

Quantum Riddles Part I: Charge, a Case for Causality

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To re-establish the universality of electromagnetism and provide a quantized description of charge and magnetic field energies, a *wave-particle* model is proposed for fermions. Like magnetism, charge is a generated field energy, not an inherent property of the particle substance. It is formed as spherical wave energy fields within a fermion. The negative and positive directional features of this energy are produced by a 1:2 intrinsic rotation of a disc-like particle substructure about two orthogonal axes. Fluid-like character of the disc provides the asymmetry required for fermionic spin. The intrinsic wave and particle substructures within a fermion provide the two quantum-statistical behaviors that occur within an atom, solving several quantum riddles.

I. Introduction

Sir J.J. Thomson's 1897 discovery of the electron dispelled the fundamental *atomos* of Democritus and opened the door to a new branch of physics that would challenge the Newtonian Universe. Thomson assumed the rules of electromagnetism extended from the largest to the smallest scale of matter. He also envisioned the atom to consist of electrons embedded in a matrix of positively charged matter. Fourteen years later, Ernest Rutherford dispelled Thomson's 'plum pudding' atomic model when his experimental data defined an atom to consist of a dense, positively charged core that was surrounded by a cloud of near massless electrons. [1-3]. With this new model, seemingly unanswerable questions arose that challenged the universality of electromagnetism. Why do the like-charged protons clump together in the nucleus rather than fly apart from the expected charge repulsion? In maintaining discrete distances between orbiting electrons and a nucleus, is the expected charge attraction somehow overcome?

Because the electron and proton particles within the atom defied the rules of charge attraction and repulsion fundamental to electromagnetism, the founding fathers of quantum theory believed that on the subatomic level there existed certain 'hidden' variables that were beyond our 'cause and effect' experience. [4] Rather than questioning the classical concept of charge, it was perhaps easier to restrict the theory to quantum 'effects' by enlisting the aid of the Heisenberg Uncertainty and Bohr Complementary Principles. This direction has literally precluded causal explanations for particle behavior for almost a century. [5] Statistical probability replaced certainty, indistinguishability replaced individual identity and, to simplify energy approximation equations, the electron was demoted to an indescribable point mass that somehow possessed particle character as well as a wave character like that of a photon. [1,6,7]

In the years that followed the establishment of quantum theory, new particles began to emerge within the subatomic realm. In 1930, Dirac proposed the existence of a positively charged electron. One year later, discovery of the positron by Carl Anderson established the concept of 'matter and anti-matter'. [2] In 1932, the neutron was discovered by James Chadwick. [1,3] Because an isolated neutron decays into a proton after it emits an electron, the neutron was considered to be a composite particle.

In contrast, the proton was thought to be a fundamental particle until 1968. Electron-proton scattering experiments then revealed the proton possessed an uneven distribution of charge, suggesting the proton is also a composite of smaller particles, described as quarks. [8]

To resolve the problem that like-charge repulsion should exist between the protons in the nucleus, and also between the two up quarks within the proton, physicists embraced quantum chromodynamics (QCD), and introduced a statistically derived, chargeless, boson particle called the gluon. Gluons purportedly mediate a strong nuclear attractive force, which supersedes the electromagnetic repulsion between the like-charged particles. [1,9] To date there is no experimental evidence for gluons. Superficially, gluons appear to resolve the nuclear part of the electromagnetic contradiction but QCD still does not address the problem involving the atom's electrons. While the negatively charged electrons are attracted to the positive charge of the protons, they are restricted to discrete distances from the nucleus, as if also repulsed by some field. [10] What is the source of this repulsive field and how does it prevent the electrons from a close attraction to protons as in Thomson's atomic model much less the closer reaction with protons to form neutrons?

Electron behavior is defined by fermionic quantum statistics and, from quantum theory, all matter possesses both particle and wave natures. Is the balanced attraction between the electrons and a nucleus caused by the fermionic behavior of the electrons, or might it be caused by real wave packets of energy emanating from the nucleus? When an atomic electron moves from a higher energy state to a lower one, it releases a packet of chargeless wave energy, called a photon. Photons demonstrate both particle and wave behavior like their source material, but do not have charge. If electrons emit real wave energy that bears no charge then nucleons should be able to do this as well, which leads us to two very important questions. What is charge, and what role does charge play within the wave-particle dual states of matter?

Since the Stern-Gerlach experiments (1921), the electron has been tentatively but inaccurately described as a 'charged substance' that is spherically shaped. As this substance spins about its axis, the rotating charge *mechanically* generates a toroidal magnetic energy field that is centered about the axis. [1,11] This explains how the magnetic field is generated, but does not ex-

plain what charge is, or how it might be generated. Indeed, of utmost importance: is charge a special property existing inherently within the particle's physical substance, or is it a mechanically produced property like the magnetic field? If charge were an inherent property, then the electron and its 'anti-matter' twin, the positron, would have to be composed of two types of particle substance. Each of these particles possess an exactly equal amount of their respective particle substances, but each substance possesses an opposite charge value. Furthermore, the positron and the up quark are both positively charged. Does the positive nature of their charge mean they are both composed of the same type of 'anti-matter' substance? If not, then the Universe would have to contain a bewildering array of different types of particle substances.

Recent experiments have shown that the electromagnetic field within an electron is spread inhomogeneously throughout the particle and increases toward the center. [12] The standard electron model consisting of a single rigid sphere where all the 'charge' existed on the surface was dispelled! The 50 authors, led by Levine and Koltick of Purdue University, must have met with some difficulty in challenging the standard model. They explain the electron as negatively charged core surrounded by a fuzzy cloud of "virtual charge particles that wink in and out (in polarized pairs) throughout the particle." The evidence implies a dynamically changing charge location.

What if charge were a mechanically generated field energy, as is magnetic field energy. Then both energy fields might be produced simultaneously by rotation of a non-spherical particle substructure. Both would be dependent on the intrinsic spin within the particle. If charge is indeed a mechanically generated property, a field, then the standard concepts of charge and matter require new definitions, framing the case for causality.

II. A Causal Solution for Charge

Because experimental data often do not agree with the Standard Model, many scientists have been forced to resume searching for causal models at several levels. [12-16] By taking the essence of the Bohr Complementary Principle, a model of matter will be developed wherein electromagnetic law once again applies. First, our assumptions and choices are briefly presented:

- 1) If physical states or events occur in pairs, then the description of the events or states *must* be treated as complimentary pairs, where the description of either state defines both. The following are examples of complementary states or events: **a)** wave & particle duality, **b)** positive & negative charge **c)** electric & magnetic fields, **d)** matter & anti-matter, and **e)** fermionic & bosonic behaviors.
- 2) According to Einstein's energy-mass equivalence equation, $E = mc^2$, energy and mass are the same thing. [17,18] Because energy exhibits fluid-like behavior, the particle substance within a fermion is assumed to be fluid-like as well. Thus, the fluid nature of the particle substance is inferred in the term 'energy-mass substance', or *ems*.
- 3) Additionally, fermionic *ems* is characterized by charge. The critical choice is either: **a)** charge is an inherent physical property that exists within the particle substance, or **b)** a charge field is produced by a mechanical manipulation of

the *ems*. Because the classical interpretation of charge, 'choice a', has not effectively resolved the paradoxical behavior of the particles within the atom, we chose to investigate the later view.

Fermionic Particle Substructure and Intrinsic Spin

David Bohm described the electron as a rigid hollow sphere that spins about an axis. He explained that the gyromagnetic ratio of the electron's intrinsic spin with respect to its magnetic moment "is exactly that which would be obtained if the electron consisted of a uniform spherical shell spinning about a definite axis." [4] The standard model assumes that the charge energy is an inherent property of the particle substance. In the Bergman and Wesley spinning ring model of the electron, the gyromagnetic ratio is derived from a rigid ring of charge that exists without 'material'. The authors also state "a charged non-spinning ring would have electrostatic energy." [14] Furthermore, neither model attempts to explain the origin of the required intrinsic spin. In fact a rigid substance, for example like a child's top (toy), cannot rotate about an axis without the aid of an external force to initiate the spin. Maintenance of spin would require continuous energy input to overcome friction. Similarly, a spherically shaped particle composed of *ems* can neither initiate nor maintain an intrinsic spin because of the super symmetry of the sphere. Consider a point on the surface of a spherical *ems* particle and let that point represent all the points within the particle. Next, allow each point to represent a mass value, Δm , permitting the total mass of the substance to be a sum of all the mass points. The independent vibration of each mass point provides the fluid state of the substance. The symmetry of the sphere causes the vibrational energy of all the mass points to be paired and balanced through the center of the sphere, providing no internal difference about which to initiate a spin.

Now consider an *ems* particle that has an amorphous shape, such as an imperfect sphere. The vibrational energy from the unmatched mass points initiates spin (tumble) within the particle, *eg.*, a vector set like $\blacktriangleright\blacktriangleleft$. The rotation produces centrifugal force spreading the fluid-like *ems* outward toward the equatorial region to form a thin disc-like membrane with a finite nodal perimeter. Within the membrane, the vibrational energy of the *ems* is transformed into a symmetrical standing wave (Fig. 1a) that oscillates perpendicularly to the particle plane. The nature of the *ems* together with the forces developed do not allow a discontinuous membrane. The vibration is described by the Bessel function for a vibrating drumhead [19]:

$$u(r, \theta, t) = J_m(rx_n^m) \cos(m\theta) \cos(ctx_n^m) \quad (1)$$

Fig. 1b represents a cross sectional view of the particle plane. An arbitrary number of surface zones and nodes were chosen for these illustrations, with $n = 11, 9,$ and 6 in Figs. 1a, 1b, and 1c, respectively, and $m = 0$. The white and black zones between the nodes in Fig. 1c represent the crest and trough of each wave when viewed down the z -axis (wave axis). Fig. 1c is a convenient two-dimensional view of the symmetry of the oscillation of the standing wave. Vibration of the crests back through a nodal plane and to the opposite troughs occurs all the time, so this view mainly helps to show the constant nodal rings. In a non-

traveling standing wave the nodes do not move. Wolff intended to develop such a symmetrical standing wave structure for the electron. [16] His combination of circularly symmetric *traveling* waves that had “no charged substance” and had opposite phase that should have resulted in cancellation.

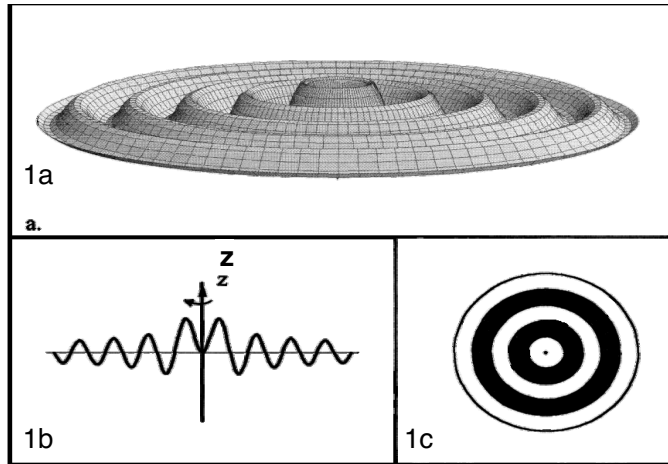


Figure 1.

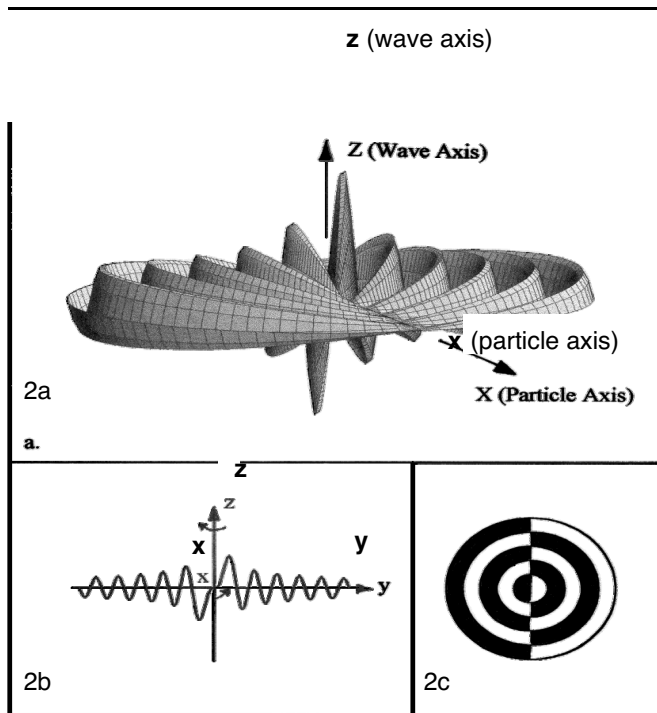


Figure 2.

However, we propose the uniformity of the symmetrical standing wave around the axis is similar to that of a sphere: it removes the basis for spin. Then, like a top, the decrease in angular velocity induces precession about the *z*-axis, causing the particle to tip over then spin about a second and coplanar axis (Fig. 2a). The presence of the coplanar or *particle* axis causes the vibrational kinetic energy to form an anti-symmetrical standing wave. The particle axis is a nodal line that separates the particle disc

into mesochiral [20] halves. A two-dimensional cross sectional view shows the anti-symmetrical standing wave of the particle disc in Fig. 2c in the *xy*-plane. The Bessel function of Eq. 1 now has $m = 1$. The particle axis (*x*) is the nodal line passing vertically through Fig. 2c. Asymmetric vibration around the particle axis may also provide spin.

The commonly accepted fermionic ‘half-integral spin’ arose from Dirac’s relativistic operator for the orbital angular momentum of an electron, $L_x = \Delta n \hbar$. [21] However, no model has been shown that can *cause* this effect. To be valid, any model must first describe the asymmetry for the Pauli Exclusion Principle for half-integral spin entities like the electron. That the numerical value for electron spin is either +1/2 or -1/2 of the units chosen to describe the orbital angular momentum, *i.e.*, $\hbar / 2\pi$, is of little importance compared to the asymmetry required.

Beginning with this asymmetry requirement, a real model with a ‘half-integral spin’ is now demonstrated. Rotational symmetry operations are viewed with respect to the anti-symmetrical standing wave as it rotates about each axis. In the stationary frame, sole rotation about the *z*-axis of a full 360° is required to return the original particle, a C_1 rotational symmetry. However, only a 180° rotation of the standing wave about the *x*-axis returns the original particle. This gives the particle axis a C_2 rotational symmetry in the stationary frame. When combined however, the *ems* rotates about the particle axis as the particle simultaneously rotates about the wave axis. The combination of the dual rotation of the particle and the oscillation of the anti-symmetrical standing wave about the two axes physically generates a ‘half-integral spin’. More appropriately the 1:2 spin symmetry ratio provides the electron with fermionic asymmetry. Identity in the rotating frame is achieved after 180° *x* / 360° *z* simultaneous operations, and is shown in more detail later.

In the symmetrical standing wave state (Fig. 1a), the rotating *ems* generates toroidal magnetic energy fields that are circles about the single vertical *z*-axis. In contrast, the formation of the anti-symmetrical standing wave state is brought about by the *ems* changing its primary rotation from this vertical axis to the coplanar particle axis. In conjunction with this change, the nodal rings are thus rotated around the particle axis. The resulting magnetic field in the stationary frame is 90° from the vertical axis and is centered about the particle axis.

Intrinsic spin within an isolated system requires an internal fluid-like energy that can be deformed, providing a difference about which the system can rotate. To initiate the spin, the system must lack perfect symmetry, allowing some randomness in the internal vibrational energy. After the spin has been initiated, the system must incorporate an anti-symmetrical standing wave state to sustain the spin, which requires rotation about two perpendicular axes. In the particle system, the angular velocity of the membrane disc about each axis is maintained by the magnetic field being generated 90° out of phase (aligned with *x*-axis) from the moving electric field (aligned with *z*-axis). Any change in the rotational speed about either axis causes the toroidal magnetic field to shift its orientation with respect to the particle and wave axes. A moving magnetic field induces current and, within the particle system, this movement would equilibrate and restore the

angular velocity of the particle disc about both axes. Essentially, a fermion constitutes the illusive perpetual motion machine.

Neither a rigid hollow sphere nor a rigid ring possesses fluid-like properties and, therefore, cannot spin on their own accord. However, like the sphere and the ring, the thin membrane of the particle disc consists of concentric, rigid, ring-like *nodes* that separate the oscillating standing waves. As the nodal rings are rotated about the particle axis, they form the 'effect' of thin and rigid spherical nodes in three-dimensional space. The 'effect' of the spherical nodes comes from the 'real' wave nature of matter.

The Real Wave State of Matter

Wave and particle duality theory was devised long ago in attempts to describe experimental behavior of photons or particles, such as electrons. A photon acts like a wave (the double-slit experiment) and it acts like a particle (the photoelectric effect). Is a photon a wave, a particle or is it both? The photon wave consists of a discrete amount of kinetic energy, which possesses the quality of mass, $m = E / c^2$. This mass 'effect' imparts a 'real' particle-like impact force when the photon contacts an atomic electron, causing the electron to move into a higher energy state with respect to the nucleus. The electron absorbs this energy and releases it as a transmitted photon, allowing the electron to return to its ground state. [22] If the mass 'effect' in a photon's kinetic energy wave permits it to act like a particle and is 'real' mass, then what exists within an electron that permits it to simultaneously be a particle and a 'real' wave?

The acceleration of a mass generates kinetic energy. Consequently, the dual rotation of the particle disc about the orthogonal axes generates kinetic energy within the three-dimensional space of the particle. Movement of each mass point generates a kinetic energy wavelet and the total energy of this wavelet depends on the location of the mass point on the standing wave. A mass point held rigidly on a nodal line would produce a maximum energy whereas the mobility of a mass point located at the anti-node or crest of each standing wave, would yield a minimum energy. The dual rotation of all the mass points produces layers of kinetic wave energy within a three-dimensional 'real' wave system, forming a *wave-particle*.

The standing wave within the particle membrane is the wave characteristic of the particle structure, which permits the absorption and release of photon energy. Absorption of the energy increases the amplitude of the standing wave, and before the electron can return to its ground state, it must release this excess energy. In a standing wave, the nodes prevent energy from moving laterally through the plane of the particle while the wave is above or below the plane of the particle. However, as the waves pass through their equilibrium positions along the plane, they flatten and form a localized nodal plane. This allows the excess energy to be transmitted laterally toward the nodal perimeter of the particle, where it is released as transmitted photon energy.

Photons do not possess charge. How can a wave energy packet, a photon, be emitted from a 'charged' electron and not have some of the same 'charge'? As stated earlier, charge is generated by a moving *ems* and since the photon has no *ems* it cannot possess the characteristic of charge. Photons are simply a kinetic energy. While the photoelectric effect of Einstein demonstrates

the equivalent mass upon absorption impact of a photon's energy, the photon still does not possess any *ems* as we have defined. Rather, it is the *ems* of an electron, after absorption of a photon, which acts as if impacted by mass.

Charge is not just a scalar quantity (q) as shown in the electric field equation $E = F / q$. It is a polar energy field analogous to a magnetic field. Both electric lines of force and magnetic lines of force (flux) are known. Energy is abstractly defined as the ability to do work. Mass (m) provides the impact force in kinetic energy to do the work, as shown in the equation $E_k = mv^2 / 2$. Magnetic and electric (charge) fields have force lines that when moved can apply these forces to do work. The energy produced by a moving charge point (electric flux line) will be designated as Q . But is a negative charge, Q^- , simply a lack of energy? No. The concept of negative and positive implies directional movement with respect to an origin. The negative and positive nature of charge energy, Q^\pm , denotes directional motion as well, and depends on the dual spin direction of the specific *ems* point that formed the wavelet.

Local Charge Energy Field

In a spherical system, the wavefunction for a moving mass, having a fixed radius to the center of the system, is dependent on the angular functions Θ and Φ of the angles θ and ϕ , such that $\psi = \Theta\Phi$. Within the *wave-particle*, the orthogonality of the axes permits their independent spin direction, where $\theta = \phi = 0$ to 2π . The angular function for a charge point rotating clockwise about the particle axis is $+\Theta(\theta)$ and the counter clockwise rotation is given by $-\Theta(\theta)$. Similarly, the two allowable spin directions about the wave axis are given by the angular function $\pm\Phi(\phi)$. Therefore, the wavefunction for a wavelet is described by $\psi(\theta, \phi) = [\pm\Theta(\theta) \pm \Phi(\phi)]$, permitting either a negative or a positive nature for the charge energy field within the wavelet.

Two particles with the same *ems* standing wave might be identical except for different spins. Fig. 3 and Fig. 4 illustrate with the rotational operations, for an electron and a positron respectively, how the same *ems* thus produces quite different net vector sums, angular momentum and magnetic moment, *i.e.*, \mathbf{L} and $\boldsymbol{\mu}$. The independent spin direction of each particle about the particle (x) and wave (z) axes yields two opposite directions for \mathbf{L} . The electron has the $-y$ direction (stationary frame) while the positron has a $+y$ direction. However, these graphics are just convenient examples for the viewer, as other step sizes can be chosen, but which still result in 'opposite' directions (opposite charge) for these two particles regardless of the final stationary frame positions. The operations upon the \mathbf{z} and \mathbf{x} vectors shown are performed in sequence (Fig. 3): $90^\circ\text{-}\mathbf{x}$ (counterclockwise), $180^\circ\text{+}\mathbf{z}$ (clockwise), $90^\circ\text{-}\mathbf{x}$, and $180^\circ\text{+}\mathbf{z}$. These operations reproduce the start position 'identity' with the total $180^\circ\text{-}\mathbf{x}/360^\circ\text{+}\mathbf{z}$ required for the fermionic asymmetry. Rotations are performed viewing down the head of the vector in the rotating frame. It is just as important to follow the magnetic component (out the $+x$ axis) and confirm that net vector sum of \mathbf{x} , representing the magnetic moment $\bar{\boldsymbol{\mu}}$ is linearly opposite \mathbf{L} for the electron rotational operators (Fig. 3b). Similarly, positron rotations in Fig. 4 with $+x$

and $+z$ give $\vec{\mu}$ coinciding exactly with \vec{L} as shown in Fig. 4b. These results match the known data for each particle.

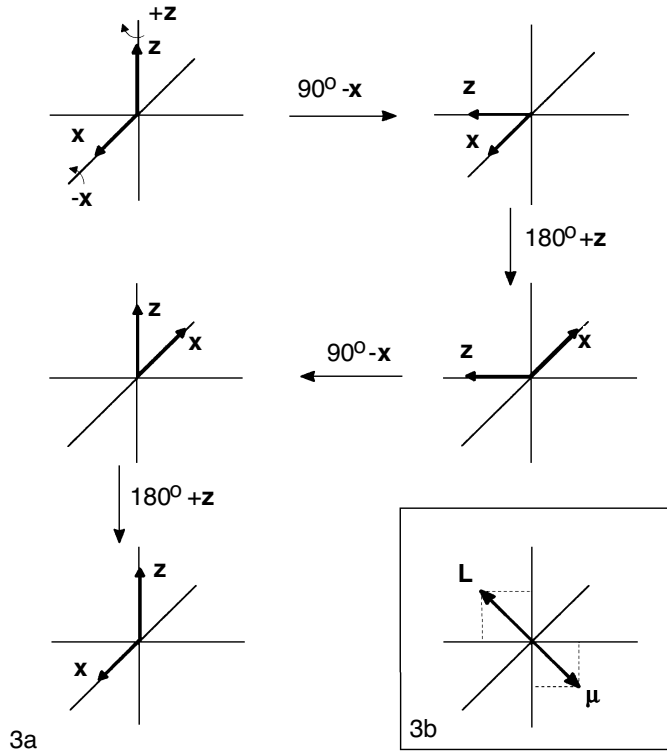


Figure 3.

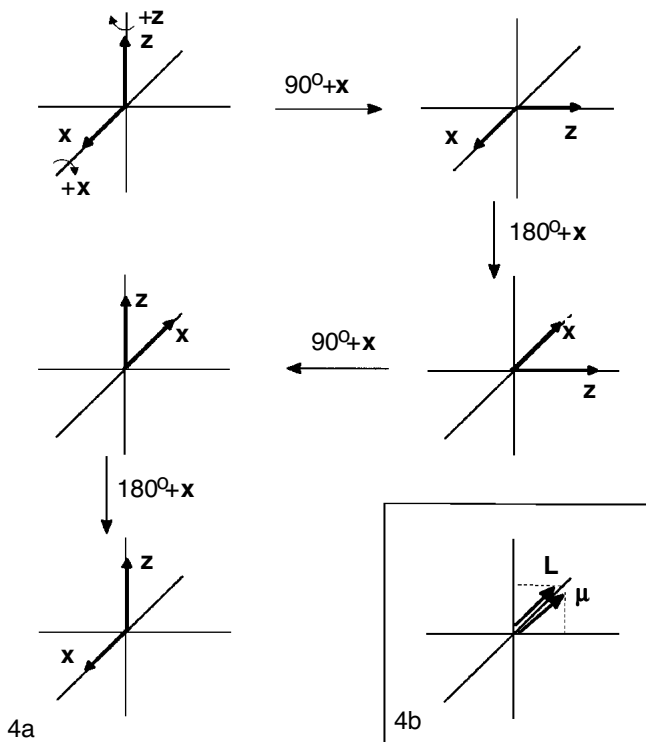


Figure 4.

The total wavefunction for the negatively charged electron is therefore $\Psi(\psi) = [-\Theta(\theta) + \Phi(\phi)] = -[\Theta(\theta)\Phi(\phi)]$ and for the posi-

tron is $\Psi(\psi) = +[\Theta(\theta)\Phi(\phi)]$. Thus, the model and the corresponding wavefunctions both reveal Q (charge) is a mechanically produced directional energy field, as is the magnetic field energy. Clearly, the two opposite charge field energies arise from the same type of *ems*. Again, there cannot be a myriad of different types of energy mass substances for matter and antimatter of every type of particle. Antimatter only differs from matter by an opposite spin about its particle axis.

According to classical physics, a magnetic (field) energy is generated when a 'charge' point moves. [1] This magnetic field energy is perpendicular to the plane of movement and forms a toroidal field around the axis of rotation. Consequently, the toroidal magnetic field within the *wave-particle* is centered around the particle axis and, as the particle axis rotates about the wave axis, the magnetic field is rotated as well. On the other hand, the charge energy wavelet (field) does not simply rotate. Instead, it is formed in three-dimensional space by the dual rotation of the asymmetric standing wave of *ems*. A complete circuit about the particle axis alone would form the wave field in two-dimensional space, giving no basis for the two opposite charges. Therefore, the existence of the two opposite charges (polarized fields) depends upon the direction of rotation of the *ems* about the wave axis.

Electrons experience coulombic repulsion within the atom, which indicates their negative charge field is directed away from the particle in all directions. In classical theory, the electric field (charge) of a particle has been considered an inherent property of the matter, or anti-matter. Additionally, electrons were previously envisioned to 'radiate' their field as a photon-like energy. Therefore, a classical electron would deplete its energy over time. Consequently, models have been sought that do not permit the electron to 'radiate' its energy, such as the Bergmann and Wesley spinning ring model. [14] Non-radiating electrons would not repel one another at a distance unless an electric field was present. The *wave-particle* model generates its electric field energy in a spherical pattern that is determined by the total wavefunctions. Because this field energy is mechanically generated like the magnetic field, it is constantly renewed.

As mentioned above, a large team of physicists presented experimental data that indicates the charge of an electron is not localized at a single, spherical surface but is spread out within the particle and may be stronger toward the core. In their particle model, they describe the charge density around this core as a "fuzzy 'cloud' of virtual particles, which wink in and out of existence in pairs." These virtual particle pairs are thought to be oppositely charged and polarized with respect to the core of the electron. This polarization is purported to cause the electromagnetic force within the electron to be non-constant. [12] Their findings agree with the features of our *wave-particle* model.

Within the particle disc, nodal lines separate the positive and negative curvatures of the anti-symmetrical standing wave, which would generate a type of polarized 'fuzzy' charge energy field. As the nodal lines rotate about the axes, they produce spherical nodes that separate the onion-like layers of kinetic wave energy. Between the nodes in the particle disc, the energy diminishes toward the anti-node at the center of the standing wave. This change in energy is mirrored in the complementary wave energy state, where the nodal spheres consist of maximum

energy and the minimum energy is located at the center of each spherical layer. The amplitude of the standing wave changes during the course of a period. Consequently, the generated Q would also change during this time, generating a non-constant electromagnetic field. The standing wave has greater amplitude near the center. This model serves as an alternate explanation of the experimental findings of the Koltic and Levine team.

The angular wave function, used to describe the *wave-particle's* resultant spin vector, raises an important question concerning the electromagnetic force. Why are oppositely charged fermions attracted to one another? The electromagnetic attractive force is an 'action at a distance'. Electrons repel one another at a distance because they project 'like' polarized electric fields or, Q^- . If electron repulsion is provided by the wave energy state of a particle, then the attractive force must involve the wave state of a particle as well. In the *wave-particle* model, the attraction between an electron and a proton arises from the nature of their wave energies.

From quantum theory, two orthogonal wave functions Ψ_1 and Ψ_2 are non-interactive, as is indicated by the nullity of their integrated product $\Psi_1 * \Psi_2$. [22] Within the *wave-particle*, the wave states of the charge and the magnetic field energies are formed along orthogonal axes and do not interact. For example, the positive charge of the proton in a hydrogen atom is canceled by the electron's charge but unequal pairing of their magnetic fields gives the nucleus a net magnetic moment, which has the value of the proton, 2.79 nuclear magnetons (nm). [23] In the hydrogen atom, we would expect the electron to be 'attached' intimately to the proton because unlike poles of magnets attract until they touch one another. However, the electron is held at a tremendous distance from the proton, as if being repelled by a force. If the proton were a fundamental particle like the electron, its charge energy would project spherically, and the electron would find no resistance as it approached the positive charged particle. Consequently, the balanced attraction between the two particles suggests the proton is not a fundamental particle.

In the 'standard model', the proton is believed to be composed of three quarks. The overall charge of the proton, $+1e$, comes from the combination of the charges provided by the two up quarks, $2(+2/3 e)$, and the one down quark ($-1/3 e$), where the fundamental charge, e , is approximately $1.602 \times 10^{-19} C$. When a proton captures an electron, it converts into a neutron because the electron interacts with one of the up quarks (q_u) to form a second down quark (q_d), giving a net charge of zero. Consequently, a q_d must be considered to be a composite fermion. Within the proton, the two q_u are spin-paired and the one q_d can have either a spin-up or spin-down orientation, obeying the Pauli Exclusion Principle. [24] QCD avoids the Exclusion Principle by giving each quark a different gluon color force and baryon number of $1/3$. Gluons (bosons) cause the quarks (fermions) to 'clump' together without like charge repulsion. [1,9] This 'standard model' theory has been limited because the fundamentals of *wave-particle* theory were not known. Indeed, it is very difficult to propose particle interactions when the very items interacting are not well defined.

Attractive and repulsive interactions between particles are described by the two branches of quantum statistics, which divides matter into two behavioral categories that are based on their type of spin. Fermions have half-integral spins and Fermi-Dirac statistics permits the maximum of two fermions in an energy state, but only if they are spin opposed, obeying the Pauli Exclusion Principle. On the other hand, the Exclusion Principle does not apply to boson quasi-particles, which have integral spins. Bose-Einstein statistics do not limit the number of bosons that can enter a single energy state. [6,7]

Helium, which has a nuclear spin number of zero, is statistically treated as a boson quasi-particle and was used to attain the first Bose-Einstein Condensate (BEC) in 1994. [25] Since then, boson condensates have been made out of Group I elements, such as sodium and rubidium, none of which have integral spins. At MIT, the BEC is described by the Ketterle group as a "giant matter wave". [26] If condensing into a single, resultant wave state is a bosonic behavior and can be achieved by elements having fermionic nuclear spin values, then the three fermions (quarks) within a proton, each having an intrinsic wave state, can overlap and condense to form a boson quasi-particle. As is discussed in the next Section, the disc like feature of the particle structure permits these fermions to condense within one another's wave energy space.

III. Wave-Particle Interactions

The *wave-particle* model provides two types of interactions between two or more particles, fermionic and bosonic. The fermionic interaction involves two oppositely charged *wave-particles* spin pairing then overlaying their particle structures to form a composite fermion. In the bosonic interaction, three fermions spin 'triple' in a triangular array, and then overlap through their wave energy layers to form a composite boson with an internal spin value of zero. Both types of interactions involve both the charge field and the magnetic field energies.

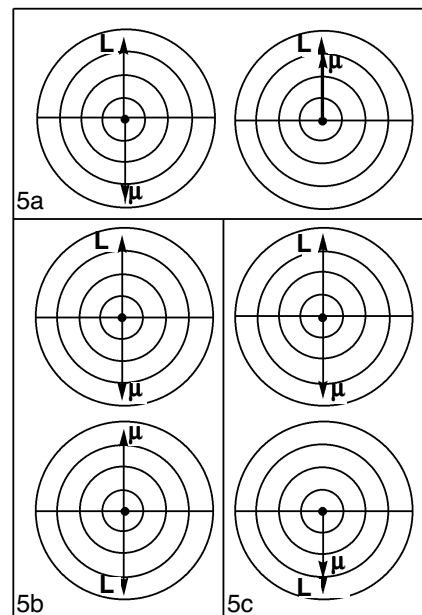


Figure 5.

Two oppositely charged fermions are shown in Fig. 5a. In the negatively charged fermion, the angular momentum vector, L , and the magnetic moment arm, μ , point in opposite directions along the wave axis, whereas the vectors coincide within the positively charged fermion. When two electrons spin pair (Fig. 5b), the like poles of their magnetic fields are directed at each other, causing magnetic field repulsion. On the other hand, the spin pairing of an electron with a positron causes the unlike poles of their magnetic fields to be pointed in the same direction (Fig. 5c) resulting in a strong attraction.

Because the charge and magnetic field energy states are generated by the rotation of the particle disc about the two axes, the amount of energy within these fields is dependent on the twin spin velocity of the mass. Consequently, a particle consisting of a greater mass would possess a slower rotational speed than a particle consisting of a lesser mass. The mass of a quark has been estimated to be about 2 to 8 MeV and would rotate more slowly than an electron with a mass of 0.5011 MeV. The angular speed about the wave-particle z -axis can be represented as ω , where $\omega = d\theta / dt = d\phi / dt$. This allows the ratio of the charge, e , to the angular velocity to be expressed by $\pm\varpi$, where $\varpi = \pm e / \omega$. Therefore, the charge to angular velocity value for an electron is -1ϖ .

The Fermionic Interaction

Composite fermions, such as the down quark, are formed by the fermionic interaction of particle overlay. The up quark (q_u , $e / \omega = +2/3 \varpi$) and the electron (β^- , $e / \omega = -1\varpi$) spin pair along their waves axes with their magnetic moment arms pointing in the same direction (Fig. 6a). As they approach one another, the orthogonality of their charge energy waves allows their particle discs to enter a mutual space. The discs overlay one another and their standing wave energies combine to form the anharmonic wave that is shown in the combined structure in the center of Fig. 6a. For the resultant down quark, (q_d), $e / \omega = -1/3 \varpi$. The combined particle discs rotate about the particle axis in a counter clockwise direction and at a slower speed, yielding a net charge of $-1/3 e$. The difference in their charge wave energies is emitted by the neutrino (ν_-), as is shown in Eq. (2). The known decay of the down quark within a neutron is Eq. (3), the reverse of Eq. (2), and includes the emission of the anti-neutrino, ν_+ .

$$q_u + \beta^- \rightarrow q_d + \nu_- \tag{2}$$

$$q_d \rightarrow q_u + \beta^- + \nu_+ \tag{3}$$

In the case of Eqs. (2) and (3), the emission of the neutrino conserves the momentum of the electron. [1,10] While the neutrino is considered to be a near massless particle, it is actually a part of the kinetic energy wave state of the two fermions.

Similarly, the combination of a positron (β^+) and an electron is given by:

$$\beta^- + \beta^+ \rightarrow \beta^0 + 2\gamma \tag{4}$$

The composite fermion, represented by β^0 , is a neutralized beta particle combination and will be referred to as an n -betatron.

Because the two fermions are composed of the same ems , their mass is not annihilated on contact. Instead, the gamma radiation that accompanies electron-positron encounters is brought about by the collapse of their equal and opposite kinetic wave energy systems as shown in Fig. 6b. In their combined state, their standing waves harmonize and form a symmetrical wave around the wave axis. Again, symmetry removes the basis for spin. The combined fermion loses rotation about the wave axis, causing the kinetic wave energy systems to collapse. Unlike the q_d , which possesses the anharmonic combination of the electron and the q_u , the n -betatron is super stable, and requires an equivalent amount of energy to separate the particles that was lost in their combining. Because the n -betatron does not produce charge energy, the composite fermion would not be detected by an electromagnetic field and could represent part of the 'missing matter' in the Universe.

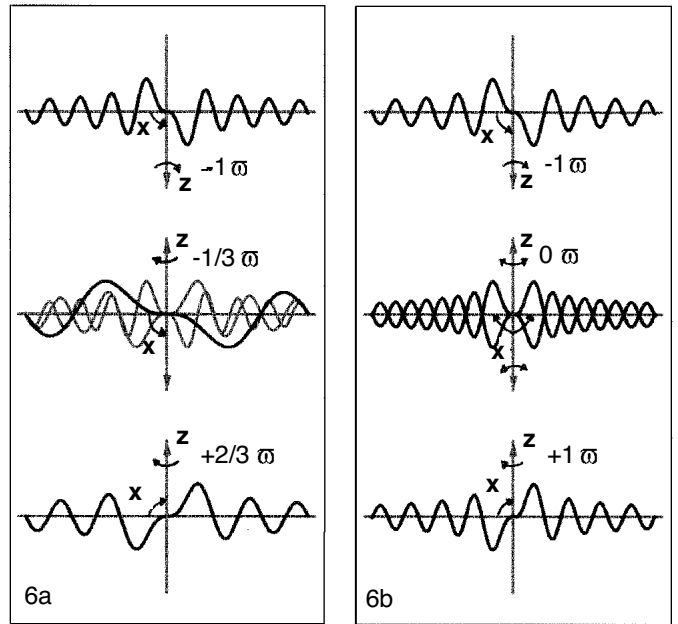


Figure 6.

The Bosonic Interaction

The Pauli Exclusion Principle has been used in attempts to explain the spin orientation of the three quarks within the proton. While the two q_u are believed to be spin-paired, the one q_d can have either a spin up ($+1/2 \hbar$) or a spin down ($-1/2 \hbar$) orientation. [6,10] When two electrons spin pair, their magnetic moments are canceled. Consequently, the magnetic moments of two spin-paired q_u would be cancelled as well, requiring the q_d to supply the magnetic moment. Because the q_d is negatively charged, it possesses a negative magnetic moment. However, the proton has a positive value, $+2.79 \text{ nm}$. Similarly, the single q_u in the neutron should provide a positive magnetic moment but the neutron has a value of -1.91 nm . [23] In addition, the two possible spin orientations permitted for the one q_d in the proton provides the fermion with choice, which would then require two types of protons. The uncertainty provided by such a choice and the sign value for the magnetic moments within the proton and

neutron indicate the Exclusion Principle alone does not adequately describe the spin state of the three quarks.

In the *wave-particle* model, the three quarks are spin-tripled and overlapped through the kinetic energy wave systems, forming a composite boson particle with a wave energy structure that is formed by the contributors in a manner that may be more complicated than simple linear superposition of fields; for this general situation, we use the word 'combinant'. As shown in Fig. 7, the wave axes of the three fermions strike from a center point in a plane. In their spin-tripled positions, the three fermions are separated by a 120° angle and have the following independent boson spin quantum numbers: $\sin 90^\circ$ (or $1 \hbar$), $\sin 210^\circ$ ($-1/2 \hbar$) and $\sin 330^\circ$ ($-1/2 \hbar$). The sum of these numbers gives the triangular array of fermions an integral spin number of zero. Therefore, a proton is intrinsically a boson. The difference provided by the larger composite q_d permits a rotational axis to pass through the q_d and between the two q_u . When rotated, the boson triangle forms a cone-like shape, which can have a spin up or spin down orientation, giving the combinant proton the required asymmetry to also behave as a fermion.

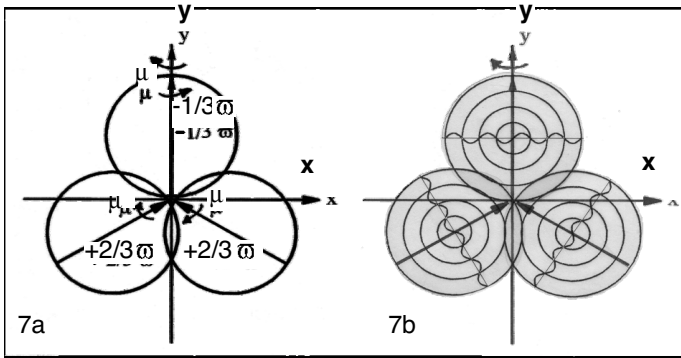


Figure 7.

In their spin-tripled state, the three disc-like particles rotate synchronously within the radius of one another's wave space, allowing the layers of wave energy to overlap between the spherical nodes (Fig. 7b). The amount of penetration in the wave space is limited by the spherical, planar and point nodes within each fermion. (The planar node is produced by the rotation of the nodal particle axis and the point nodes are located along the wave axis.) The minimum energy that exists at the center of each kinetic energy layer represents a low potential energy well. As the waves overlap, these low energy regions are brought together, requiring energy to separate them.

The down quark (q_d) is shown in the 'spin down' position along the positive y -axis in Fig. 7a. Because the fermionic q_d is negatively charged, its angular momentum and magnetic moment vectors, L and $\vec{\mu}$, point in opposite directions along the wave axis. The magnetic moment vectors of the two q_u point in the same general direction as that of the q_d , and generate an attractive magnetic field effect. Consequently, the coulombic repulsion existing between the two q_u is reduced by the magnetic field attraction, the overlap of their wave energy layers and the proton's rotation about the axis that passes through the q_d .

The spin direction of the proton is determined by the two up quarks. For each up quark $e/\omega = +2/3 \hbar$ and the single q_d has a value of $-1/3 \hbar$. The sum of these values is $+1\hbar$, which indicates the boson triangle rotates in the clockwise direction. On the other hand, the neutron (not shown) contains two q_d and one q_u . While the single q_u forms the apex of the neutron's boson triangle, the sum of quark charges to angular velocity values is zero. Consequently, the neutron does not possess a stabilizing intrinsic spin. Within the nucleus, the neutron overlaps with other nucleons, which induces a stabilizing spin. However, when isolated from the nucleus, the lack of intrinsic spin of a neutron and the inharmonic energy state of the down quark causes the emission of an electron and the conversion back into a proton. This decay into a proton is known but such a mechanistic explanation has not been modeled.

Unlike the spherical charge energy field of a fundamental fermion, the proton's charge field is shaped like a cone. Within the proton, the overlapped wave energy of the quarks generates a combinant wave similar to three overlapped sound waves. Along the axis of rotation, a potential difference exists between the two q_u , $2(+2/3 e) = (+4/3 e)$ and the lone q_d ($-1/3 e$). When combined with the rotation of the proton, the combinant wave energy is projected away from the base of the boson triangle and through the apex, forming a cone-shaped charge energy field. The wave frequency of the projected field energy appears to decrease with distance from the proton because the rotation constantly pulls the field away from any continuing projection in one direction.

In the hydrogen atom, the proton's combinant wave system forms a cone-shaped potential energy well. Because a ground state electron has a discrete wavelength, the fermion is captured by this specific wavelength within the combinant wave, a wavelength minimum, and is held at a distance from the proton. When an electron absorbs photon energy, its increased energy and wavelength forces the electron to move away from the proton and through the wavelength continuum to a higher energy level until the energy is released.

In classical nuclear shell model theory, like nucleons are spin-paired together. Protons are spin-paired with protons and neutrons with neutrons. While the proton provides the nucleus with a positive charge, the neutron adds to the atom's mass and provides each nuclide with a range of isotopes. [10] In contrast, the non-spherical shape of the proton's charge energy field in *our wave-particle* model partly explains why protons do not repel one another within the nucleus. The Coupled Nucleon Shell Model (CNSM) we propose presents a more complete and different perspective of the nucleus and gives the neutron a more profound purpose. It also details how the neutron is spin stabilized within the nucleus.

IV. Coupled Nucleon Shell Model (CNSM)

When a neutron is spin paired with a proton along a common axis, they combine to form a neutron, proton-boson or np-boson (Fig. 8). While the quark in the apex of each nucleon is pointed away from each other, the like quark pair within the base of each unlike boson triangle are in contact, forming a tetrahedral arrangement along the axis. This particular orientation of the nu-

cleons is brought about by the electromagnetic attraction between the two up quarks ($+4/3 e$) within the proton and the two down quarks ($-2/3 e$) in the neutron. Because the fermion pairs are 90° out of phase to each other, the wave overlap between the pairs occurs through their planar nodes.

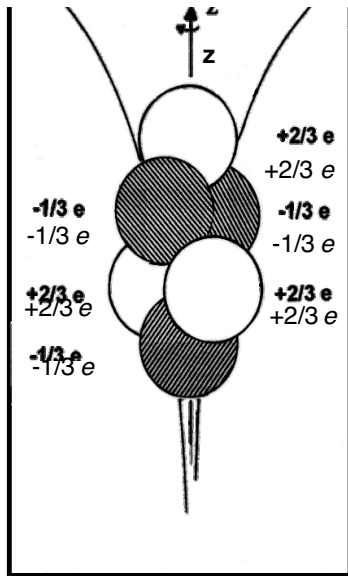


Figure 8.

Starting with the q_u of the neutron, the order of the fractional charges along the axis is as follows: $+2/3 e$, $-2/3 e$, $+4/3 e$, $-1/3 e$. The amount of attraction between the proton's two q_u ($+4/3 e$) and the neutron's two q_d ($-2/3 e$) is greater than that which exists between the q_u and the proton's lone q_d ($-1/3 e$). As the greater momentum of the positive charge energy moves past the two q_d , it encounters the positive charge of the neutron's q_u . The repulsion of the like charges causes the q_u to act like a concave lens, which diverges the combinant wave energy outward and away from the nucleus. Simultaneously, the energy of lesser momentum flows toward the lone q_d in the apex of the proton. Because the unlike charges are attracted, the q_d acts as a convex lens, causing the combinant wave energy to converge.

In the helium nucleus, two np-bosons are spin paired along the nuclear axis and through a focal point that is located at the center of the nucleus (Fig. 9). While their diverging combinant waves forms the electron s-orbitals, their converging waves meet at the focal point or focus, where the linear momentum of their wave energies approaches zero. Because the nucleon's combinant wave energy generates the electron orbitals, the orbitals mirror the quantized energy levels within the nucleus. These nuclear energy levels (nel's) are halved between the two hemispheres of the nucleus and are separated by a nodal equatorial plane. The focus represents an ultra-low energy point that exists at the intersection of this plane and the nuclear axis and, while the s-nel is aligned with the nuclear axis, p, d and f-nels form rings around the axis. The np-bosons that exist within these nels determine the orientation and the shell levels of the electron orbitals.

V. Summary

Charge is not an inherent property of a particle's substance. Charge is a field energy produced by the dual rotation of an asymmetric particle disc about two orthogonal axes. The particle disc consists of a thin membrane of energy-mass substance (*ems*) that possesses fluid-like characteristics. The kinetic energy produced by the vibration of the *ems* oscillates through the membrane as an anti-symmetrical standing wave, and is responsible for the initiation of the intrinsic spin. Dual rotation about the x and z -axes produces the fermionic 'half-integral' spin ratio (1:2) and the non-constant electromagnetic field.

Dual rotation of the *ems* generates a kinetic energy field within the particle, forming the concentric spherical layers as a wave energy state of the *wave-particle*. Oppositely charged fermions are described by the positive and negative nature of the energy within two identical *ems* through the wave functions that arise from the independent spin direction of the *wave-particle* about orthogonal axes. Consequently, the electron and the positron are composed of the same *ems*.

Bosons form through a spin-tripled magnetic attraction and combinant wave overlap of three fermions. Protons are boson particles and possess a non-spherical charge energy field. A proton and a neutron spin pair along a common axis and condense together within their wave states to form an np-boson. The positively charged combinant wave energy of the np-boson contracts and is projected along a narrow and extended cone-shaped field, forming an electron orbital. Electrons are attracted to the positive charge of the proton but they are captured by a wavelength minimum in the combinant energy field.

Seemingly paradoxical behavior of protons and electrons within the atom with regard to the rules of electromagnetism led to quantum theory. While quantum theory was founded on the riddle of wave and particle duality and the two statistical behaviors of matter, it was established long before the requisite advances in technology allowed experiments to reveal some secrets of the proton and more recently the electron. The *wave-particle* theory presented herein not only provides a model of the intrinsic substructures within a fermion but also extends to accurately describe both fermionic and bosonic inter-particle behaviors. The discoverer of the electron, Sir J.J. Thomson, believed in the universality of electromagnetism; his belief is re-established in the *wave-particle* model of the electron.

Acknowledgement

We thank The Robert A. Welch Foundation for partial support of this work.

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He-4	
2p ₋₃	---
2s ₋₁	-
1s ₋₁	▽
He	●
1s ₊₁	▲
2s ₊₁	-
2p ₊₃	---

Figure 9.

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$$\int \Psi_1 * \Psi_2 d\tau = 0$$