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The Toroidal Fine-Structure of the Electron

By Gene Gryziecki

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The Toroidal Fine-Structure of the Electron

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I. Introduction

The Bohr theory of the hydrogen atom, theorized by Niels Bohr (1885-1962), includes a negatively charged point-mass electron that travels in a circular orbit about a positively charged nucleus. In the atom's lowest energy (or ground) state, the distance between the two particles is called the Bohr radius and is equal to 0.529×10^{-10} m. Since then, further investigation indicated that sometimes the electron behaves like a wave and sometimes like a particle [1]. Thus, the Bohr-Heisenberg model of the atom arose where the electron exists only as a cloud or fuzzy cavity about the nucleus and measurements are based upon the probability of a point particle being found at a certain location in the cloud.

Recently, there has been some rather meticulous scientific research work by Dr. Paulo Correa and his team that has put forth a novel description of the electron as a torus ring, and a heuristic understanding of the Bohr radius and the Bohr-Heisenberg model of the atom. This paper is intended to provide an introduction to, and overview of, an important aspect of this work.

II. Methods and Results

Building upon the work of Wilhelm Reich (1897-1957) and his research on gravitational pendulums, it became possible to decipher his formula for determining the functional equivalence between mass and length [2]. Reich's work supported the idea that "atomic weights are gravitational functions that can be functionally replaced by pendulum lengths." He selected pendulum lengths, in centimeters (cm), such that they were numerically equal to the gram-molar masses, and thus to the atomic weights, of various elements, while keeping the actual weight of the pendulum constant at 1 gram. For example, the length of gravitational pendulums for Hydrogen, Helium and Oxygen would be 1, 4 and 16 cm, respectively [3]. His process transforms "inertial mass into the rotary or pendular wavelength of the linear free fall motion" understood as weight [4].

In the case of the electron (the entirety of this paper applies to the electron and all reference values have been taken from a single source, CODATA 2018 [5]), this gravitational wavelength is resonant with the "wavelength of the energy circularized as mass-energy (see below) and on which the inertia of a state of rest is anchored as a reaction of that inert mass or of that mass-energy," referred to as the mass-equivalent or amplitude [6] wavelength [7]. In fact, for the electron, these two wavelengths, gravitational and mass-equivalent, are numerically equal, and the wavelength of concern in this paper is the electron mass-equivalent wavelength. The equation for the mass to length transformation for the electron can be shown as:

$$\text{Length} = \lambda_e = m_e N_A 10^{-2} \text{ in meters [2]} \quad (1)$$

where λ_e is the mass-equivalent wavelength of the inert mass of the electron, m_e is the electron mass (in grams), and N_A is Avogadro's number:

$$\lambda_e = (9.109 \times 10^{-31} \text{ kg})\ (10^3 \text{ gm / 1kg})\ (6.022 \times 10^{23} \text{ / mole})\ (10^{-2})\ (\text{m}) = 5.486 \times 10^{-6} \text{ m} \quad (2)$$

Using this tremendous insight and the famous equation for calculating rest energy or mass-energy, where energy E equals the product of mass m times the speed of light squared c^2, $E = mc^2$, one can determine a functional equivalent to the mass-energy of an electron using two physical quantities rather than three, incorporating length and time instead of mass, length, and time. Accordingly,

$$E = m_e c^2 = \int = \lambda_e c^2 \quad (3)$$

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with c designating the speed of light and the symbol $=\int=$ indicating a functional transformation that involves both dimensional conversion and an equivalence between two different physical systems of measurement [8]:

$$E = (9.109 \times 10^{-31} \text{ kg}) (2.998 \times 10^{8} \text{ m s}^{-1})^2 = 8.187 \times 10^{-14} \text{ Joules} =\int= (5.486 \times 10^{-6} \text{ m})(2.998 \times 10^{8} \text{ m s}^{-1})^2 = = 4.930 \times 10^{11} \text{ m}^3 \text{ s}^{-2} \quad (4)$$

For electromagnetic (photon) energy consisting of oscillating electric and magnetic fields, where the maximum wave velocity is restricted to the speed of light, the well-known Compton electron wavelength ($\lambda_{ce} = 2.426 \times 10^{-12}$ m) can be used to determine the Compton electron frequency:

$$\upsilon_{ce} = c / \lambda_{ce} = (2.998 \times 10^{8} \text{ m s}^{-1}) / (2.426 \times 10^{-12} \text{ m}) = 1.236 \times 10^{20} \text{ s}^{-1} \quad (5)$$

When energy is quantized, it can be calculated by the product of Planck's constant ($h = 6.626 \times 10^{-34}$ J s) and frequency. If the frequency happens to be the Compton electron frequency, then the result is equivalent to the mass-energy of the electron or to the low-energy limit of a gamma ray photon. Modern science shows this calculation as

$$E = h\upsilon_{ce} = (6.626 \times 10^{-34} \text{ J s}) (1.236 \times 10^{20} \text{ s}^{-1}) = 8.187 \times 10^{-14} \text{ Joules} \quad (6)$$

matching the results of the $E = m_e c^2$ calculation shown above in equation (4).

Now, it also becomes apparent that a functionally equivalent Planck's constant h, in meter and second units of measure, can be determined by rearranging the above equation as

$$h = E / \upsilon_{ce} = (4.930 \times 10^{11} \text{ m}^3 \text{ s}^{-2}) / (1.236 \times 10^{20} \text{ s}^{-1}) = 3.990 \times 10^{-9} \text{ m}^3 \text{ s}^{-1} \quad (7)$$

Our limited understanding of charge has confused the issue of the fine-structure of the mass-energy of a mass-bearing charge more than necessary. If we go back to James Maxwell's (1831-79) theory, charge, or as he stated, "a [fundamental] quantity of electricity", could be represented using three physical quantities and dimensions, as [9]

$$q = M^{0.5} L^{1.5} T^{-1} (M = \text{mass}, L = \text{length}, T = \text{time}) \quad (8)$$

This is in agreement with the physical quantities for charge in the Electrostatic System of Units (ESU) [10], and also as proposed in the work of Harold Aspden (1927-2011) [11]. If the mass to length transformation is applied to this definition of charge it can be seen that the property of charge is equivalent to a function of linear momentum that is treated as being massfree -

$$q = M^{0.5} L^{1.5} T^{-1} =\int= L^2 T^{-1} = p_e \quad (9)$$

- where p_e symbolizes charge, with massfree dimensionality, as an electric linear momentum vector function [11]. Charge is a special type of linear momentum function that can be expressed inertially or electromagnetically in mass dependent systems of units (as q or e, see below) or electrically in the meters and seconds massfree system of units as p_e [11]. As shown below in equations (15) and (17), this linear momentum charge function is inherent to the mass-energy of the electron and every massbound charge. The functional equivalences of charge in three different systems of units (ESUs, Coulombs, and meters squared per seconds) are

$$\text{"}q = 4.830 \times 10^{-10} \text{ ESU} =\int= e = 1.611 \times 10^{-19} \text{ C} =\int= p_e = 13.970 \text{ m}^2 \text{ s}^{-1}\text{" [12]} \quad (10)$$

In addition to being expressed in joules, per equation (4) above, the electron mass-energy can also be expressed as charge, represented by "e," multiplied by voltage, found to be equal to 510,998.950 electron volts (eV), per Codata 2018:

$$E = m_e c^2 = (e)(511\text{kV}) = h\upsilon_{ce} =\int= (p_e)(h / p_e)(\upsilon_{ce}) \quad (11)$$

The Duane-Hunt Law states that the maximum frequency of X-rays emitted from a tube, resulting from electrons that being accelerated by an applied voltage strike a metal anode, is proportional to the applied voltage and is quantized by Planck's quantum of action h, per the equation:

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$$\upsilon_{max} = Ve / h = K / h \quad (12)$$

where υ_{max} is the maximum frequency, V is the voltage applied to the tube, e is charge, and K is equal to the kinetic energy of the accelerated electron. Notice that if the terms are rearranged to solve for energy and if the maximum frequency happens to be the Compton electron frequency (υ_{ce}), then the kinetic energy would have the same magnitude as the mass-energy of the electron:

$$K = h\upsilon_{ce} = Ve = E = (e)(511kV) =\!\int\!= p_e\,(h / p_e)\,\upsilon_{ce} \quad (13)$$

In the meter and second system of units, the term (h/p_e) has the physical dimensionality of length which is expressed in meters and is a wavelength. Under the above condition, this wavelength may be determined for the electric equivalent of the electron mass-energy as the quantum of action h divided by the quantum of charge p_e; it is, therefore, a constant:

$$\lambda_x = h / p_e = (3.990 \times 10^{-9}\ m^3\ s^{-1}) / (13.970\ m^2\ s^{-1}) = 2.856 \times 10^{-10}\ m \quad (14)$$

Expanding the electron mass-energy equation to include both inertial and electric linear momentum functions results in

$$E = m_e c^2 = p_{Ae} c = h\upsilon_{ce} =\!\int\!= \lambda_e c^2 = p_e W_x = h\upsilon_{ce} \quad (15)$$

where p_{Ae} is the (photo)inertial linear momentum $m_e c$, p_e is the electric linear momentum, and W_x is the electric wavefunction corresponding to the intrinsic voltage (511kV) of the electron mass-energy. The function W_x is called "the voltage equivalent electric wave speed of the electron mass-energy" [13] and it can be directly expressed by its equivalent electromagnetic form as a function of the Compton frequency and the Duane-Hunt wavelength – thus, as a function of two constants:

$$511kV =\!\int\!= W_x = \lambda_x \upsilon_{ce} = (2.856 \times 10^{-10}\ m)\ (1.236 \times 10^{20}\ s^{-1}) = 3.529 \times 10^{10}\ m\ s^{-1} \quad (16)$$

This confirms that

$$E = 511keV =\!\int\!= \lambda_e c^2 = p_e W_x = 4.930 \times 10^{11} m^3\ s^{-2} = (13.970\ m^2\ s^{-1})\ (3.529 \times 10^{10}\ m\ s^{-1}) = 4.930 \times 10^{11}\ m^3\ s^{-2} \quad (17)$$

and it expands the electron mass-energy expression to include W_x and its constituents. It results in

$$E = m_e c^2 = p_{Ae} c = h\upsilon_{ce} =\!\int\!= \lambda_e c^2 = p_e W_x = \lambda_e W_k W_x = \lambda_e W_k\ (\lambda_x \upsilon_{ce}) \quad (18)$$

Note that the Compton electron frequency υ_{ce} of the electromagnetic equivalent of the electron mass-energy, $p_{Ae}c = h\upsilon_{ce}$, is shared with the actual electric structure of that mass-energy ($W_x = \lambda_x \upsilon_{ce}$) [14].

Equation (18) requires another wave speed function, namely W_k, which is the magnetic wave speed characteristic of the electron charge. As shown by that equation, there is a fundamental equivalence of $c^2 = W_k W_x$. The product of these two wavefunctions, W_k and W_x, represents a superimposition, where the two separate wavefunctions are superimposed nearly perpendicularly to one another. Since c and W_x are known, it is a simple matter to solve for W_k:

$$W_k = c^2 / W_x = (2.998 \times 10^8\ m\ s^{-1})^2 / (3.529 \times 10^{10}\ m\ s^{-1}) = 2.547 \times 10^6\ m\ s^{-1} \quad (19)$$

Besides being intrinsic to the electric equivalent of the electron mass-energy, the wave speed W_k is actually the magnetic wave speed "intrinsic to the elementary charge of the electron" [15]:

$$p_e = \lambda_e W_k \quad (20)$$

Rearranging the above terms permits the confirmation of the value of W_k. An interesting sidebar to the main purpose of this paper is an insight into the meaning of the charge to mass ratio. It can be seen below that this ratio results in a wave speed that is exactly equal to W_k, the magnetic wave speed intrinsic to charge [6, 15]:

$$W_k = p_e / \lambda_e = (13.970\ m^2\ s^{-1}) / (5.486 \times 10^{-6}\ m) = 2.547 \times 10^6\ m\ s^{-1} \quad (21)$$

This can be verified by performing the transformation process on the 2018 Codata value of the electron charge to mass ratio of 1.758 x 10^{11} C / kg, as follows. Rearranging a portion of equation 10 and substituting the Codata 2018 value for the electron charge "e" gives

$$p_e / e = (13.97\ m^2 s^{-1}) / (1.602 \times 10^{-19}\ C) = 8.72 \times 10^{19}\ m^2 s^{-1} C^{-1} \tag{21A}$$

and from equation (1)

$$1kg =\int= 1kg\ (10^3 gm / 1kg)(6.022 \times 10^{23} / mole)(10^{-2}\ m\ gm^{-1}) = 6.02 \times 10^{24}\ m \tag{21B}$$

then,

$$1.758 \times 10^{11}\ C\ m^{-1} =\int= [(1.758 \times 10^{11} C)\ (8.72 \times 10^{19}\ m^2 s^{-1} C^{-1})] / (6.02 \times 10^{24}\ m) = 2.546 \times 10^{6}\ m\ s^{-1} \tag{21C}$$

showing the enduring value of the process and confirmation of the value of the charge to mass ratio and thus of the magnetic wave speed intrinsic to charge, W_k, per equation 21.

Returning to the Electrostatic System of Units of charge as mentioned above in equation (9) and repeated here for reference,

$$q = M^{0.5} L^{1.5} T^{-1} =\int= L^2 T^{-1} = p_e \tag{9}$$

squaring both sides

$$q^2 = ML^3T^{-2} =\int= L^4T^{-2} = p_e^{\ 2} \tag{22}$$

and solving for M results in

$$M = q^2 / L^3T^{-2} =\int= p_e^{\ 2} / L^3T^{-2} = L \tag{23}$$

Whereas, as we have seen from equation 21, the electron mass is part not only of the mass-energy of the electron, but of its very charge structure ($p_e = \lambda_e W_k$), it can also be obtained from dimensional equation 22 (and the squared superimposition of charges) by invoking the proportionality of the fine structure constant, if the term (L^3T^{-2}) is made to equal the electron mass-energy

$$\lambda_e = (100\ \alpha^{-1})\ p_e^{\ 2} / E = (W_x / W_k)\ p_e^{\ 2} / E \tag{24}$$

But in the absence of such a proportionality invocation, what results is the very wavelength characteristic of the electron's magnetic wavefunction W_k:

$$\lambda_h = p_e^{\ 2} / E = (13.970\ m^2 s^{-1})^2 / (4.930 \times 10^{11}\ m^3 s^{-2}) = 3.958 \times 10^{-10}\ m \tag{25}$$

This immediately allows the determination of the magnetic wavefunction frequency [6] specifically characteristic of the electron:

$$\upsilon_k = W_k / \lambda_h = (2.547 \times 10^6\ m\ s^{-1}) / (3.958 \times 10^{-10}\ m) = 6.433 \times 10^{15}\ s^{-1} \tag{26}$$

This analytical methodology leads to a totally new and strictly electric expression of the electron mass-energy, where basic components and their functions define its fine structure:

$$E = m_e c^2 =\int= \lambda_e c^2 = p_e W_x = \lambda_e W_k W_x = \lambda_e\ (\lambda_h \upsilon_k)\ (\lambda_x \upsilon_{ce}) = (5.486 \times 10^{-6}\ m)\ [(3.958 \times 10^{-10}\ m)(6.433 \times 10^{15}\ s^{-1})]$$
$$\times [(2.856 \times 10^{-10}\ m)\ (1.236 \times 10^{20}\ s^{-1})] = 4.930 \times 10^{11}\ m^3 s^{-2} \tag{27}$$

Evidently, the wavefunctions W_k and W_x are not electromagnetic, since the W_x wave speed exceeds the speed of light [6]. In effect, it describes the wave speed of the flux in each of the rings of a torus, just as the magnetic wave speed describes the equatorial velocity of the rings with respect to the center of the torus. As such, the radii of the two circular wavelengths are calculated in the normal manner:

$$r = \lambda / 2\pi \tag{28}$$

$$r_h = \lambda_h / 2\pi = (3.958 \times 10^{-10}\ \text{m}) / 6.283 = 6.30 \times 10^{-11}\ \text{m} \tag{29}$$

$$r_x = \lambda_x / 2\pi = (2.856 \times 10^{-10}\ \text{m}) / 6.283 = 4.456 \times 10^{-11}\ \text{m} \tag{30}$$

resulting in the fine geometry of the electron mass-energy torus:

$$E = m_e c^2 = \int = \lambda_e c^2 = p_e W_x = \lambda_e W_k W_x = \lambda_e\ (2\pi r_h \upsilon_k)\ (2\pi r_x \upsilon_{ce}) \tag{31}$$

The structure of the electron mass-energy, broken down this way into its basic constituents, presents itself as a flux of electric energy shaped as a torus due to the superimposed wavefunctions W_k and W_x. When the geometric mean of the two wavefunction radii is calculated, the result is the Bohr radius which compares favorably with the CODATA 2018 value of 0.529×10^{-10} m:

$$(r_h r_x)^{0.5} = [(6.30 \times 10^{-11}\ \text{m})\ (4.456 \times 10^{-11}\ \text{m})]^{0.5} = 0.535 \times 10^{-10}\ \text{m} \tag{32}$$

The implication is that the Bohr radius is not really the radius of a spherical cavity, or of a quasi-spherical cloud where a point-mass may locate once the probability wave collapses, but merely the geometric mean of the two radii of the electron mass-energy torus. The latter has the "normal" volume given by [6]:

$$V = 2\pi^2 r_h r_x^2 \tag{33}$$

III. Conclusions

The proposed model is a much more satisfactory and rigorous description of the electron and explanation of the phenomenological nature of the Bohr radius. Rather than leading a nebulous existence as a supposed particle, wave, cloud, cavity, or “point particle in a cloud of probable locations”, it is best understood as a “precise toroidal volumetric flux structure” of electric energy resulting from two longitudinal waves being superimposed upon and trapped with each other, “that occupies the location of the entire ‘cloud’ [16].”

The torus model also rejoins the problematics of "the ring electron" originally proposed in 1915 by Alfred Parson [17], and taken up during 1917-1921 by others, in particular by Arthur Compton [18, 19] and H. Stanley Allen [20]. However, unlike the ring electron model, the model proposed by the Correas does not invoke for the electron a vortical ring structure, but rather that of a closed torus composed by a large number of continuous rings. The two models share many of the features that overcome the present-day conceptualization and treatment of the electron. Loss of energy by radiation of the closed-loop mass-energy is done away simply by assuming rotation of a ring-shaped charge, and the virtually impossible complications raised by independent orbitals required to explain diamagnetic atoms melt away, given that it is the electron mass-energy itself that has a diamagnetic moment [6]. Likewise, paramagnetism and X-ray diffraction patterns are explained by the tilting of the toroidal ring, confirming the contention of the above three physicists that the elementary magnet is not the atom, but the electron itself. The magnetic susceptibility of paramagnetic substances flows directly from the electron retaining its magnetic properties at low temperatures. Asymmetric scatter of X-radiation is explained by the striking of distinct loops of the torus. Runge's rule that abstrusely related variable magnetic effects to the ratio e/m [20] is replaced by the elegant and eloquent result of equations 21, 25 and 26:

$$W_k = \lambda_h \upsilon_k = p_e / \lambda_e = \int = e / m_e \tag{34}$$

Well beyond what the ring electron model could provide, the Correa model of the electron torus addresses other features still. In effect, the number of toroidal loops is directly obtained by the relation that accounts for both the composite nature of the mass of the electron and the proportionality role played by the reciprocal of the fine structure constant – whose actual value is thereby revised [21] – in the topogeometry of the electron:

$$\text{No. loops} = \lambda_e / \lambda_x = \alpha^{-2} = 19{,}205.9 = (138.5853745)^2 \tag{35}$$

The very fact that the number of loops is very nearly an integer may suggest that it is simply 19,206 or, instead, that the fractional value actually indicates a kink in the toroidal structure (the shorter loop), one that may have phenomenologically induced existing physics into believing that the electron is a point-mass engaged in orbital motion, since the kink will rotate with the magnetic wave speed of the torus. Communication from the Correas suggested they incline to the latter case, as if the torus contained a beat – in perfect agreement with Allen's notion of a pulse travelling around the ring-shaped electron as a "small hump" [20].

While the energy stored in the rotating torus is in a non-radiating form, absorption of kinetic energy by the torus will, under specific conditions (collision, field deceleration), originate radiating energy in the form of photons emitted 1:1 by the loops, such that Planck's radiation law stands explained by

$$K = \alpha^{-2} (h\upsilon_p) \tag{36}$$

where υ_p is the frequency of the emitted photons.

This suggests that the real measure of angular momentum is simply

$$h / 2\pi = p_e r_x \tag{37}$$

Further development of the toroidal model of the electron has led the Correas to analyze dynamic changes in the radial dimensions of the toroidal loops and the magnetic wave speed [6]. It permitted identification of the photoinertial (a.k.a. "spin state") configuration as a limiting one, where the angular momentum conforms to Compton's notion of a wavelength maximum, the Compton wavelength λ_{ce}:

$$h / 2\pi = p_{Ae} (\lambda_{ce} / 2\pi) = p_{Ae} r_o \tag{38}$$

where r_o is the radius of the wavelength of the wave speed of the flux in each of the rings of the electron torus while in the (photo)inertial configuration.

Such limit is reached when pair annihilation occurs. The same approach also permitted a full understanding of the anomalous gyromagnetic ratio and the Landé factor [6].

Unlike the present explanation for orbital jumps, the torus model of the electron indicates that elastic variation in its volumetric and winding features is not to be assimilated to the fine structure of added kinetic energy. Addition of extra energy does not accelerate the ring rotation – as the ring model held – since the magnetic wave speed of the torus is a conserved characteristic. It is only the loop flux that accelerates to a maximum fixed by the electron mass-energy itself. So-called orbital jumps, then, merely abide by equation 36, as successive kinetic energy states result in emission of resonant photon frequencies. Likewise, the Zeeman effect first observed in 1896 stems from the same resonant process being split by an applied magnetic field.

All the consequences of the Correa model of the electron torus cannot possibly be discussed in the scope of the present paper. They range widely, from a better understanding of thermoelectric effects and the quantum nature of the temperature scale, to a thorough revision of Louis de Broglie's (1892-1987) theory of matter/particle waves, a totally new treatment of the fine structure of nucleons and, most importantly, the discovery of *massfree* (ambipolar) electricity in induction devices, ambipolar plasmas and nuclear fusion. This complex dramatic breakthrough has been ignored for nearly two decades just as the work that started it all 75 years ago - Reich's mass to length transformation technique.

For those further interested in this earth-shaking science, in-depth learning can only be accomplished by reading the monographs, books and other publications generated by the Correas and their research associates (Dr. Gene Mallove, Dr. Malgosia Askanas, Dr. Harold Aspden, to name a few) at the Aurora Biophysics Research Institute. The Correas have provided various proof of concept machines based on their research – demonstrating the utility and correctness of the theories - some of which may be commercialized. Descriptions of these technologies can be found at www.aetherenergy.com. The monographs, meticulously describing the experiments, thought processes and conclusions can be found at www.aetherometry.com.

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