The high Q resonance characteristics of the CEWL electron model may predict directionality of virtual photons and neutrinos

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ABSTRACT

Matter forms from high-energy photons by Electron-Positron pair production. The Charged Electromagnetic Wave Loop (CEWL) Electron model was developed in 2011 to explain this transition and ended up explaining more by matching all known values of the electron and explaining the previous mystery of why the Electron's bare g-factor is 2 rather than 1 (½ spin). Two new insights are explored in this paper:

- Since an Electron is stable, its internal electromagnetic resistance is essentially zero which allows unique solutions for the Electron's capacitance and inductance to be calculated ($3.419126348 \times 10^{-24}$ Farads and 4.85262×10^{-19} Henries), and the Capacitance value can then give an approximate size of the internally oscillating charge.
- Another insight (probably testable) predicts the directionality of virtual photons (and possibly Neutrinos). This stems from the fact that the loop characteristics of the CEWL Model, in which the circumference exactly matches the wavelength of a (virtual) photon with an Electron's energy, is analogous to the characteristics of a resonant loop antenna in which the circumference must also exactly match the wavelength in order to achieve high Q resonance, which leads to a prediction that Leptonic virtual photons (and possibly Neutrinos) will be generated in the same directions as high Q loop antennas i.e. in the North and South magnetic directions of the CEWL loop.

(Non-resonant antenna loops have very different absorption/radiation patterns that tend to leak photonic energy sideways which is in contradiction with the fact that Electrons are stable). The high Q directionality might guide future research into how and where virtual photons (and possibly Neutrinos) form near Leptons.

Key Words: *Charged Electromagnetic Wave Loop, CEWL Electron Model, Pair Production, spin g-factor, Capacitance Reactance, Relativity Mass, Magnetic Moment, Lepton, and High Q Resonance loop Antenna*

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BACKGROUND

Many interesting models of the electron have been attempted since the early 20th century, but none has given a full picture or accurately generated all electron values. Some, for the sake of simplicity, just use point like charges which unfortunately have infinite energy problems (an infinite amount of energy would be required to force the charge of an electron down to zero radius), and other models (Parson's, Lorentz's, Uhlenbecks & Goudsmitts', and Mac Gregor's for example have unvarying charge shapes, that without any apparent δCoulomb/δt, they would not be able to generate a wave nature (Quantum Mechanical equations suggest a wave nature). Without an oscillating electromagnetic wave nature, it would be hard to explain how an Electron can interact with itself going through a double slit for example. Some Electron models have also invoked superluminal velocities (that violate Einstein's relativity) to produce the necessary magnetic moment (in the early days of quantum mechanics, the "superluminal problem" was used to suggest that electrons have some mysterious nature that can't be explained fully by any model and hence this justifies the mathematical simplifications of using just a point model). Here's a brief history of the famous Lorentz model and how it was later used in a superluminal model. The "Grand Master of Physics" Lorentz was one of the first to equate energy with mass (Einstein later simplified his calculations into the more famous $\boldsymbol{E = mc^2}$).

Lorentz used that mass-energy equivalence to develop a spherical electron model, but it relied only on static "Electric" energy which produced an electron radius that was therefore much too small. The only reason he didn't originally include spin (magnetic energy), is that "spin" had not yet been discovered and accepted until Uhlenbeck and

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Goudsmit published their famous spin paper. Their famous spin paper, unfortunately, relied on the by-then prevalent spherical Lorentz electron model (with a radius that was too small!), and it therefore failed to generate the correct magnetic moment without resorting to superluminal velocities of the charge on the surface of their rotating sphere [4]. In their defence, the Lorentz Classical "static" Electron model had gained persistent acceptance in the "current" theories of the time.

The Charged Electromagnetic Wave Loop (CEWL) model solves both the magnetism and superluminal problems of the older models (and matches all known values of the electron to at least 6 decimal places and explains why the Electron's internal g-factor is 2 instead of one). Before explaining the details of what it is, it is important to first point out that although the CEWL model may look like an attempt to use the same "classical" Lorentz static energy equivalence method described above, it is actually significantly different in that instead of using static calculations, the CEWL model relies on oscillating energy solutions of both the Electric And Magnetic energies as found when Maxwell's equations as applied to Photonic type wave propagations as shown in Equations 1 and 2 (energy equations that work for static fields do not work for the speed-of-light oscillating charges in a photonic type electromagnetic wave). A quick way to see the difference is to look at a Photon, which because it travels at the speed of light, has no calculable "Rest" mass, i.e. at the speed of light, classical equations no longer work and the total energy equation now becomes E=hf (the Plank-Einstein relationship) Photons do however have "moving" mass-energy in the form of momentum (E=pc), and likewise the CEWL model, which although it also has no "Rest" rotational mass due to its speed of light oscillation internally, it does have rotational electromagnetic mass-energy internally. See comment "f" under Fig. 1 and 2 Re Feynman describing how a photon can generate transverse rotational energy).

The CEWL model postulates that an electron has an electromagnetic nature (the same as the photon that produces an electron-positron pair) whereby the net charge of the electron varies sinusoidally as it rotates in a loop at a diameter of $7.72318536 \times 10^{-13}$ m, at the speed of light (the circumference of the loop happens to exactly match the wavelength of a photon of the same energy as an Electron). In addition to exactly generating the correct bare magnetic moment to over 6 decimal places, without resorting to superluminal velocities, the CEWL model also exactly matches all other known values of the electron, including the energy frequency (de Broglie base frequency of an electron as well as the Plank-Einstein energy frequency), charge, mass, and also explains the mystery of why the Electron's bare g-factor is 2 rather than one (½ spin) [4].

This paper starts with a description of how the CEWL model explains electron-positron pair production from high energy photons, and then goes on to show a new insight about how to estimate the resonant capacitance of the electron and then uses that value to estimate the rough width of the charged area relative to the diameter of the rotationally oscillating charged loop and then goes on to discuss a variety of characteristics of the CEWL model including the second new insight about the probable directionality of virtual photons and Neutrinos and then includes a brief conclusion.

Note: Reliable references are included for all subject "matter", but many common concepts can be quickly googled if those expensive references are not available. The "Waveplate" Wiki article for example has excellent diagrams showing how a photon's E potential (due to charge separation) rotates as it travels through space, and also shows how a photon's cross-section can be transformed from any form of an elliptical cross-section to any other form of an elliptical cross-section. Likewise, the "Stress-energy tensor" wiki article is a quick way to find Einstein's General Relativity Tensor equation which equates the space-time distortions of electromagnetic energies to the space-time distortions of mass.

The CEWL electron model

The CEWL model starts with the premise that since an electron-positron pair forms from a purely electromagnetic photon (of energy >1.022 Mev), and since the resulting pairs of an electron and a positron (of energy 0.511 Mev each) have the same electromagnetic nature (as witnessed by their de Broglie base frequency), then they must have the same electromagnetic wave nature as the photons from which they originated, except for one detail [1-5]. The charge and magnetic field lines of electrons and positrons can close back on themselves (trapping a specific amount of magnetic moment), which allows matter to exist at rest, whereas the magnetic field lines and charge separations within photons do not close back on themselves (and hence the magnetic and electric fields of photons chase each other forward at the highest speed possible, i.e. the speed of light).

Note: Maxwell was the first to be able to calculate the speed of light "c" with his equation $c^2 = \frac{1}{\epsilon_0 \mu_0}$, where $\epsilon_0$and μ_0 are the electric and magnetic permittivity constants of free space. Where does the mass come from? One can combine Maxwell's equation above with Einstein's $E = mc^2$ to get $m = E\epsilon_0\mu_0$ where mass can be equated to the purely electromagnetic terms on the right. The electromagnetic energy tensor equations of general relativity theory are also shown to contribute to space-time distortion exactly the same as mass does (see below).

From photon to fermion

<u>From photon:</u> Modern modelling of photons generally focuses on the "potential" E and B fields (electric and magnetic fields), but it is impossible to generate an E potential without a charge separation, which is why Maxwell himself first envisioned a photon as composed of a charge separation spiralling through space at the speed of light (the electric permittivity constant of free space ϵ_0 describes the capacitance like the ability to induce a charge separation in free space) [6]. Fig 1 "before" is similar to how Maxwell envisioned the charge separation of a photon spiralling through space (the spiral can be either right-hand or left polarity). Note: The cross section perpendicular to the direction of travel is of the general form of an ellipse, with "circularly" polarized light having the circular extreme of elliptical cross-section, and regular "polarized" photons having a more elongated extreme of the elliptical cross section (appendix a)[2,7]. Circularly polarized photons can be changed into "regular" elliptically polarized photons and, vice versa, "regular" photons can be changed to circularly polarized by sending the photon through non-linear optics such as "quarter wave plates" [8].

<u>To fermion</u>: Matter in the form of an Electron Positron pair forms when a gamma photon of at least 1.022 Mev strikes a nucleus (or otherwise gets accelerated sufficiently by some other interaction with matter/energy). Reference #1 has an excellent summary by J.H. Hubbell of pair production when gamma photons "strike" different nuclei etc. (Appendix b) shows a graph of Pair production in an aluminium plate for different gamma photon energies.

The CEWL model for electron-positron pair production is shown below by the transition from a high energy photon in Fig 1 "before" to two charged loops in Fig 2 "after". The positively charged loop is a Positron and the negatively charged loop is an Electron. Due to the original spin rotation of each at formation, the magnetic fields are opposed at the moment of formation, allowing the electron and positron to separate despite their enormous electrostatic attraction at that scale. The original paper contains the math to show that the opposing magnetic field at the initial formation of an electron-positron pair would exceed the electrostatic attraction between them [4].

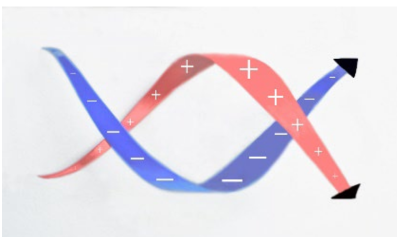

Figure 1) *"Before" Photon* λ*=12.13 x* 10^{-13}*m*

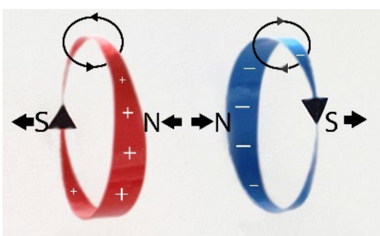

Figure 2) *"After" Loop Diam = 7.723 x* 10^{-13}*m*

Fig 1 "Before" and Fig 2 "After" show the transition from a 1.022+ Mev photon to positive and negative loops, of 0.511 Mev each, which are now closed loops and repelling away from each other magnetically. The positive loop is a positron, and the negative loop is an electron.
For simplicity, not all the magnetic fields are shown, but they are required for the propagation of a photon as well as for containing the charges in an Electron or Positron.
Note:

a) The charge distribution shown for a photon in Fig 1 should be viewed as a representation of how a varying charge separation within a photon induces a sinusoidally varying "potential" as the photon passes a given point in our own rest frame (and is not necessarily an exact representation of the charge distribution in its own rest frame).

b) "Matter" only forms when the charge fields and magnetic fields can close back on themselves (trapping a specific magnetic moment), which allows "Matter" to exist at rest in a given rest frame (a Photon has no "rest" mass, i.e. only "moving" mass in the form of momentum, whereas the Mass of Matter, although internally still similar to a photon, the Lepton can now exist at "rest" within a given rest frame).

c) In the same way that a photon is "contained" from expanding laterally by its own electric and magnetic fields, the closed loops of Matter somehow also "contain" themselves into loops using their own resonant electromagnetic fields. A Tokomak torus or the highly contained "Astrophysical Jets" of spiralling charged particle beams ejected close to the speed of light along the rotational axis of massive Black Holes might give insight into the mechanisms by which a Lepton's internal (resonant) speed of light electric and magnetic fields confine the circulating charge.

d) The charge varies sinusoidally as it progresses around the loop in Figures 2 and 3 due both to resonance requirements and also because it produces the necessary δCoulomb/δt required to produce an electromagnetic wave).

e) The width "W" of the loops in Fig. 2 and 3 are exaggerated to show how the charge inside an Electron is most likely sinusoidally distributed around the loop but the capacitance calculations (below) indicate a narrower width that is approximately 0.53% of the loop diameter.

f) Feynman describes how a photon's momentum energy can be transferred into circular electromagnetic energy that is transverse to the direction of photon travel [7].

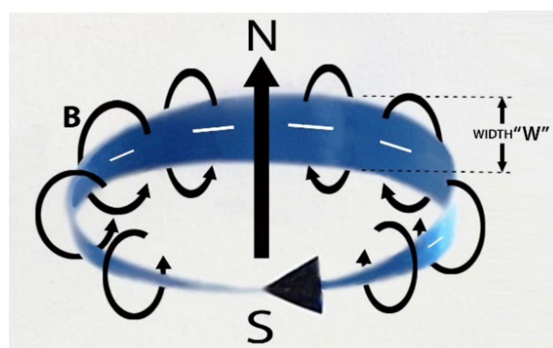

Figure 3) *The Magnetic "B" field lines which are due to the rotational oscillation of the charge inside an electron/positron have no component in the direction of the charge rotation and hence can add no rotational energy/mass. An electron or positron has zero internal resistance (or it would lose energy and decay) therefore ½ the mass is "electric" and ½ is "magnetic" [5]. Since only half the mass rotates, it is a ½ spin particle with a "bare" (undressed) gyromagnetic g-factor of 2 rather than 1*

Electromagnetic energy and mass: MIT Physics professors' emeriti Slater and Frank (Slater was Feynman's advisor at MIT) have used solutions to Maxwell's Electromagnetic equations for the general case of plane wave propagation of photons to show that the total Electro-Magnetic energy density in free space, i.e. with no resistive component is:
Total Electro-Magnetic Energy Density =

$U = \frac{1}{2}\left(\epsilon_0 E^2 + \frac{1}{\mu_0} B^2\right)$[9] (1)

As further explained by Slater and Frank, the average magnetic component (the B half of this equation) is only greater than the average Electric component when a resistive component is present [8,9]. In any given rest frame, photons and electrons do not lose energy, i.e. they have no resistive component, so therefore if the electrons and positrons maintain the same electromagnetic wave nature as the photons from which they originated, then the average electric energy must exactly equal the average magnetic energy in both cases.

Using E= mc^2, one can divide the above Energy density equation (1) by c^2 to get Mass density:

Mass density = $\frac{U}{c^2}$ == $\frac{1}{2c^2}(\epsilon_0 E^2 + \frac{1}{\mu_0} B^2)$ (2)

Note: Using Maxwell's $c^2 = \frac{1}{\epsilon_0 \mu_0}$ to get rid ofμ_0, it is easy to show that this is exactly the same equation as the Electromagnetic Stress-Energy tensor form for mass used in Einstein's General Relativity [10].

Electromagnetic Tensor equation for Mass [10]:

$T = \frac{\epsilon_0}{2}\left(\frac{E^2}{c^2} + B^2\right)$ (3)

Since only half the electromagnetic mass contributes to L angular momentum, we can simply substitute L/2 for L into Feynman's electron gyromagnetic equation:

Feynman Gyromagnetic ratio= $\frac{\mu}{L} = g_e * (\frac{q}{2m_e})$ [11],

Where g_e =1 (4)

With L/2 instead of L:

Gyromagnetic ratio= $\frac{\mu}{L/2} = 2 * (\frac{q}{2m_e})$ (5)

Therefore, with only half the internal mass rotating, the electron's g-factor g_e is 2 instead of one (½ spin).

No other diameter model can match reality without violating either Einstein's general relativity or Maxwell's equations: The various reasons why the CEWL model leads to a unique solution for the Electron's charge diameter (7.72318536 × 10^{-13}m) can be found in a previous CEWL paper, but in general, the main reason the CEWL Diameter is unique is as follows [5].

Due to the energy constraints of Einstein's Relativity, all velocities must be at or under the speed of light, therefore:

1. The charge must rotate at or inside the CEWL diameter in order to produce the correct Plank-Einstein Energy Frequency (de Broglie base frequency of an Electron)
2. In order to generate the correct magnetic moment, the charge must rotate at or outside the CEWL diameter

The only simultaneous solution to both conditions is that the charge rotates at the speed of light at the CEWL diameter.

Calculating the capacitance and inductance of the electron

When designing efficient power supplies or antennas, capacitors and/or inductors are generally added to the circuits to increase power factor and to match impedances for maximum energy transfer. The graph below shows a typical reactance graph showing the "real" resistance on the X axis and the positive and negative "impedances" due to the net capacitance and inductance of the circuit on the Y axis. Man-made Inductors have real internal resistance which needs to be allowed for when calculating the best capacitor/inductor to add to the circuit (figure 4).

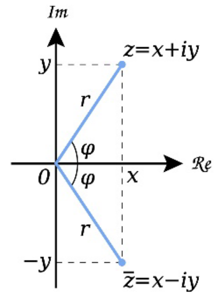

Figure 4) *Calculating the capacitance and inductance*

Electrons and positrons however have zero "real" internal resistance (or they would decay) which simplifies the analysis to the case of simply matching the positive and negative impedances on the Y axis, i.e. the capacitance reactance must match the inductance reactance, i.e. both will match the reactive impedance of free space $\mathbf{X}_0$.

The reactive Impedance of Free Space is:

$\mathbf{X}_0$ = 376.730313668 (57) Ω [12]

The Reactive Impedance X_L of an inductor L and impedance X_C of a capacitor C depend on Frequency in the following way:

X_L = ω L, and X_C = 1/(ωC) [13] (6)

Where ω=2πF_{Hz}

The CEWL rotational oscillation frequency (which also matches the Plank-Einstein energy frequency and the de Broglie base frequency of an Electron) is:

F_{CEWL} = 1.235590085×10^{20} Hz; Therefore,

ω_{CEWL} in this case is = 2π F_{CEWL} = 7.76344147×10^{20}

Solving for L and C of the Electron:

L_{CEWL} (Inductance of the Electron) = $\mathbf{X}_0$/ω = 4.85262×10^{-19} Henries (7)

C_{CEWL} (Capacitance of Electron) =1/(ω $\mathbf{X}_0$) = 3.419126348×10^{-24} Farads (8)

The above C and L reactance calculations are frequency dependent (but silent on resonance) we can double-check these values with an additional equation for the Resonance of a capacitor-inductor (CL) loop:

CL Loop Resonant F_{Hz}= $1 / \left(2\pi\sqrt{CL}\right)$ =1.235590085×10^{20} Hz (9)

(Which correctly matches the Electron's energy frequency and the CEWL rotational oscillation frequency).

CEWL Electron charge width calculations

The Width of the circulating charge in the CEWL Model (see Fig. 3) can be estimated by calculating the area of the charged loop required to match the above Electron capacitance.

The capacitance of an isolated object is defined as Q/V, where Q is the total charge on the object when it is at V volt potential relative to infinity. In the case of a conductive sphere, only the exterior surface area affects capacitance due to the Faraday Cage effect. In the case of a sheet of thin conductive material, however, the area of both sides of the sheet would be used to calculate Capacitance. The capacitance of shapes other than spheres is generally approximated by applying a "shape factor" to the capacitance of a sphere with an equivalent area

[14].

Chow and Yovanovich have shown that an elongated needle-like spheroid or a long thin strip of conducting material will both have slightly more capacitance than a sphere of equivalent area and hence require an additional "Shape Factor" correction of approximately 1.2 [14].

The capacitance of a conductive Sphere in free space is well known to be $4\pi\epsilon_0 r$

Area of Sphere (with the same Capacitance as C_{CEWL})= $1.186647377 \times 10^{-26}$ m^2

The area of both sides of the sinusoidally rotating charge in the CELW model is

= $2\pi D_{CEWL} \times (W_{max}/2)$ (see fig. 3)

Solving for W_{max} = (Area Sphere/1.2)/(πD_{CEWL})

= 4.0757×10^{-15} m (or Approx 0.53% of the Diameter D_{CEWL})

(10)

Note: The Width "W" should not be confused with the size of the electron i.e. the electron is the entire electromagnetic loop, whereby the sinusoidally varying electric charge component rotates at the CEWL diameter, but the magnetic component extends further, leading to interactions which can have both a particle nature and/or a wave nature (the wave nature would interact with itself going through a double slit for example).

DISCUSSION

Width

The width "W" calculation above should be viewed mainly as a reality check on whether the calculation provides a "reasonable" value, i.e. a value that is neither way too high nor way too low compared to the diameter. For example; an antenna with a width larger than its diameter would not be a very high Q antenna leading to failure to reabsorb virtual photons. Likewise, a value that's much smaller than the one calculated would need too much compressive energy compared to the amount of total energy in the system. The capacitive charge distribution shown is similar to that of a conducting object, which should be a valid assumption since an electron has essentially no internal resistance (or it would decay), but the actual dynamic charge distribution is unknown so a refinement may be necessary in the future. Note: in conductive materials, the charge will be most concentrated near the edges, which suggests that the highest concentration of charge in the CEWL model would be in the upper and lower edges of the band in Fig. 3.

Compatibility with quantum mechanics

The CEWL Electron model does not conflict with quantum mechanics. The CEWL model exactly matches all known values of the electron and goes a step further by generating a wave nature and explaining the previous mystery of why the Electron has a g-factor of two internally rather than the expected 1 (which allows quantum equations to correctly predict the observed energy levels within an atomic ecosystem). Any quantum or other model of Electron behaviour, which has already been shown to be compatible with all known values of the electron, should therefore also be compatible with an electron model which exactly replicates all those same known values.

No contradiction with the Stern-Gerlach experiment

The Stern-Gerlach experiment is sometimes used to suggest that an isolated electron has some mysterious "extra" dual nature that would need to be explained, but the Stern-Gerlach experiment is not actually measuring anything about an isolated electron, i.e. it is only measuring the up or down states [15]. Within an atomic ecosystem and hence there is no contradiction with the CEWL model. Here's a quick explanation: The outermost, lone, electron of the Silver atoms used in the experiment is usually in the lowest energy state, whereby that electron's internal magnetic moment aligns with the magnetic moment created by the same electron as it orbits the nuclei (the Down state), but after being heated in the oven (that sends a stream of silver atoms through a magnetic separator), many of the atoms now have their outermost electron in the next higher energy state i.e. the "Up" state (the only other stable state), which means it's internal magnetic alignment is opposite the direction of the orbital magnetic field. The Stern Gerlach magnetic separator then deflects the atoms which have the two magnetic fields aligned more than the atoms in which the alignments are in contradiction. Note: in a previous paper I suggested that the up or down alignment of the outmost electron will either add or subtract to the nuclei magnetic moment (which is a phenomenon which does happen), but as Quantum Physics Professor J. Shertzer Ph.D. pointed out to me, the nuclei magnetic moment is not strong enough to be detected by the Stern Gerlach experiment. (My own Muon loop model for neutrons and protons predicts an insufficient magnetic moment as well, so that should also have alerted me that I was using the wrong ecosystem, so I apologize for the misdirection). The conclusion is the same, however, i.e. the Stern Gerlach experimental results are an atomic ecosystem phenomenon, not a phenomenon of an isolated electron itself, so there is no contradiction with the CEWL model.

Note: The Stern-Gerlach experiment is usually described as "proving" that an Electron has only 2 possible discrete angular momentum states, but that is not completely accurate since the apparatus only measures magnetically, i.e. a better way to describe it is that the experiment shows that an unpaired Electron has 2 possible magnetic moments within the atomic ecosystem (either Up or Down relative to its own orbit). The angular momentum just happens to be related to the magnetic moment (after applying the correct g-factor)

Magnetic moments

An interesting side note about the internal magnetic moment of an electron *vs* the (separate) magnetic moment due to its atomic orbit, is that the first orbit of an electron as it orbits around a hydrogen nucleus will generate a magnetic moment that is exactly the same as the magnetic moment of the Electron itself. Then in the second allowable hydrogen orbit (see radius in allowed Rydberg orbits), the magnetic moment of the orbit around the nucleus is now exactly twice the magnetic moment of the electron itself [16]. This suggests that one interpretation of stable orbits is that only the atomic orbits with magnetic moments that are exact multiples of the electron itself will be stable. Larmor type "wobble" oscillations are proportional to the magnetic moment which means that, regardless of the external magnetic field, the Larmor "wobble" frequency of the atomic orbits $\omega = g_e * (\frac{-qB}{2m_e})$ and the Larmor "wobble" frequency of the electron itself will resonate together only at orbits which generate exact multiples of the electron's magnetic moment (and hence will only produce stable orbits when the orbit resonates with the electron itself) [17].

Huygens's system of dual pendulum clocks is an example of how resonance between two nearby systems can lead to stable synchrony between the two systems. When two of his pendulum clocks were placed close to each other on a shelf, they interacted through vibrations to produce a combined stable state whereby the two pendulums swung in exact synchrony (180 degrees out of phase with each other) [18-21]. This was the 17^{th} century's version of spooky action at a distance. It should be noted that the effect only lasted while the clocks were close to each other. The important part of this analogy is that much like Huygens pendulums, atomic orbital Larmor "wobble" frequencies that are different from the electron's wobble frequency, will get either retarded or advanced until they are in stable synchrony with the wobble frequency of the Electron itself (i.e. any non-resonant orbit will decay to a harmonic resonant orbit).

Note: the observant reader will notice that although the first hydrogen orbit has a magnetic moment identical to the internal magnetic moment of the electron itself, the Larmor wobble frequencies of each are also dependent on the g-factor of each, which would normally double the resonant wobble frequency for the electron itself relative to its lowest orbital wobble, but as explained by Jackson, there is one additional precession correction when a wobbling electron makes an orbit around the nucleus (called the "Thomas half" since it requires an additional factor of ½ to be applied) [18].

Resonance

Resonance is the main unifying theme in this paper since without it an Electron would surely lose energy and decay. Any suggested form of an Electron/Lepton that doesn't include resonance-type reabsorption of virtual photons (with zero energy loss), would lead to energy loss from the Lepton in the form of photons. The circular loop of the CEWL electron model happens to be extremely resonant (at the energy frequency of an Electron), i.e. it has the exact same form as a high Q resonant inductive single loop antenna in that the circumference around such a resonant loop antenna must match the wavelength of the received/transmitted electromagnetic photonic energy in order to prevent energy loss [13]. Likewise, the circumference of the CEWL model exactly matches the wavelength of a photon of energy equal to that of an electron. Antenna theory subdivides electromagnetic interactions into 3 regions [13]. The "Near Field" where electromagnetic oscillations are induced near the antenna, but the electromagnetic interaction is strictly "reactive" i.e. energy in this near field leads to no net loss of energy from the antenna because all "virtual photon" energy is reabsorbed by the antenna, 2) The "Fresnel" intermediate region and 3) The "Far Field" where photons fully form and propagate away (leading to net energy loss from the antenna). An interesting "antenna" observation is that Feynman (one of the 4 QED originators) happened to be a radio antenna expert and had an intuitive sense of how all the radio waves reflecting off surrounding surfaces, back towards the antenna receiver needed to be summed both for intensity and phase, whereas Schwinger and Tomonaga (also QED originators) were antenna experts of the smaller microwave type (radar microwave cavity resonance and waveguide experts) [19]. The interesting part is that Tomonaga and Schwinger both developed (independently of each other) very similar extremely complex purely mathematical models of QED self-interactions, whereas Feynman used his more visually intuitive Feynman diagram approach. Did their different backgrounds in antenna "fields" shape their approaches to QED? I suspect so but that will take some historical research far afield from the main topics of this paper.

The ability of electrons, positrons and other forms of matter to induce oscillations in the vacuum of free space is what distinguishes modern quantum physics from the previous more "classical" interpretations of physics, i.e. interactions of particles with a pure vacuum cannot be calculated as simply "one-way" interactions, but rather the energy fluctuations of all the virtual photons (and virtual particles) induced near matter must also be calculated, both for their effect back on the original particle as well as for their effect on nearby photons and matter [11,20].

Q factor of resonance

Antenna Theory uses a "Q" resonance factor to characterize the efficiency of an antenna [13]. Since an Electron does not lose energy (or it would decay), the "Q" resonance factor of an Electron is effectively near infinite. High "Q" loop antennas are ones where the circumference of the loop exactly matches the wavelength of the transmitted or absorbed photon [13]. Loop antennas in which the circumference does not match the absorbed/transmitted wavelength generally transmit/absorb best in the same plane as the loop (90 degrees away from the rotational axis of the loop) [13]. At perfect "Q" resonance however, when the loop circumference exactly matches the wavelength, photons are best transmitted and absorbed in a completely different direction, i.e. such that their travel direction lines up directly with the rotational axis of the loop i.e. only in the North and South magnetic directions generated by the loop [13]. To visualize this, refer to Fig. 1 and Fig. 2, where either the electron or the positron in Fig. 2 will induce circular "virtual" proto photons like what is shown in Fig. 1, (propagating away from both sides of the electron or positron loop), except due in part to the extremely high Q of the electron or positron loop, the virtual photons are immediately reabsorbed. Note: Reference [13]. "Antenna Theory Analysis and Design" By Balanis has excellent visual diagrams showing the 90 degree difference in directionality between High Q resonant loop antennas (where the wavelength exactly matches the circumference) vs. loop antennas without these characteristics.

CEWL Model is compatible with other leptons

Other Leptons match the CEWL model. The Muon and Tau forms of the electron have the same CEWL Model characteristics as the electron, except that the charge would rotate at a smaller diameter (the Muon rotates at a diameter that is about 207 times smaller than the electron, and the Tau rotates at a diameter about 3,477 times smaller than the Electron). The magnetic moment of a rotating charge is proportional to amperage multiplied by the area enclosed. For a constant speed of light velocity, as the diameter decreases, the amperage increases in inverse proportion to the diameter, but the area enclosed falls off faster due to being proportional to the diameter squared, hence the CEWL model predicts that the magnetic moment for each will be proportional to the diameter of each (which matches reality). In addition to the magnetic moment scaling correctly, the following table of Lepton values based on the CEWL model indicates that the diameter is inversely proportional to both frequency and mass-energy. The capacitance and Inductance and resulting Maximum "W" width (as a percentage of diameter) for the Electron, Muon and Tau are calculated using the same method as above (equations 6- 9).Table1

Table 1:
CEWL Model is compatible with other leptons

Lepton	Diameter	Frequency of Rotation	Capacitance Farads	Inductance Henries	Max W % Diameter
Electron	D_C *	$1.235590085\times 10^{20}$ Hz	$3.41912635 \times 10^{-24}$ F	4.85262×10^{-19} H	0.53%
Muon	Dc/206.77	2.554808×10^{22} Hz	$1.6536029 \times 10^{-26}$ F	2.34689×10^{-21} H	0.53%
Tau	D_C/3477	4.296×10^{23} Hz	9.834×10^{-28} F	1.3956×10^{-22} H	0.53%

*DC (D_{CEWL}) =$7.72318536 \times 10^{-13}$ m

The fact that the Max Width "W" (see Fig. 3 above) is the same percentage of the diameter for all cases, indicates that the Total Mass-energy of the CEWL model does not need a "shape" correction at different Radii and therefore supports that the Total Mass-energy will scale proportional to 1/Radius (or 1/Diameter) as expected.

Note: Just a quick reminder that the 1/R Mass-energy relation of the CEWL model should not be construed as meaning that the CEWL model Capacitance calculations will match the Lorenz classical electron calculations (where Mass-Energy also scales with 1/R) because this is a speed-of-light photonic wave model with no rotational "Rest" mass internally, i.e. only rotationally oscillating electromagnetic mass and hence the classical static equations of Lorentz don't apply (Photonic speed of light oscillating solutions to Maxwell's equations for both Electric and Magnetic energies given in Equations 1 and 2 are more appropriate).

One of the greatest mysteries of physics is why the Electron, Muon, and Tau (as well as the positively charged antimatter forms of these Leptons) only form stable matter at the mass of the electron and again at roughly 207 times that mass and again at roughly 3,477 times the Electron mass. If the CEWL model is correct, then that question can also be re-stated as: Why does the high "Q" resonance only occur at precisely the CEWL diameter and again at ~(1/207) of that diameter (the Muon diameter) and again at ~(1/3,477) of the CEWL diameter (the Tau diameter)?

Neutrinos

Feynman Diagrams show that a Tau Neutrino is ejected when a Tau Electron decays into a Muon Electron, and a Muon Neutrino is ejected when a Muon decays into an electron. Electrons have never been shown to decay, but it is safe to assume an electron neutrino would be involved if such decay were possible. The above suggests that the electron neutrino, the muon neutrino and the tau neutrino most likely have the same diameter as the electron, muon, and tau respectively (but with a much smaller net charge). If the lesser (opposite polarity) charge of the Neutrino(s) "follows" the Electron's charge rotation, slightly offset from the electron's charge rotation, at the same radius, then the resulting oppositely aligned magnetic field of the lesser-charged loop(s) might add a stabilizing effect on the CEWL loop by guiding the CEWL magnetic fields back towards the purely reactive "Near Field" thereby preventing any possibility of photon or energy escape in the North or South magnetic directions, The high Q resonant CEWL loop (which is tuned to a 511 Kev photon i.e. the energy of an Electron) prevents energy escape in the only other direction possible i.e. sideways).

This is just a preliminary guess about the nature of Neutrinos, but regardless of the actual form of Neutrinos, it is highly likely to be a necessary part of achieving the near-perfect "Q" required for Lepton stability. This is because in order to achieve very-high Q, an Antenna must be extremely precisely "tuned". If a Neutrino is ejected upon decay, then most likely an essential component of the previous precise "tune" has left the Lepton.

Similar photonic antennae physics

Similar photonic antennae physics can be found by examining "Rayleigh Scattering", which describes the antennae-type absorption and re-transmission of photons hitting atmospheric molecules or atoms, as well as "Mie Scattering" for absorption and re-transmission of photons off microscopic particles with various complex indexes of refraction (these were some of this author's areas of expertise while taking graduate courses in the Harvard Medical area).

Rayleigh scattering, which applies to atoms and molecules with a diameter much smaller than the incident wavelength, has a $(1+cos^2\theta)$ term showing significant perpendicular re-radiation probability.

Mie Scattering functions by contrast apply to droplets or particles which have diameters near or larger than the incident photon wavelength. In this case, the photon generates a more efficient and resonant excitation, and as the particle diameter approaches the wavelength of the incident photon, generates mostly forward/backward scattering (less sideways scattering).

The current wiki article on Mie Scattering shows an excellent animation of the change in re-emission angles as the incident photon wavelength changes from 0.1 to 1.0 (of a droplet diameter). The re-emission of the photon changes from mostly perpendicular to the original photon direction of travel, to mostly in line with the direction of travel as the wavelength approaches the particle diameter.

As described in page 4 above, the only way any electron model can match all known values of the electron simultaneously is to assume the charge of the electron has a circular oscillation, at the CEWL diameter and rotates at the speed of light. (Other diameters and shapes would violate relativity or energy equations). This rules out using spherical models, but the absorption and emission angles of resonant vs. non-resonant loop antennas are very similar to that of spherical Mie Formulas (compared with diagrams in Balanis [13]), and both show that the dominant angle of absorption and re-transmission changes from perpendicular to the direction of photon travel, to in-line with the direction of photon travel as the photon wavelength approaches the more resonant antennae/particle diameter [13].

Sideways re-emission, whether Rayleigh or Mie, or a loop is always highly polarized. If you look at a loop sideways, the charge oscillates in a linear direction, which means that any photon emitted sideways will be extremely polarized. The Sky is blue due to re-emission at various angles of blue wavelength photons interacting with Nitrogen and oxygen molecules (the red wave lengths are too long for efficient interaction). If you take a pair of polarized sunglasses and rotate them as you look up at a blue sky you can see this, i.e. the polarization reaches a maximum when looking 90 degrees away from the source of the photons (the sun). Sideways energy loss is completely suppressed with an extremely high Q resonant loop that has a circumference equal to the wavelength in question (a 511 Kev photon in the case of the CEWL model)

CONCLUSION

The Charged Electromagnetic Wave Loop (CEWL) model of the Electron has been validated by the fact that it explains pair-production and also exactly matches all known values of the electron, including energy, frequency of energy (de Broglie base Electron frequency and Plank-Einstein frequency), charge, mass, and also generates the correct magnetic moment without resorting to superluminal velocities. The model also explains why Leptons have both a particle and wave nature and also explains the previous mystery of why the electron's g-factor is 2 rather than one (½ spin). The new insight that the capacitance and inductance can be uniquely calculated and used to estimate the width "W" of the charged part of the electromagnetically oscillating CEWL loop relative to the diameter (0.53%) is another validation of the model since it produces a realistic width that doesn't conflict with any other part of the model, i.e. the model is internally consistent.

A second recent insight stemming from the model provides a prediction about virtual photon directionality (and possibly Neutrino directionality). If one combines:

1. How the CEWL Model's loop circumference exactly matches the wavelength of a photon of energy and wavelength equal to that of an Electron.
2. How high Q resonant loop antennas also share the same characteristic, i.e. the circumference must exactly match the wavelength to achieve high Q resonance.
3. How high Q resonant loop antenna theory shows that virtual photons will be generated in the North and South magnetic directions generated by the CEWL loop (loop antennas without these high Q resonance characteristics have very different radiation/absorption patterns which can leak photonic energy sideways), all this suggests a possible new research "direction" into how and where virtual photons (and Neutrinos) form near the Electron, Muon and Tau Leptons.

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CONFLICTS OF INTEREST

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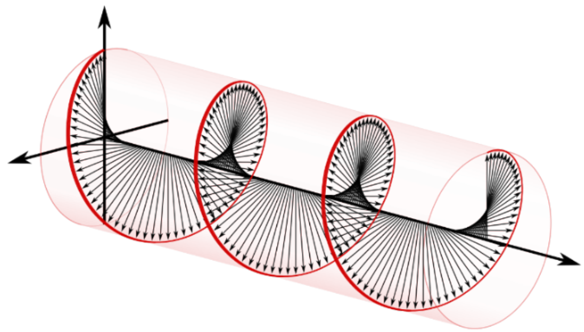
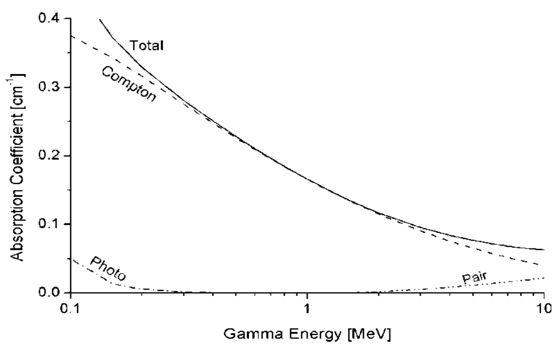
APPENDIX



a) *This is a typical representation of the electric field rotation of a circularly polarized photon as it travels through space (a "fuller" picture would show that a net charge separation exists on opposite sides of the axis). The rotation can be either clockwise or counterclockwise. The magnetic fields (not shown) would be orthogonal to the direction of charge travel. Photon cross-sections are of the general form of an ellipse with "regular" polarized photons having cross-sections that form a more elongated ellipse. The "length" of the wave packet is not shown because different theorists have proposed different values all the way from zero to infinity. This author uses "one" wavelength in Fig 1. to represent the photon packet "interaction" length, because antenna theory and Mie theory have shown that maximum absorption occurs when the antenna is sized to match one wavelength*



b) *Electron-positron pair production in Aluminum*