, and the gyromagnetic ratio. The self-mass of the intrinsic electron is 100% electro-magnetostatic and it is shown how to compute its value. The classical-quantum divide no longer exists. Relation between the intrinsic electron and the electron is fundamentally defined. The electron is the composite fermion consisting of the intrinsic electron and the neutrino. The ontology of the anomaly in the electron magnetic moment is demonstrated—it is due to the addition of the neutrino magnetic moment to the overall electron magnetic moment. The intrinsic electron replaces the W^- boson in particle physics, resulting in a fundamental implication for the Standard Model.

Keywords

Intrinsic Electron, Inner Structure, Electro-Magnetostatic Self-Mass, General Compton Conditions, Charged C-Ring, Visualization, C-Ring Length Constant

1. Introduction: General Comments on the Electron

One would think that not much is left to discover about the electron. What a misconception! A physical Quantum Mechanics (AQM) [1] [2] [3] expands dramatically the fundamental understanding and ontology of the electron including its three-dimensional composite inner structure, electrodynamic properties, and the explanation of all electron related Quantum Mechanics (QM) enigmas. From now on, contrary to [4], the electron is no longer enigmatic. It can be visualized in all details in spacetime dynamics. Visualization and ontology are the unique strengths of AQM.

According to AQM, the actual electron is not a fundamental fermion as presented in the Standard Model. It is a composite fermion of the quantum electromagnetism consisting of the intrinsic electron $\hat{e}^-$ (the fundamental fermion of quantum electromagnetism) and the electron neutrino ν_e of duo configuration (see [3], Chapter 4). However, the composite electron is not the subject of this article. The subject of this article is the intrinsic electron and especially its principal component—the charged c-ring. We shall explore its many properties and demonstrate ontology.

The terms "intrinsic" and "fundamental" are interchangeable.

2. Historical Background of the Electron

Electron was discovered in 1897 by J.J. Thomson. Today electron is one of the most studied elementary particles with many of its properties discovered and experimentally measured, such as mass, electric charge, spin, magnetic moment, anomaly in magnetic moment, and quantum properties.

Most historical electron models are based on classical electrodynamics. From the time of its discovery, all efforts to explain the origin of electron self-mass in terms of electromagnetism have failed.

For further discussion, we need to consider only two classical electrodynamics models—the charged spinning sphere and the Goudsmit and Uhlenbeck concept.

3. The Charged Spinning Sphere Electron Model

The spherical spinning electron model with electric charge density distributed uniformly on the rigid sphere surface was proposed by Abraham in 1902 (see **Figure 1**). At the relativistic limit, the maximum linear velocity at the sphere equator is equal to the speed of light and maximum angular velocity is equal to Compton angular velocity, $\omega = c/R$, where R is radius of the sphere, and c is the speed of light.

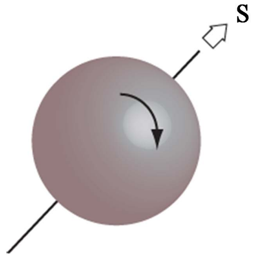

Figure 1. The charged spinning sphere as electron model.

At such maximum spin, the performance of the spherical model is somewhat disappointing. It is unstable. The sphere would explode in the direction of the poles from electrostatic repulsive force where no opposing magnetostatic force exists. Electromagnetic self-mass, spin and magnetic moment are much below experimental values.

Since 1902, the spherical spinning model of the electron has been studied and rejected by many physicists. In 1904, Laurence proposed a revised model where the sphere was flattened along the direction of motion. It was also rejected. In 1905, Poincare proposed a non-electromagnetic force of unknown origin to balance electrostatic repulsive force. Eventually, the spherical spinning electron model was abandoned, even though it is somewhat intuitive and easily visualizable.

However, the spherical spinning model is not a complete failure. It brings some useful information and is a step in the right direction. Here is what we have learned from the model:

- Electro-magnetostatic energy can produce some electron self-mass (self-energy), although not to the full extent.
- Spin and magnetic moments are below their experimental values.
- Stability is achieved only at the equator where the Compton angular velocity $\omega = c/R$ is applied. At the equator the repulsive electrostatic force is exactly balanced by the inward magnetostatic pinch force.
- Spin constitutes spinning in the classical way and can be visualized.
- The spherical spinning model is unstable and if Nature ever creates such an electron, it would explode instantaneously in the direction of the poles, where the electrostatic repulsive force is totally unopposed.

4. Goudsmit and Uhlenbeck's Idea

In 1925-1926, two Dutch graduate students, Samuel Goudsmit and George Uhlenbeck, attempted to explain electron magnetic moment [5] [6]. They put together the following basic thought: electron spin, electric charge, and magnetic moment are interrelated. They assumed that electron spin is not just a quantum parameter, but an actual spinning and rotating electric charge, thus producing electron magnetic moment. Thus, Goudsmit and Uhlenbeck postulated that the electron has the intrinsic classical spin and the related classical magnetic moment.

That was a step in the right direction. Rather than capitalize on the idea and develop it further, the concept was met with skepticism from many eminent physicists including Pauli.

"But despite these quite reasonable objections, their model stubbornly continued to agree with experimental results!"—stated Frank Wilczek, a Nobel Prize winner in his book ([7], page 163).

5. Toward a Viable Physical Model of the Electron Based on Classical Electrodynamics

Let us re-examine the spinning charged spherical model in depth. At the equator, the forces are balanced between electrostatic repulsion and magnetostatic pinch. However, in the direction of the poles, the electrostatic repulsive force is unopposed by magnetostatic force (see **Figure 2(a)**).

Let us remove troublesome areas in the model, namely both semi-spheres, and retain only the infinitely narrow equator strip (see **Figure 2(b)**). As a result, we obtain a singularity model which is balanced and stable. This is the first *extreme* electrodynamic model of the intrinsic electron. Then we proceed by stretching the singularity equator into a short section of the cylinder with uniformly distributed electric charge ($-e$) thus producing *the charged c-ring* (see **Figure 2(c)**). Voila! We have arrived at the electrodynamic model of the intrinsic (fundamental) electron where the correct electro-magnetostatic field configuration, self-mass, spin, and magnetic moment, are achieved and can be calculated.

The c-ring is only a part of the intrinsic electron inner structure. In order to be a viable quantum electrodynamic model, another component must be added, the quantum a-cylinder [3], which explains quantum properties such as entanglement, interference and diffraction. The a-cylinder and its properties are not part of this article.

The question can be asked: "is the c-ring 100% electrodynamics and nothing else?" The answer is "all classical electrodynamics properties are included in the c-ring". However, the c-ring is much more than just a classical electrodynamic design. There are other quantum properties such as the ability of the c-ring to radiate photons when it is under stress, in situations such as the synchrotron radiation or in elastic interactions with another charged particle. The photon is an elementary particle with its own inner structure [2].

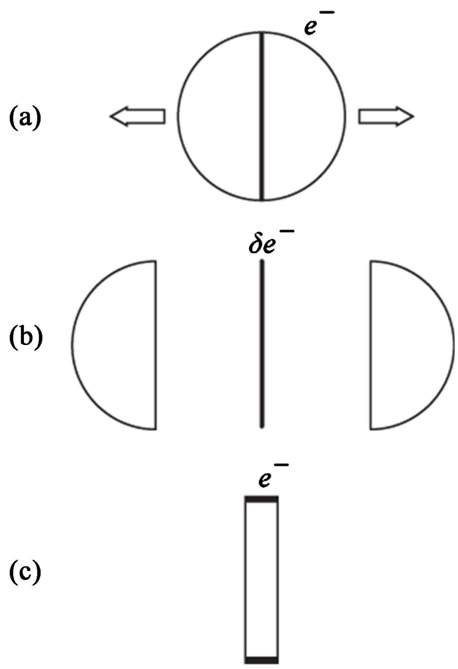

Figure 2. The transformation of the spherical model into the c-ring.

6. A Simple Relativistic Test for Electrodynamic Electron Models

The charged c-ring model is the only electrodynamic model which passes a simple relativistic test. Both electrodynamic electron models, the spinning charged sphere and the spinning charged c-ring with initial arbitrary spin orientation at a pre-relativistic velocity ($v \ll c$), are subjected to acceleration to a velocity approaching the speed of light ($c - v \ll c$). The sphere changes its shape, thus causing a non-uniform charge distribution over its surface, while the c-ring, after relativistic contraction, remains in its c-ring form, thus preserving uniform charge distribution, although with a much greater charge density (see Figure 3).

The radius of the electron c-ring does not experience relativistic contraction. The relativistic electron-electron collisions are collision of electron c-rings, although most colliding c-rings are only partially overlapped.

7. The Ontology of the Electron Charged C-Ring Model in Charge Fractionation

The charged c-ring electron model is the only one among the several historical electrodynamics models that survives charge fractionation test: $1/3e$, $2/3e$, e as demonstrated in Figure 4.

8. The Ontology of the Electron C-Ring Cooper Pairs in Superconductivity

The existing theory of superconductivity is based on the formation of the electron pairs (Cooper pairs). An unanswered question remains—how can electrons attract each other overcoming the Coulomb repulsion at sufficiently low temperature when interactions of electrons with the vibrating crystal lattice are reduced?

The c-ring model provides a straightforward explanation stating that there is no Coulomb repulsion between an aligned pair of electrons as long as the vibrating energy of crystal lattice is sufficiently low, thus preventing disruption of the electron pair formation.

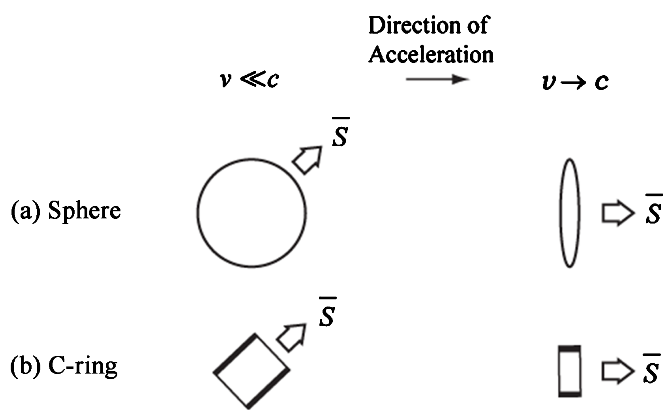

Figure 3. A simple relativistic test for the two electrodynamic electron models.

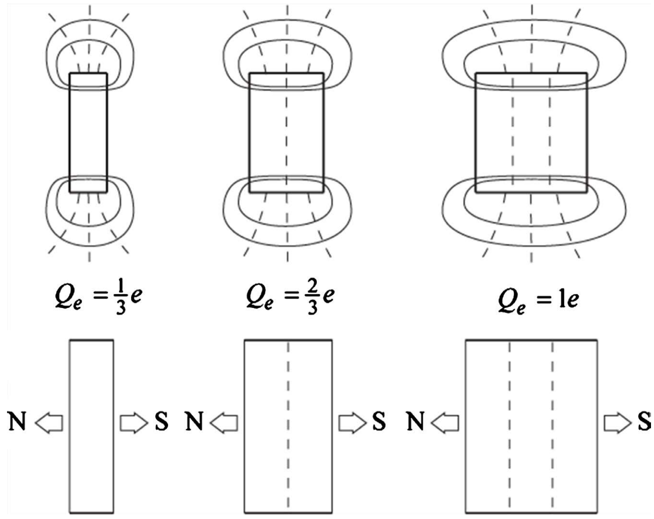

Figure 4. A charge fractionation test for the electron c-ring model.

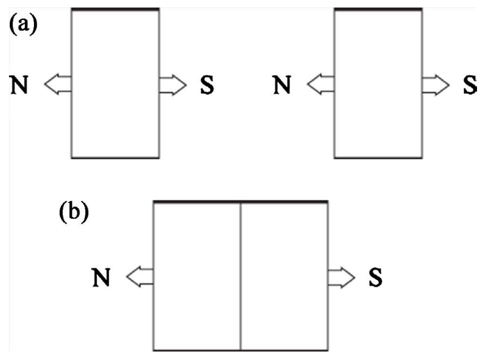

Figure 5. Ontological explanation of Cooper electron pair formation.

The process of formation occurs when two electron c-rings are aligned along their common axes with their magnetic moments in attraction mode—"north" meets "south" (see **Figure 5**).

In such configuration, the Coulomb repulsion between two electron c-rings rotating at equal Compton angular velocity and equal Compton radius does not exist.

The pair formation is a statistical process proceeding at fast rate at sufficiently low temperature when a binding energy between two magnetic moments is greater than a disrupting vibration energy of surrounding ions of the crystal lattice.

During electron pair formation, magnetic moments M1 and M2 and spins S = 1/2 are aligned, resulting in an electron pair with double spin S = 1 and double magnetic moment M equal two times of one Bohr magneton.

Such pair arrangement is energetically more advantageous as compared to a single electron. The formation process releases some energy, reduces Compton angular velocity, and increases Compton diameter. The released energy is transferred to the lattice and promptly removed from the system.

The produced Cooper electron pairs with spin S = 1 acquire some bosonic properties. In fact, it is the assembly of entangled electron pairs with properties similar to the Bose-Einstein condensate (BE condensate). The assembly of Cooper pairs can be kept indefinitely while the BE condensate exists in micro-Kelvin temperature environment for just a few seconds.

Aside from Cooper pairs, what other electron combinations are possible?

A combination with odd number of electrons is fermionic and cannot be formed according to the Pauli's exclusion principle. But the exclusion principle is a formal statement with no ontological explanation.

Combinations of odd number of electrons, such as 2 + 1, would not work because the Compton diameters and angular Compton frequencies of the c-rings are slightly different between a pair and a single electron. For a formation to succeed, these properties must be absolutely identical. The only other viable combinations are multiple pairs of 2^n, where n = 1, 2, 3, etc.

As we keep reducing temperature beyond micro-Kelvin range toward the absolute zero, one should expect the electron formation of higher orders: 2, 2 + 2, 4 + 4, 8 + 8, and so on. The higher the order the more it is energetically advantageous.

9. The Charged C-Ring versus the Charged Ring

I emphasize that there must be no confusion between "the c-ring" and "the ring". Comparison of the c-ring versus the ring is shown in Figure 6.

The electrodynamic inner structure of the intrinsic electron is the charged c-ring. The c-ring consists of the cylindrical surface of zero thickness made from uniformly distributed electric charge ($-e$). The c-ring spins with the Compton angular velocity $\omega_c = c/r_c$ and with peripheral linear velocity equal to the speed of light. In addition to classical electrodynamic properties, the c-ring also has some specific quantum properties, such as emission of real photons (called "virtual photons"), emission of synchrotron radiation photons, and radiation of electromagnetic energy.

The charged spinning ring model is described in [8] and it is not considered here. It is not scientifically viable—half of the surface of the charged ring has linear velocity exceeding the speed of light as compared with the charged c-ring where each element of its surface has linear velocity equal to the speed of light.

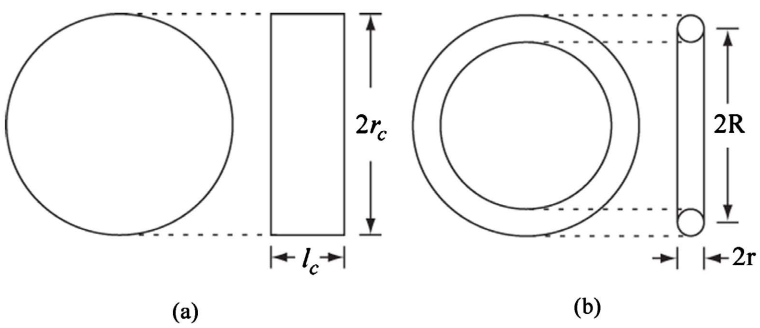

Figure 6. Comparison of the c-ring and the ring. C-ring with $\omega_c = c/r_c$ and ring with $\omega = c/R$.

10. General Compton Conditions as Basis for Design of the Intrinsic Electron

The Compton relation is well-known and defined at the relativistic limit of velocity $v = c$ as a relation between Compton angular velocity ω_c and Compton radius r_c: $\omega_c r_c = c$.

The Compton relation is as fundamental in elementary particle physics as Einstein's formula $m = E/c^2$. *The Compton relation is incorporated into the inner structure of every elementary particle.*

According to the Standard Model, electron spin should not be considered in a classical sense as something actually spinning. Spin is a quantum parameter found experimentally and assigned *by proclamation.*

Here, I assert that the classical-quantum divide does not exist. It does not imply that quantum physics can be reduced to classical physics. In the c-ring, spin is considered as something actually spinning and can be visualized in human mind. The intrinsic electron spin is derived mathematically from the charged c-ring model in a straightforward way with no approximation.

The Compton relation is only a first step in the right direction.

Here, we expand the Compton relation to a more comprehensive *the General Compton Conditions* as defined below. The Compton relation is a subset of the General Compton Conditions. According to author's opinion all elementary particles, fundamental and composite, can be explained on the basis of the General Compton Conditions adapted to each particular class of elementary particles and to each particular fundamental force.

The fundamental meaning of the General Compton Conditions as applied specifically to the intrinsic electron c-ring is defined as:

- The intrinsic electron c-ring spins with a classical Compton angular velocity: $\omega_c = c/r_c$, where r_c is a classical Compton radius.
- Under the General Compton Conditions, electrostatic energy E_E is equal to magnetostatic energy E_H: $E_E = E_H$.
- Radial forces at the c-ring surface are balanced. Outward repulsive electrostatic pressure P_E is opposed equally by inward magnetostatic pinch pressure P_H over the entire c-ring surface: $P_E = -P_H$.
- There are no repulsive or attractive tangential forces along the c-ring surface. All elements of electric charge rotate in parallel to each other at the speed of light.
- The c-ring surface is made of negative electric charge ($-e$) with uniform charge density distribution and zero thickness.
- Electric charge is a special state of matter not yet recognized by science. By itself, it has no self-mass, or inertia. It exists under the General Compton Conditions.
- Under stress, the intrinsic electron radiates photons with exponential intensity and exponential energy as applied stress increases.
- If accelerated or changes direction, the intrinsic electron radiates electro-

magnetic energy.

The c-ring model of the intrinsic electron is mathematically accurate requiring no approximation.

11. Electro-Magnetostatic Field Configuration of the Intrinsic Electron C-Ring

The c-ring electromagnetic field configuration is described by classical electrodynamics. Boundary conditions are precisely defined. Negative electric charge is uniformly distributed on the surface of the c-ring producing electrostatic field. The c-ring spins with Compton angular velocity generating magnetostatic field. Electrostatic and magnetostatic field lines cross each other in space always perpendicular to each other, as shown in **Figure 7**.

By calculation, one can demonstrate that electrostatic and magnetostatic energies are equal: $E_E = E_H$. Immediately, a question arises "what length of the c-ring is to be assumed?"

With respect to the c-ring length l_c for the intrinsic electron, Nature assigns only one specific value. The c-ring length l_c is a fundamental constant. One cannot theoretically derive fundamental constants, such as the speed of light c in vacuum, Planck constant h, or elementary electric charge e. All of them are found experimentally. The c-ring length is also a fundamental constant. It can be derived on the basic of the General Compton Conditions, Planck constant, and available experimental data, such as intrinsic electron self-mass.

12. Self-Mass (Self-Energy) of the Intrinsic Electron

In particle physics, the origin of self-mass (self-energy) for the electron has never been satisfactorily explained. As Pauli stated in 1945, "We will be considered the generation that left behind unsolved such essential problems as the electron

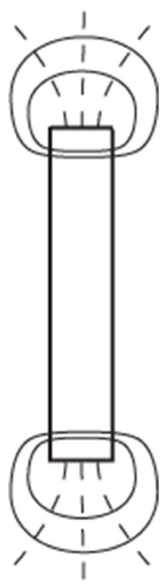

Figure 7. Electrostatic and magnetostatic field configurations for the charged c-ring.

self-energy." In author's opinion the explanation of the origin of electron self-mass on the basis of Higgs mechanism is a sign of desperation.

In AQM, under the General Compton Conditions, the c-ring electrostatic energy E_E and magnetostatic energy E_H are equal:

$$E_E = E_H$$

The total self-energy and self-mass of the intrinsic electron are:

$$E_{\hat{e}} = E_E + E_H$$

$$m_{\hat{e}} = m_E + m_H$$

Here is the basic formula for total physical self-energy and self-mass of the intrinsic electron:

$$E_{\hat{e}} = 2\hbar\omega_c$$

and

$$m_{\hat{e}} = 2\hbar\omega_c / c^2$$

where ω_c is a classical Compton angular velocity of the c-ring.

The above relations provide the complete explanation for the c-ring physical self-energy and the origin of self-mass. *The intrinsic electron self-mass is 100% electro-magnetostatic and can be computed.*

13. Spin of the Intrinsic Electron

In particle physics, a value of electron spin is found experimentally and assigned to the electron as quantum parameter *by proclamation*. Here a straightforward calculation of the value of intrinsic electron spin is provided. It is a classical formula for spin calculation: $S = mvr$.

The physical properties of the c-ring can be expressed on the basis of classical electrodynamics. The c-ring electrostatic energy E_E does not contribute to spin. Only magnetostatic self-energy E_H or one half of its total self-energy $E_{\hat{e}}$ contributes to the intrinsic electron spin

$$S_{\hat{e}} = \hbar/2$$

This is the long-awaited explanation and ontology of why fermions have spin $\hbar/2$.

In the case of bosons, the entire boson self-energy contributes to spin, resulting in spin $\hbar$.

14. Magnetic Moment of the Intrinsic Electron

In classical electrodynamics, magnetic moment M is defined as $M = IA$, where I is the total current and A is the area. In the case of the c-ring:

$$I = e\omega_c / 2\pi \quad \text{and} \quad A = \pi R^2 = \pi c^2 / \omega_c^2 .$$

In terms of magnetostatic self-mass, the intrinsic electron magnetic moment is:

$$M = (1/4)\hbar(e/m_H),$$

or in terms of total self-mass m_e, the intrinsic electron moment is:

$$M = (1/2)\hbar(e/m_{\hat{e}}) = \text{one Bohr magneton}$$

The intrinsic electron is a fundamental fermion of electromagnetic force. It does not have "anomaly" in its magnetic moment. In any case, the so-called "anomaly" is a fundamental misconception in the Standard Model as explained in Section 19.

15. Intrinsic Electron Gyromagnetic Ratio. AQM Asserts that the Classical-Quantum Divide Does Not Exist

The gyromagnetic ratio is defined as *M/S*. In a classical example of the spinning cylinder with uniformly distributed electric charge Q on its surface and a total mass m

$$M/S = -Q/2m. \quad (1)$$

In the case of the intrinsic electron, the gyromagnetic ratio is

$$M/S = -e/m_{\hat{e}}. \quad (2)$$

The Standard Model cannot explain such discrepancy of factor two between Equations (1) and (2) and claims that it is an example of the classical-quantum divide. Such explanation is another misconception. The so-called divide does not exist.

Here is the explanation.

Intrinsic electron self-mass consists of two equal contributors: electrostatic self-mass m_E and magnetostatic self-mass m_H. Electrostatic self-mass does not contribute to spin or to magnetic moment. In this respect, it is a passive by-stander. Therefore, in Equation (2) we should include only the magnetostatic self-mass m_H:

$$M/S = -e/2m_H \quad (3)$$

Comparing Equations (1) and (3), one can see in this particular case, the classical-quantum divide does not exist. Consideration of the g-factor is not required.

In conclusion, gyromagnetic ratio of intrinsic electron, classical and quantum, is presented as

$$\begin{aligned} M/S &= -Q/2m(\text{classical}), \\ M/S &= -e/2m_H(\text{quantum}), \end{aligned} \quad (4)$$

where $m_H = \hbar\omega_c/c^2$ is magnetostatic self-mass of the intrinsic electron. Only magnetostatic self-mass contributes to spin and magnetic moment of the intrinsic electron.

In this respect, the classical-quantum divide does not exist.

Concept of g-factor becomes irrelevant.

16. The Boundary Conditions and the Issue of Stability of the Intrinsic Electron

There is an equilibrium of electrostatic and magnetostatic forces over the entire surface of the charged c-ring. Magnetic field on outer surface is $B_0 = 0$. Magnetic field on inner surface is

$$B_i = \mu_0 I \tag{5}$$

where $I = e\omega_c / 2\pi$. Surface electric charge density is defined as:

$$\sigma = e / (2\pi r_c l_c) \tag{6}$$

where l_c is the length of the c-ring and $r_c = c / \omega_c$. Taking into consideration Equations (5) and (6), we obtain magnetic field B_i on inner surface of c-ring:

$$B = B_i = \mu_0 \sigma c \tag{7}$$

Electric field E on outer surface is:

$$E = \sigma / \varepsilon_0 \tag{8}$$

Combining Equations (6) and (8) we obtain

$$B = Ec \tag{9}$$

Outward pressure on the surface is caused by electrostatic field and equal to:

$$P_E = \sigma E \tag{10}$$

Inward pressure is caused by magnetostatic "pinch" and equal to:

$$P_B = -\sigma c B \tag{11}$$

Taking into consideration Equations (10) and (11), we obtain equilibrium of electro-magnetostatic radial forces on the surface:

$$P_B = -P_E \tag{12}$$

Tangential forces on the surface do not exist. All elements of electric charge are spinning in parallel to each other at the speed of light, thus neutralizing any repulsive or attractive tangential electric or magnetic forces.

At first glance, it appears that the intrinsic electron is stable. Electrostatic repulsive outward force applied to c-ring surface is balanced by magnetostatic inward pinch force over the entire surface of the c-ring.

This is only *apparent stability*. It appears that the c-ring is stable with any value of Compton radius and corresponding value of self-energy. That only means that c-ring is not stable at all. The intrinsic electron is looking for any opportunity to quickly release energy and create other inner structures. As a fundamental fermion, the intrinsic electron does not decay but cannot exist by itself in a stable state. In a specific pathway scenario, by releasing part of its self-energy within 10^{-22} - 10^{-25} seconds, the intrinsic electron creates a neutrino-antineutrino pair, acquires a neutrino as a partner, releases antineutrino and in combination with the neutrino create the composite electron (known as the electron). In case of muon or tau, it provides conditions for temporary stability and temporary lifetime. In case of electron, it acquires permanent stability and infinite lifetime. The intrinsic electron is trapped for ever within the electron.

In contrast to historical classical electrodynamic models, the c-ring model is mathematically accurate, requiring no approximation.

17. How to Calculate the Length of the C-Ring for the Intrinsic Electron

The length of the c-ring of the intrinsic electron l_c is a fundamental constant. It belongs to the same class of fundamental constants as the speed of light c, the electric elementary charge e, and the Planck constant h. By definition, the fundamental constants cannot be theoretically derived. They are preset by Nature and must be found experimentally.

As the principal contributor to electron self-mass, intrinsic electron self-mass is experimentally established and known as $m_e = 0.511\ \text{MeV/c}^2$. The constant l_c can be computed under the General Compton Conditions. This is a 100% classical electrodynamics problem.

Here is the explanation. The c-ring geometry, the electron charge distribution, and the boundary conditions are well defined. To solve the problem, one has to select a specific value of Compton c-ring radius r_c, the corresponding value of Compton angular velocity ω_c, and the corresponding self-mass m_e. Here is a well-known point: $r_c = 2 \times 3.86 \times 10^{-13}$ m, $\omega_c = 3.87 \times 10^{20}$ rad/sec, $m_e = 0.511$ MeV/c^2 corresponding to total self-energy of the c-ring $E_p = \hbar\omega_c \times 2$.

The solution of this problem requires computation of the magnetostatic and electrostatic field distributions, their energy density, and total intrinsic electron magneto-electrostatic energy for various values of l_c. By extrapolation, one can find the correct value of constant l_c corresponding to correct value of self-mass. The correct value of l_c defines the correct value of intrinsic electron self-mass. All other values of l_c correspond to different values of self-mass and different values of Planck constant.

The length of the intrinsic electron c-ring is independent of the c-ring energy level. One can select any value of Compton angular velocity with corresponding self-mass $m_{\hat{e}} = 2\hbar\omega_c / c^2$. Then computation would result in the same value of l_c, as was found for "the known point". The length l_c is the same for the intrinsic electron, the intrinsic muon, and the intrinsic tau. Both, the intrinsic muon and the intrinsic tau represent higher energy levels of the intrinsic electron as shown in **Figure 8**.

The constant l_c is a fundamental constant of the intrinsic electron.

The value of the constant l_c is exact. Even a tiny deviation from the correct value would result in a deviation from the established value of the Planck constant and would create a conflicting situation between the intrinsic electron and the photon.

18. Summary: The Complete Definition of the Intrinsic Electron

- The intrinsic electron $\hat{e}^-$ is the fundamental fermion of electromagnetism. It is the exclusive carrier of negative electric charge, same as the intrinsic positron $\hat{e}^+$ is the exclusive carrier of positive electric charge. Both, $\hat{e}^-$ and $\hat{e}^+$ are antiparticles of each other.

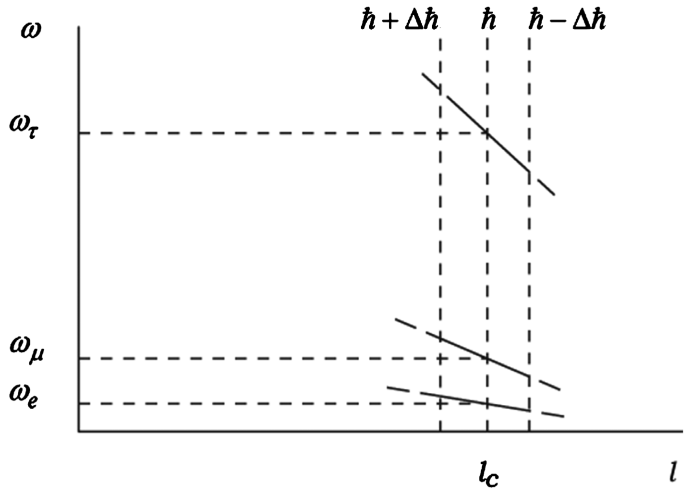

Figure 8. Computation of constant l_c with the electric charge of one unit ($-e$), where ω_τ, ω_μ, ω_e are Compton angular velocities for tau, muon and electron.

- The intrinsic electron inner structure consists of the physical charged c-ring, and the a-cylinder as explained in section 19.
- The surface of the intrinsic electron is made of a single elementary unit of negative electric charge ($-e$) with uniform charge density distribution.
- Repulsive electrostatic force is balanced by magnetostatic pinch force over the entire c-ring surface.
- The intrinsic electron has two fields: electrostatic and magnetostatic. The fields are described by classical electrodynamics.
- The General Compton Conditions are especially applicable to the intrinsic electron:

  self-energy $E_p = \hbar\omega_c \times 2$;
  self-mass $m_{\hat{e}} = 2\hbar\omega_c / c^2$;
  electrostatic energy $E_E = (1/2) E_p$;
  magnetostatic energy $E_H = (1/2) E_p$;
  magnetic moment $M_{\hat{e}} = e\hbar / 4m_H$, where $m_H = \frac{1}{2} m_{\hat{e}}$.
- The intrinsic electron spin is equal to $\hbar/2$. Only its magnetostatic self-energy E_H or one half of its total self-energy $E_{\hat{e}}$ contributes to intrinsic electron spin. This explains why fermions have spin 1/2.
- The length of the c-ring l_c is a fundamental constant.
- A free intrinsic electron expands radially at nearly the speed of light, releasing its energy in 10^{-22} - 10^{-25} seconds, producing other inner structures, such as neutrino-antineutrino pairs, or quark-antiquark pairs.
- Along its pathway from high energy level to low energy level with intermediate energy releases and creation of other intermediate inner structures, the intrinsic electron finally arrives at the ground energy level: *the electron,* where the intrinsic electron together with its partner, the electron neutrino, are trapped "forever" with the total self-energy of 0.511 MeV, including small

neutrino self-energy contribution. During this chain process helicity of the intrinsic electron remains unchanged.

- There are no free intrinsic electrons in existence below the ground energy level.
- The physical charged c-ring model of the intrinsic electron is mathematically accurate, requiring no approximation.
- Each individual intrinsic electron is unique for it has a unique position parameter (see [3]).
- Electric charge is a special state of matter, not yet recognized by science. By itself, electric charge has no self-energy, no gravitational properties, and no inertia.

19. Concluding Remarks: The Role and Place of the Intrinsic Electron in Particle Physics

Here I refer the reader beyond this article to references [1] [2] [3].

What is the place and role of the intrinsic electron in the Standard Model of particle physics?

The charged c-ring is the principal component in the inner structure of the intrinsic electron. However, there is another component called the a-cylinder which explains electron quantum properties such as wave-particle duality, collapse of the wave function, interference, diffraction, and entanglement.

The intrinsic electron has no upper energy limit. However, its low energy limit is 0.511 MeV at which it converts into the electron with Compton radius of $r_c = 2 \times 3.86 \times 10^{-13}$ m.

In the Standard Model, the intrinsic electron is misidentified. What is known as W^- boson [9] is in fact the intrinsic electron (or W^+ boson in case of the intrinsic positron). The boson, due to its bosonic inner structure, cannot carry charge, which is the principal part of the fermionic inner structure, especially at the speed of light.

W boson is a fundamental misconception in the Standard Model.

The recognition of such fact has fundamental implications in particle physics.

Things fall in the right place if one replaces W^- boson by the intrinsic electron in all related interactions such as beta decay, neutron decay, tau decay, muon decay, etc.

What about the electron?

The electron is a composite fermion consisting of the intrinsic electron and the neutrino in duo configuration. The neutrino small magnetic moment is added to the intrinsic electron magnetic moment. Such small addition is mistakenly considered as "the anomaly". In process of the electron formation the neutrino performs its fundamental role as "the corset", squeezing the electron size from initial classical Compton radius to final quantum radius by several orders of magnitudes [3].

The early discovery of the charged c-ring structure of the electron would have changed the historical trajectory of quantum mechanics. Such discovery could have been made prior the Fifth Solvey Conference (1927). By then, Einstein special relativity and classical electrodynamics were established and well understood.

Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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