Toward Viable Electron Model based on Classical Electrodynamics

Victor Vaguine, Ph.D
The Center for Ontological Quantum Studies

Abstract

A brief review and analysis of historical models of the electron, such as the charged spinning sphere, Goudsmit and Uhlenbeck's idea, and the charged spinning ring leads to discovery of principal component in the electron inner structure – *the c-ring.* The AQM intrinsic electron model based on the c-ring successfully explains the charge fractionation in quantum chromodynamics and the 3D configuration and the formation of Cooper pairs in superconductivity.

"You know, it would be sufficient to really understand the electron" – Albert Einstein.

"Thus, the electron may have size and structure!" – Hans Dehmelt, 1989 Nobel Laureate.

"We will be considered the generation that left behind unsolved such essential problems as the electron self-energy" – Wolfgang Pauli, 1945 Nobel Laureate.

Introduction

Aphysical Quantum Mechanics is a deeper and more profound quantum theory and the origin of the Second Quantum Revolution. Aphysical Quantum Mechanics (AQM) is published in three separate volumes under the title The Second Quantum Revolution [1], [2], [3].

In principle, one would not expect AQM to produce immediate scientific revolutions in other branches of fundamental physics, such as quantum optics and elementary particle physics, but that is exactly what has happened. Both of these branches—quantum optics and especially elementary particle physics—have undergone the dramatic foundational transformation.

AQM opens the floodgates of new physics. It brings democracy into foundational physics. Graduates and undergraduates will be able to select new physics problems to work on among the thousands immediately available. Hundreds of doctoral dissertations will be written based on AQM. And most importantly, for a change, the general public will be brought along

- Each elementary particle has non-zero size.

A pre-corset c-ring Compton radius of elementary particles can be calculated in a classical way. In case of the electron, prior its formation, a pre-corset c-ring classical Compton radius r_c is equal to $2\times3.86\times10^{-13}$ meters. After the corset action, the c-ring is “instantaneously” and “dramatically” reduced to extremely small *quantum Compton radius* r_q, estimated in the range of 10^{-22} – 10^{-23} meters.

- Each elementary particle has spin rotating with the speed of light at the Compton angular velocity. The speed of light has a special significance in the world of elementary particles. It is incorporated into the inner structure of each elementary particle.
- SM declares that the electron is the basic fermion of electromagnetism. This is an SM fundamental misconception, among many others.
- According to AQM, the electron is a composite particle consisting of two constituents: the intrinsic electron and the electron neutrino (“duo-electrino”). Electron magnetic moment is the result of electric charge rotation and *weak electric charge rotation*. There is no “anomaly” in the electron magnetic moment. The so-called “anomaly” is actually the electron neutrino magnetic moment. Calculation of “anomaly” on a basis of QED contributions is scientifically “illegitimate”.
- For over a hundred years, scientists have been searching for the electron physical model, with no success. I have discovered the correct electron physical model, which in itself is a historical milestone. The discovery explains a plethora of new physical-aphysical properties of the electron including the origin of self-mass, spin, the electron formation, electrostatic and magnetostatic field configurations, combined magnetic moment, the electric and weak charge fractionation, and three-dimensional configuration of the Cooper electron pairs in superconductivity.

A new challenge for the mathematically inclined physicists with intuition is to develop a mathematical formalism for the description of individual elementary quantum processes in spacetime dynamics. This is what is on the horizon and coming to quantum physics in the near future. However, even without new mathematics, I was able to reconstruct in detail the spacetime dynamics of selected individual elementary quantum interactions and processes, such as the muon decay and the subsequent formation of the electron.

1. General Comments on the Electron

One would think that not much is left to discover about the electron. What a misconception! Aphysical Quantum Mechanics (AQM) expands dramatically the fundamental understanding of the electron including its three-dimensional composite inner structure, physical and aphysical properties, elementary consciousness, and the explanation of all electron related Quantum Mechanics (QM) enigmas. The electron is no longer enigmatic. It can be visualized in all details. Visualization is the strength of AQM. The challenge for mathematically inclined physicists with intuition is to develop a new mathematical formalism on the basis of AQM for the description of an individual elementary interaction of an individual electron with another individual elementary particle in spacetime dynamics. It would keep mathematically intuitive physicists productive for many decades. It is challenging, rewarding and exciting task, comprising for example, of detailed spacetime dynamics, the electron inner structure transformation, process of annihilation and reconstruction.

The Standard Model (SM) claims that the electron is the fundamental fermion of the electromagnetism. This is another SM misconception.

According to AQM, the electron is a composition fermion of the electromagnetism consisting of the intrinsic electron $\hat{e}^-$, the fundamental fermion of electromagnetism, and the electron neutrino ν_e of duo configuration.

2. Historical Models of the Electron

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

Most of historical models of the electron are based on classical electrodynamics. From the time of its discovery, there has been ongoing effort to explain the origin of electron self-mass in terms of electromagnetism. All proposed classical models have failed.

For further discussion, I select only those classical electrodynamics models which are educational and a step in the right direction.

Here are three examples of classical electrodynamics models: the charged spinning sphere, the Goudsmit and Uhlenbeck concept, and the spinning uniformly charged ring.

3. The Charged Spinning Sphere as 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, maximum angular velocity for the spinning sphere is equal to Compton angular velocity,

$$\omega = c/R$$

where R is radius of the sphere and c is the speed of light.

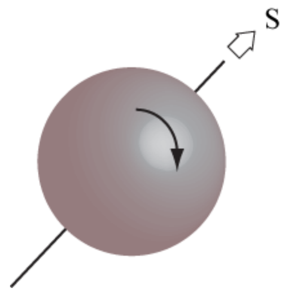

Figure 1
The charged spinning sphere as electron model

That means that the maximum linear velocity on the sphere equator is equal to the speed of light. With such maximum spinning, the performance of the spherical model is somewhat disappointment. It is unstable. The sphere would explode in the direction of the poles from electrostatic repulsive force with no opposing force. Spin and magnetic moment are below experimental values. The electromagnetic self-mass is only 75% of the experimental electron self-mass.

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:

- Electromagnetic energy can produce 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. Here the repulsive electrostatic force is exactly balanced by the inward magnetostatic pinch force.
- Spin constitutes spinning in the classical way and can be visualized.
- If Nature ever decides to create such a creature as the spherical spinning 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 two Dutch graduate students, Samuel Goudsmit and George Uhlenbeck, attempted to explain electron magnetic moment. 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 to 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 [4].

5. The Charged Spinning Ring as Electron Model

Now, let us consider the spinning ring electron model proposed by David L. Bergman and J. Paul Wesley [5]. The proposed charged spinning ring is another electron model based on classical electrodynamics (see Figure 2). This model was totally ignored by the physics community. The spinning ring electron model has electric charge density uniformly distributed over the entire surface. The ring is spinning with Compton angular velocity

$$\omega = c/R \ ,$$

where R is Compton radius.

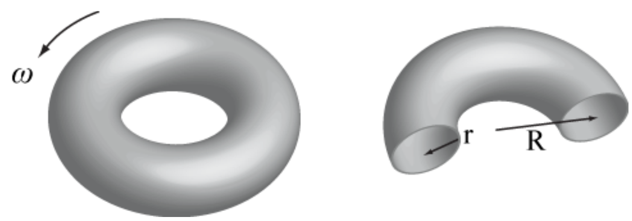

Figure 2
The charged spinning ring as electron model

The spinning ring has four parameters: ring radius R, inner radius r, electric charge e, and spinning Compton angular velocity

$$\omega = c/R$$

The surface of the ring is formed by uniformly distributed elementary electric charge ($-e$). The surface charge elements travel with tangential linear velocity in the range

$$1 - r/R \le v/c \le 1 + r/R.$$

This is problematic. Classical electrodynamics does not allow physical substance to exceed the speed of light. *Strictly speaking, the model is not scientifically viable.*

The reduction in value of inner radius r would not cure the deficiency unless $r = 0$. In such a case, the model collapses into a singularity.

However, contrary to the model reality, the authors made *a forceful assumption* – all surface elements travel with the speed of light, regardless. Then things begin to fall into right places.

The outward repulsive electrostatic force is balanced exactly with inward magnetostatic pinch force over the entire ring surface, thus making the model stable. Electrostatic energy E_E is equal exactly to magnetostatic energy E_H.

Spin of the electron is equal to ½ $\hbar$, magnetic moment is equal to one Bohr magneton, and self-mass is equal to electromagnetic mass $(E_E + E_H)/c^2$.

However, this model has to be rejected. As mentioned above, some surface elements exceed the speed of light regardless of the authors' forceful assumption. In other surface areas where velocity is less than the speed of light, there is no balance of opposing forces. In addition, the model has an extra geometrical parameter, inner radius r. The parameter r is not fixed, it is variable. It allows one to produce a whole spectrum of electron models, which is an absurdity. In the extreme case of $r/R = 0$, it brings the model to a singularity. The model is "fancy". Nature demonstrates to us, over and over again, *its majestic simplicity and sophistication.*

However, we have to be open-minded. Although the model is not viable, it shows certain conditions and is in the right direction towards the correct electron model based on classical electrodynamics. A viable model must have linear velocity on the surface equal to the speed of light over the entire charge surface:

(1) to achieve stability by balancing electrostatic repulsive inward pressure P_E at the surface with inward magnetostatic pinch pressure P_H

$$P_E = -P_H;$$

(2) to achieve equality of electrostatic energy E_E with magnetostatic energy E_H

$$E_E = E_H; \text{ and}$$

(3) to obtain correct values of spin, magnetic moment, and self-mass of electromagnetic nature.

The search for a viable electron model must continue.

6. The Electron Quantum Model according to the Standard Model

There is one more electron model to consider. My work is devoted to quantum mechanics issues. Even if I would prefer to, I cannot afford to skip the SM electron quantum model, which is described in all particle physics literature and is reluctantly accepted by quantum physicists.

The SM electron quantum model is point-like with no structure. Electron mass m and electric charge e are placed into an infinitely small point in space, thus bringing mass density and electric charge density to infinite values.

In the vacuum, electron is surrounded by cloud of virtual particles, such as electron-positron pairs producing what is called *the vacuum polarization*, thus causing the shielding effect for electron charge and making the effective charge, looking from a distance, smaller than its "true" value that exceeds electric charge e (see Figure 3 (a)).

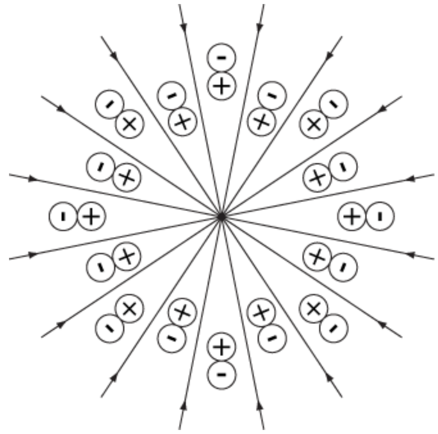

Figure 3 (a)
The SM quantum model of the electron

Other electron quantum parameters, such as spin and magnetic moment with empirically correct values, are attached to the point model by *proclamation*. There is no explanation for the origin of electron self-mass. The countless virtual electron-positron pairs, in principle, require their own vacuum polarization, thus bringing the model into infinite regress.

Obviously, this is not a scientific model. It is a nonsensical model. It is, as John Bell would have said, a model "for all practical purposes."[6]. It is a mathematical model, where one has to use renormalization technique by deducting one infinity from another infinity to obtain the result. The electron model is another SM misconception.

The issue of the vacuum polarization is suspect. It has to be totally re-examined. According to AQM, pairs of virtual particles arising spontaneously from the vacuum do not exist. Such mechanism violates the energy conservation law. Appealing to the Heisenberg uncertainty principle does not help. The uncertainty principle is a probabilistic principle. It applies to assemblies and not to individual quantum interactions.

At the first sign of difficulty, rather than compromise with half-baked ideas, it is much safer to stick to the integrity of the energy conservation law. *Science is uncompromising search for truth of objective reality.*

After all, haven't we learned something from history of physics? In 1930s, after the discovery of beta-decay, there was no explanation to beta-decay energy imbalance. Bohr proposed a compromise: the conservation energy law is not applicable to individual quantum interactions – it is valid only for assemblies. A similar situation exists with countless virtual particles arising from the vacuum. They violate the energy conservation law by borrowing energy from the vacuum for a tiny instant of time and then return the borrowed energy back. Such concept is entrenched in particle physics. It is part of quantum mindset. It is one of numerous fundamental misconceptions of the SM quantum model of the electron.

In elastic electron-electron interaction, involving, just as an example, only two colliding electrons, both electrons experience stress in each other's electrostatic fields. As a result, the electrons radiate photons (real photons) in the direction of their momenta causing repelling force additionally to Coulomb force, thus creating impression that electric charge is larger than it actually is (see Figure 3 (b)).

No vacuum polarization is needed for the explanation of "charge screening".

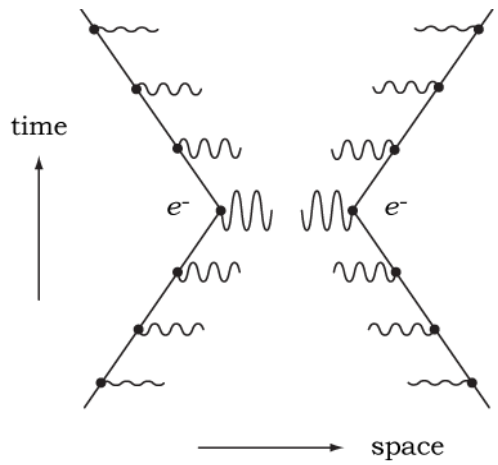

Figure 3 (b)
Electron-electron elastic interaction
(With permission from ConsReality, Inc.)

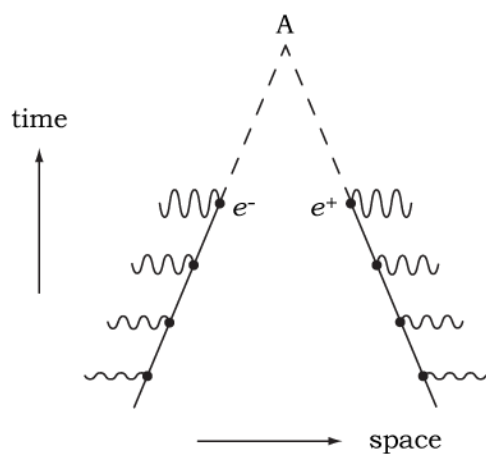

Figure 3 (c)
Electron-positron collision and their annihilation (point A)
(With permission from ConsReality, Inc.)

In electron-positron collision prior their annihilation, both electron and positron radiate photons (real photons) in the direction opposite to their momenta, causing attractive force additional to Coulomb attractive force, thus creating impression that electric charge is larger than it actually is (see Figure 3 (c)).

Again, no vacuum polarization is needed for explanation of "charge screening".

Resulting kinetic energy in elastic collision is reduced by photon radiation, thus proving that the radiation is real and not virtual. There are no virtual photons.

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

According to AQM, the electron has size and the inner structure.

In fact, according to AQM, *there are three types of electrons – the intrinsic electron, the duo-electron, and the electron.* The electron is a composite fermion of the electromagnetism. The intrinsic electron is the fundamental fermion of the electromagnetism and in its bound state is a constituent of the duo-electron and the electron.

Since 1902, when it was first proposed by Abraham, 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.

Let us re-examine the spinning spherical model in depth. At the equator, the forces are balanced between electrostatic repulsion and magnetostatic pinch. However, in the direction of poles, the electrostatic repulsive force is unopposed. If Nature were to create such an electron, it would instantaneously explode in the direction of poles (see Figure 4 (a)).

Rather than show impatience, which is amply demonstrated by great scientific minds, let us remove troublesome areas in the model, namely both semi-spheres, retain only the infinitely narrow equator strip, and then distribute uniformly the whole electric charge e along the equator (see Figure 4 (b)). As a result, we obtain a singularity model which is balanced and stable. This is a first extreme electrodynamic model of the intrinsic electron. After that, we proceed to the next step by stretching the singularity equator into a uniformly charged short section of the cylinder, the c-ring (see Figure 4 (c)). Voila! We have arrived at the electrodynamic model of the intrinsic electron where correct electromagnetic field configuration at electrodynamic parameters, including self-mass, spin, and magnetic moment, are achieved and can be calculated.

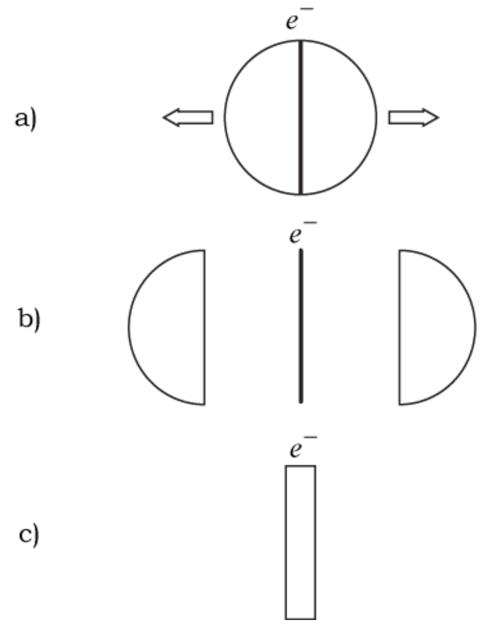

Figure 4 (a, b, c)
The transformation of the spherical model into the c-ring
(With permission from ConsReality, Inc.)

The c-ring model is an amazing scientific discovery. Nature proves again its majestic simplicity and sophistication. This discovery could have been made before the Fifth Solvey Conference (1927). By then, Einstein' special relativity was established and well understood. *The discovery of the c-ring structure of the intrinsic electron would have changed the historical trajectory of quantum mechanics.*

Rather than using abstract mathematical tools, such as operators, propagators, commutation, wave function, observables, eigenvalues and eigenstates, which describe only statistical reality, quantum mechanics would be dealing with physical reality of the intrinsic electron in spacetime dynamics.

By now, the reader understands that the c-ring is only a part of the intrinsic electron inner structure. The remaining parts are the aphysical cylinder and the elementary consciousness. Furthermore, the complete electron is a composite elementary particle consisting of the intrinsic electron and the electron neutrino. In its term, the neutrino is the composite of the intrinsic neutrino and the intrinsic antineutrino in duo configuration.

For many decades, the electron has been left largely unexplored. A plethora of new electron properties is discovered by the author and included in [3].

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". The c-ring is more than just a classical electrodynamic design. There are other quantum properties such as self-entanglement and entanglement, and the ability of the c-ring to radiate photons when it is under stress, in situations such as the synchrotron radiation or elastic interaction with another charged particle.

8. A Simple Relativistic Test for Electrodynamic Electron Models

The AQM c-ring model is the only electrodynamic model which passes a simple relativistic test. All three electrodynamic electron models: the spinning sphere, the spinning ring, and the spinning c-ring with initial arbitrary spin orientation at a pre-relativistic velocity (v<<c), are subjected to acceleration to a velocity approaching the speed of light (c-v << c). Both, the sphere and the ring change their shapes, thus causing a non-uniform charge distribution over their surfaces, while the c-ring, after relativistic contraction, still remains in its c-ring form, thus preserving uniform charge distribution, although with a greater density (see Figure 5).

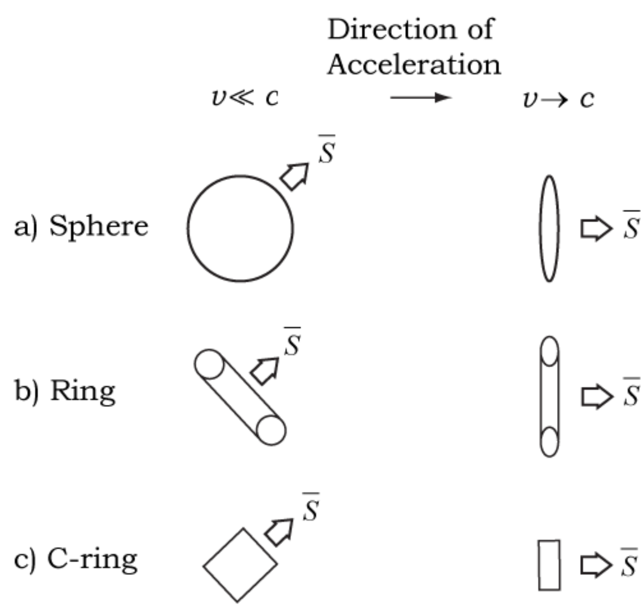

Figure 5

A simple relativistic test for electrodynamic electron models

(With permission from ConsReality, Inc.)

During one of his visits to SLAC in 1970s, Richard Feynman was shown a high energy electron-electron colliding experiment. Feynman exclaimed enthusiastically that the collision of super-relativistic electrons looked like a collision of “pancakes.” The reader, glancing at Figure 5, might notice that this statement implies the discredited spherical model of the electron. The correct statement is that electron-electron collision is the collision of electron c-rings, although most of colliding c-rings are only partially overlapped.

The radius of the electron c-ring does not experience relativistic contraction.

9. The AQM Intrinsic Electron Model Survives the Charge Fractionation Test

The AQM intrinsic electron model is the only one among historical electrodynamics models that survives charge fractionation test: e, $\frac{2}{3}e$, $\frac{1}{3}e$. The intrinsic electron electric charge fractionation is shown in Figure 6.

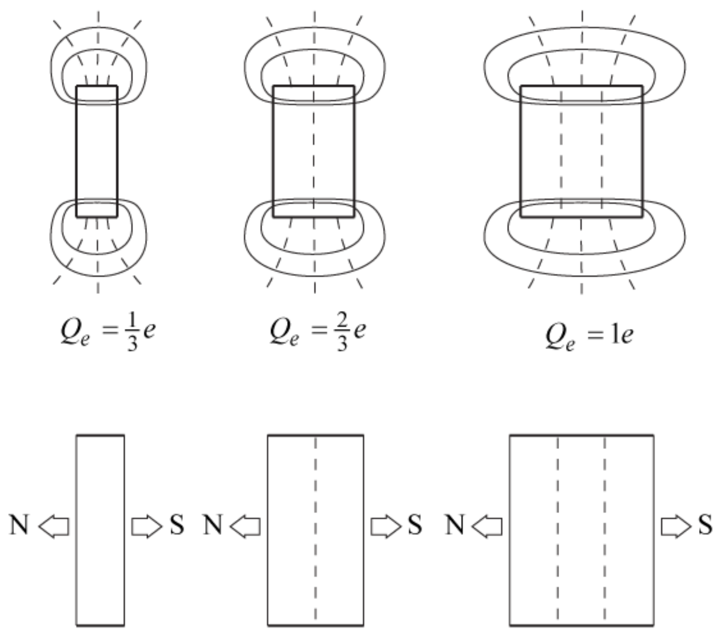

Figure 6
A charge fractionation test for the AQM intrinsic electron model
(With permission from ConsReality, Inc.)

10.The AQM Electron C-ring Model Survives Cooper Pairs Test 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 is reduced?

AQM provides a straightforward explanation stating that there is no the 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.

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 Figures 8 a, b).

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

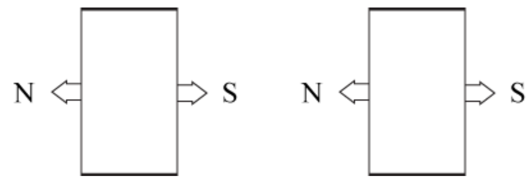

Figure 8 (a)
(With permission from ConsReality, Inc.)

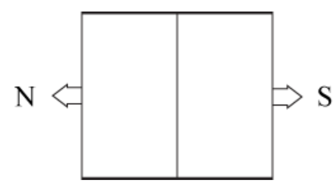

Figure 8 (b)
Ontological explanation of Cooper electron pairs
(With permission from ConsReality, Inc.)

The pair formation is a statistical process proceeding fast 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 S1 and S2 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 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. It is a matter of technology.

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. "QM explains nothing."

The strength of AQM is in its ontology. It does not need the exclusion principle to explain why combinations with odd number of electrons, such as 2 + 1, would not work. 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.

Where is the limit? Eventually, at extremely low temperature, in the range of 10^{-12} – 10^{-18} K *all electrons of the assembly form the single structure of the highest order.* It is my educated guess.

References

[1] Victor Vaguine, *The Second Quantum Revolution. Volume 1. Foundational Transformation of Quantum Mechanics. Aphysical Quantum Mechanics as Deeper Quantum Theory. Elementary Consciousness of Elementary Particles.* ConsReality Press, 2020.

[2] Victor Vaguine, *The Second Quantum Revolution. Volume 2. Foundational Transformation of Quantum Optics. AQM Theory of the Photon.* ConsReality Press, 2020.

[3] Victor Vaguine, *The Second Quantum Revolution. Volume 3. Foundational Transformation of Quantum Electrodynamics. Two Branches of Electromagnetism.* ConsReality Press, 2021.

[4] Frank Wilczek, Fantastic Realities; 49 Mind Journeys and a Trip to Stockholm, World Scientific, New Jersey, 2006.

[5] David L. Bergman and J. Paul Wesley, Spinning Charged Ring Model of Electron Yielding Anomalous Magnetic Moment, *Gallilean Electrodynamics,* Vol.1, 63-67 (Sept./Oct. 1990.

[6] J.S. Bell, *Speakable and unspeakable in quantum mechanics*, Cambridge University Press, Cambridge, 1987.