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From Classical to Relativistic Mechanics via Maxwell

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Abstract

It can be shown that Newton's non relativistic equations can be upgraded to full relativistic status by means of integrating the magnetic aspect of massive elementary particles derived from deBroglie's hypothesis on the internal structure of localized photons and from Paul Marmet's remarkable exploration of the relation between the magnetic aspect of electrons and the contribution of this magnetic aspect to the electron rest mass and relativistic mass, which he termed the "magnetic mass", which allows distinguishing the magnetic aspect of the electron rest mass from its velocity related relativistic mass increment.

The outcome is a complete relativistic equations set, one of which is the first to allow velocity calculation of all existing elementary particles, from photons at the speed of light, to velocity and relativistic mass of all massive particles going from total rest to asymptotically close to the velocity of light and related infinite mass.

This paper was published in 2013 in the *International Journal of Engineering Research and Development*:

Michaud, A. (2013) *From Classical to Relativistic Mechanics via Maxwell*, International Journal of Engineering Research and Development e-ISSN: 2278-067X, **p**-ISSN: 2278-800X. Volume 6, Issue 4 (March 2013), PP. 01-10.

http://ijerd.com/paper/vol6-issue4/A06040110.swf

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From Classical to Relativistic Mechanics via Maxwell

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Abstract:- It can be shown that Newton's non relativistic equations can be upgraded to full relativistic status by means of integrating the magnetic aspect of massive particles derived from de Broglie's hypothesis on the internal structure of localized photons and from Paul Marmet's remarkable exploration of the relation between the magnetic aspect of electrons and the contribution of this magnetic aspect to the electron rest mass and relativistic mass, which he termed the "magnetic mass". The outcome is a complete relativistic equations set, one of which is the first to allow velocity calculation of all existing particles, from photons at the speed of light, to velocity and relativistic mass of all massive particles going from total rest to asymptotically close to the velocity of light and related infinite mass.

Keywords:- Relativistic equations, classical equations, Marmet, Maxwell, magnetic mass

I. CONTRIBUTION OF THE MAGNETIC ASPECT OF AN ELECTRON TO ITS MASS

Physicist Paul Marmet made a remarkable discovery regarding the relation between the magnetic aspect of electrons and the contribution of this magnetic aspect to the electron rest and relativistic masses. In a paper that he published in 2003 **[2]**, Paul Marmet obtained the following definition of current by quantizing the electron charge in Biot-Savart's equation and doing away with the time element as he replaced dt by dx/v, since the velocity of current is constant at any given instant:

$$\mathrm{I} = \frac{\mathrm{dQ}}{\mathrm{dt}} = \frac{\mathrm{d(Ne)}}{\mathrm{dt}} = \frac{\mathrm{d(Ne)v}}{\mathrm{dx}} \tag{1}$$

Where "e" represents the unit charge of the electron and N represents the number of electrons in one Ampere.

> Note that although in his article **[2]**, Marmet exposes a personal hypothesis obviously subject to discussion, the first part, from Section 1 to Section 7, is a flawless mathematical demonstration whose implications are an enormous progress to further advance the understanding of the electromagnetic structure of elementary particles. The reader should also be aware that due to some transcription error in the published paper, the **B** field has the exact intensity related to the instantaneous velocity being considered, in view of the fact that only one charge is involved, which Marmet clearly explains by the way; his equation (7) should read:
>
> $$\mathbf{B}_{\mathrm{i}} = \frac{\mu_0 \, \mathrm{e}^{-} \, \mathrm{v}}{4 \pi \mathrm{r}^2}$$

Substituting the resulting value of "I" in the following scalar version of the Biot-Savart equation allows eliminating the time factor from this equation also:

$$\mathrm{d}\mathbf{B} = \frac{\mu_0 \mathrm{I}}{4\pi \mathrm{r}^2} \sin(\theta)\,\mathrm{dx} = \frac{\mu_0 \mathrm{v}}{4\pi \mathrm{r}^2} \sin(\theta)\ \mathrm{d(Ne)} \tag{2}$$

Without going into the detail of his derivation, which is very clearly laid out in his paper **[2]**, Equations (1) to (26)), let us only mention that the final stage of this development consists in spherically integrating the electron magnetic energy, whose density is mathematically deemed to vary radially from a minimum limit corresponding to r_e to a maximum limit located at infinity.

$$M = \left\{ \frac{\mu_0 e^2 v^2}{2(4\pi)^2 c^2 r^4} \right\} 2\pi \int_0^{\pi} \sin(\theta) d\theta \int_{r_e}^{\infty} r^{-2}\, dr \tag{3}$$

The electron classical radius r_e = 2.817940285E-15 m is the mandatory lower limit in such an integration to infinity, due to the simple fact that integrating any closer to r = 0 would accumulate more energy than experimental data warrants. After integrating, we finally obtain:

$$M = \frac{\mu_0 e^2 v^2}{8\pi r_e c^2} = \frac{m_e}{2}\frac{v^2}{c^2} \tag{4}$$

Which very precisely corresponds to the total mass of the magnetic field of an electron moving at velocity v. He discovered by the same token that **any instantaneous "magnetic mass" increase of an electron is a direct function of the square of its instantaneous velocity**, even though its charge remains unchanged.

When this velocity is small with respect to the speed of light, the following classical equation is obtained, allowing to clearly determine the contribution of the magnetic component to the rest mass of the electron, a contribution that corresponds in the present model, to a discrete LC oscillation of that energy between magnetostatic space and normal space, as clarified in a separate paper (**[1]**, Section 8):

$$\frac{\mu_0 e^2}{8\pi r_e}\frac{v^2}{c^2} = \frac{m_e}{2}\frac{v^2}{c^2} \tag{5}$$

Where "r_e" is the classical electron radius (2.817940285E-15 m), and "e" represents the charge of the electron (1.602176462E-19 C), from which can be concluded that the invariant magnetic field of the electron at rest corresponds to a mass of:

$$M_0 = \frac{m_0}{2} = \frac{\mu_0 e^2}{8\pi r_e} \tag{6}$$

Which is exactly half the rest mass of an electron, the other half of which being made up of what could be termed its "electric" mass **[1]**.

Paying attention to the difference between equations (4) and (6), we observe that $M - M_0$ represents the relativistic mass increment related to instantaneous velocity v. We note also that the translational energy required to propel the electron at this velocity is absent from the equation. Close analysis and calculation reveals however, that the amount of translational kinetic energy required to propel an electron with magnetic mass M at velocity v is exactly equal to the energy captive in the instantaneous relativistic mass increment $M - M_0$.

This means that the total amount of energy that must be communicated to an electron at rest for it to move at any velocity can be defined as an amount of translational kinetic energy plus an equal amount of kinetic energy that momentarily converts to the instantaneous relativistic mass increment related to that velocity:

$$E_{\text{total}} = E_{\text{translational}} + E_{\text{magnetic mass increment}} \tag{7}$$

Since energy in motion cannot be dissociated from electromagnetism, it can be surmised that an electric component is *de facto* involved in relation with the half of the energy making up the magnetic mass increment that in context clearly is “magnetic” in nature, and the only way it can be introduced in context, is for this magnetic energy to alternate between this magnetic state and an electric state at the frequency that can be associated to this amount of energy:

$$E_{\text{total}} = E_{\text{translational}} + \left[E_{\text{electric}}\cos^2(\omega t) + E_{\text{magnetic}}\sin^2(\omega t)\right] \tag{8}$$

This form in turn immediately suggests the following LC relation to represent the internal structure of the carrying energy of an electron in motion, including its half in electromagnetic oscillation that corresponds to its magnetic relativistic mass increment:

$$E = \frac{hc}{2\lambda} + \left[\frac{e^2}{2C_\lambda}\cos^2(\omega t) + \frac{L_\lambda\, i_\lambda^{\,2}}{2}\sin^2(\omega t)\right] \tag{9}$$

Where λ is the wavelength associated to this amount of electromagnetic energy in motion and where the following are the classical equations for calculating capacitance and inductance during a LC cycle:

$$E_{E(\max)} = \frac{q^2}{2C} \qquad\qquad E_{B(\max)} = \frac{L\, i^2}{2} \tag{10}$$

As strange as this may seem, Marmet's demonstration seems to imply that only the magnetic half of an electron's mass is involved in accelerating, and that the other half, corresponding in this model to the constantly unidirectional energy localized within electrostatic space, would then have no role to play during the acceleration of an electron! But of course, things are not so simple, and as we know, energy can be represented in a number of ways.

However, guided by Marmet's clean conclusion and the LC relations that were established for the photon and the electron in separate papers **[1]** and **[3]**, we will now explore how a moving electron's energy can be represented as a ratio of the unidirectional kinetic energy sustaining its motion (energy located within normal space in the 3-spaces model) and the invariant unidirectional kinetic energy which is part of its rest mass (energy located in electrostatic space), over a representation of the magnetic energy making up the corresponding velocity dependant total instantaneous relativistic magnetic mass of the particle (energy located in magnetostatic space).

We will thus obtain a ratio of all unidirectional energies over all magnetic energies that are involved in the electron in motion.

II. NEWTON'S NON-RELATIVISTIC KINETIC EQUATION

We will start our derivation from Newton's elementary kinetic equation

$$E_K = \frac{1}{2}mv^2 \text{ or, in context : } E_K = \frac{m}{2}\frac{v^2}{} = m_m v^2 \tag{11}$$

Where m/2 would be equal to m_m (Marmet's "magnetic mass"). Note that we could as well have proceeded by equating "$2E_K$"to "mv^2", but to keep the focus on Marmet's magnetic mass approach, we will rather divide the electron rest mass by two here.

III. THE MAGNETIC COMPONENT OF AN ELECTRON'S MASS

On the other hand, we established in a previous paper (**[1],** Section VIII, equation (26)) the LC equation for the electron at rest from that of the photon, the latter having been clarified in a separate paper [**3]**, which very clearly identifies the magnetic component of the electron's mass:

$$E = m_e c^2 = \left[\frac{hc}{2\lambda_C}\right]_Y + \left(2\left[\frac{(e')^2}{4C_C}\right]_X \cos^2(\omega t) + \left[\frac{L_C i_C{}^2}{2}\right]_Z \sin^2(\omega t)\right) \tag{12}$$

As equation (12) was being established (see paper **[1]**), it became clear that the unidirectional energy present in electrostatic space (Y-space) amounts to half the total energy making up the invariant rest mass of the electron, which leaves the amount of energy oscillating between magnetostatic space (Z-space) and normal space (X-space) to make up the other half of the electron invariant rest mass.

So let's reduce equation (12) to an inertial instantaneous form involving the energy present in electrostatic space and that which is at its maximum in magnetostatic space (thus at zero in normal space):

$$E = m_e c^2 = \left[\frac{hc}{2\lambda_C}\right]_Y + \left[\frac{L_C\ i_C{}^2}{2}\right]_Z \tag{13}$$

Where subscript ($_C$) refers of course to the electron Compton wavelength.

Although the magnetic field of the electron will be treated here as if it was mathematically static at maximum in magnetostatic space, to make more obvious the relation between the electron and its carrier-photon, the reader must keep in mind that its LC oscillation between magnetostatic and normal spaces nevertheless remains permanently active at the frequency of the electron rest mass energy [**1]**.

The same will of course be true of the magnetic field of the electron carrier-photon and that permanently LC oscillates between magnetostatic and electrostatic spaces at its own frequency [**3]**. This carrier-photon is actually the added energy that we will introduce a little further on (equation (18)) that propels the electron at the related velocity.

The consequence of the difference between the frequency of the energy of the electron rest mass and that of the energy of its carrier-photon (named "Zitterbewegung") is explored in (**[6]**, Sections 25.11.1 and 25.11.2).

IV. THE ELECTRON REST MAGNETIC MASS

Since mass can be calculated by dividing the energy making up this mass by the square of the speed of light:

$$m_e = \frac{E}{c^2} \qquad \text{(from } E=mc^2\text{)} \tag{14}$$

We can of course also calculate the rest magnetic mass of the electron by dividing the magnetic energy obtained in equation (13) by the square of the speed of light:

$$m_m = \frac{E}{2c^2} = \frac{L_C \ i_C{}^2}{2 \ c^2} \tag{15}$$

V. THE CLASSICAL ELECTRON KINETIC ENERGY AS A RATIO

Substituting now this form of the magnetic mass obtained with equation (15), in Newton's kinetic equation adapted to account for Marmet's magnetic mass (11), we obtain:

$$E_K = m_m v^2 = \frac{L_C \ i_C{}^2}{2 \ c^2} v^2 \tag{16}$$

Isolating the velocities ratio, we obtain the following form:

$$E_K = \frac{L_C \ i_C{}^2}{2} \frac{v^2}{c^2} \tag{17}$$

Which is a form identical to that defined by Marmet and that we posed as equation (5).

VI. RATIO OF THE UNIDIRECTIONAL KINETIC ENERGY OVER THE MAGNETIC ENERGY OF THE ELECTRON IN MOTION

We know also that the unidirectional kinetic energy that can be calculated with Newton's equation is not part of the energy making up the rest mass of the electron. Consequently, it is extra kinetic energy on top of the invariant rest mass energy of the electron. But, in this model, the only form of kinetic energy contributing to maintain a velocity in normal space has been defined in a recent paper as part of the discrete LC equation for the photon (**[3]**, Equation (16)), that is, the term $(hc/2\lambda)_X$ of the following equation:

$$E = \left(\frac{hc}{2\lambda}\right)_X + \left[2\left(\frac{e^2}{4C}\right)_Y \cos^2(\omega t) + \left(\frac{L \ i^2}{2}\right)_Z \sin^2(\omega t)\right] \tag{18}$$

that is, an equation that we will now reduce to its instantaneous version involving on one hand the unidirectional energy located in normal space, and on the other hand, that which is at its maximum in magnetostatic space (consequently at zero in electrostatic space), just like we did with LC equation (12) for the energy of the electron at rest.

$$E = \frac{hc}{2\lambda} + \frac{L \ i^2}{2} \tag{19}$$

Let us replace "E_K" in equation (17) with the expression for the unidirectional kinetic energy ($hc/2\lambda$) of a photon that equation (19) now provides:

$$\frac{hc}{2\lambda} = \frac{L_C \ i_C{}^2}{2} \frac{v^2}{c^2} \tag{20}$$

Let us now give equation (20) the form of a ratio of unidirectional kinetic energy over the electron magnetic energy that will be opposed to the ratio of squared velocities:

$$\frac{hc/2\lambda}{(L_C \ i_C{}^2/2)} = \frac{v^2}{c^2} \tag{21}$$

VII. RECTIFYING THE UNBALANCED ELECTROMAGNETIC VERSION OF NEWTON'S EQUATION

So we immediately observe that equation (21) comes out as an un-squared energy ratio in opposition to a squared ratio of the velocity of the particle over the speed of light, which appears mathematically untenable, but that could not possibly have come to Newton's attention since the knowledge that mass is equivalent to a particle's rest energy divided by the square of the speed of light was unknown in his time. But from the knowledge accumulated since Newton, we will now explore how this relation can be rectified to become mathematically correct.

Before we proceed however, we will confirm the identity of this mathematically unbalanced equation (21) with the initial Newtonian kinetic energy equation (11). We will use for that purpose an energy very well known in fundamental physics, which is the mean energy induced at the classical rest orbit of the Bohr atom. So, by means of the know parameters of the Bohr atom, let us first verify if we still obtain the same classical velocity of the electron with equation (21) that we obtain with equation (11).

Let us first calculate the various variables of the equation.

Product hc is of course the product of two fundamental constants, that is, the speed of light (c=299792.458 m/s) and Planck's constant (h=6.62606876E-34 J·s)

$$hc= 1.98644544 \text{ E-25 J·m} \tag{22}$$

We will of course use here the energy induced at the Bohr radius, which is 4.359743805 E-18 Joules, so the wavelength to be used turns out to be:

$$\lambda_B=hc/E=4.556335256 \text{ E-8 m} \tag{23}$$

See paper (**[3]**, Section 6.4, equation (12)) for calculation of the inductance (L) of an energy. We will use for thiscalculatioon the electron Compton wavelength, which is λ_C = 2.426310215 E-12 m, the fine structure constant (α = 7.297352533E-3) and the magnetic permeability constant of vacuum (μ_0 = 1.256637061E-6):

$$L_C = \frac{\mu_0 \alpha \lambda_C}{8\pi^2} = 2.817940285 \text{ E - 22 Henry} \tag{24}$$

See the same paper, **Equation (14)** for calculation of the current associated to that inductance for the electron, where "e" is the unit charge of the electron (1.602176462E-19 Coulomb)

$$i_C = \frac{2\pi e c}{\alpha \lambda_C} = 17045.08865 \text{ Amperes} \tag{25}$$

Even though the Coulomb equation reveals that the energy induced by the Coulomb force at the Bohr orbit is 4.359743805 E-18 j (27.2 eV), the energy level considered in classical mechanics to calculate the non-relativistic velocity of an electron on the Bohr orbit has traditionally been the ionization energy of the electron on that orbit, which corresponds to half the energy calculated with the Coulomb equation, that is E_K=2.179871902E-18 J (13.6 eV). So this will be this latter energy level that we will use to calculate the non-relativistic velocity of the electron by means of Newton's kinetic energy equation (11), as well as the rest mass of the electron, that is m_e=9.10938188E-31 kg.

Isolating the velocity in equations (21) and (11), we obtain

$$v = \frac{c}{i_C}\sqrt{\frac{H}{\lambda_B L_C}} = 2187691.252 \text{ m/s}, \qquad \text{et} \quad v = \sqrt{\frac{2E_K}{m_e}} = 2187691.252 \text{ m/s} \tag{26}$$

Which is very precisely the classical velocity of the electron on the Bohr orbit, that we have now calculated with an electromagnetic version of Newton's classical kinetic energy equation (21), as well as with his classical equation (11).

Considering again equation (21) let us analyze the implications.

We observe that despite having used the absolute wavelength (λ_B) of an energy of 4.359743805 E-18 Joules, which is the unreleasable kinetic energy permanently induced by the Coulomb force at the Bohr orbit, this energy allows obtaining the exact classical velocity of the electron with equation (26) stemming from equation (21), despite the fact that the classical kinetic equation (11), and also the converted kinetic equation derived from electromagnetism (20) use only half that energy to calculate the classical velocity, which turns out to be the unidirectional portion of the energy induced at the Bohr orbit, that is 13.6 eV:

$$E = \frac{hc}{2\lambda_B} = \frac{mv^2}{2} = 2.179871902 \text{ E} - 18 \text{ Joules} \tag{27}$$

Before proceeding further let us recall that in the ratio of equation (21), repeated here for convenience, the unidirectional kinetic energy ($hc/2\lambda$) is clearly separated from the magnetic energy ($L_C i_C^2/2$):

$$\frac{hc/2\lambda}{(L_C\ i_C{}^2/2)} = \frac{v^2}{c^2} \tag{21}$$

We observe immediately that in this equation, the magnetic energy ($L_C i_C{}^2/2$) of the electron remains constant by definition since it is opposed the constant squared velocity of light "c", itself being constant, while its carrying energy (hc/2λ) seems to be variable in relation to the square of its velocity "v", which is variable. But, we know from equation (18) for the energy of a photon that as its kinetic energy (hc/2λ) varies, its magnetic energy ($Li^2/2$) will vary in equal proportion!

It must be realized that in Newton's time, experimentally verifiable velocities were so low with respect to the minimal velocities that would have revealed the slightest increase in relativistic mass, that it was impossible for Newton to even suspect such a possibility. Moreover, electric charges and electrostatic induction were still totally unknown.

Now let us hypothesize that the calculated unidirectional kinetic energy (hc/2λ) in Newton's kinetic equation would be part of some sort of "carrier-photon" that would be associated to the electron and that the measured velocity would be due to the fact that this carrier-photon could not move faster on account of the handicap of having to carry the inert electron mass on top of its own inert electromagnetic component ($Li^2/2$). Assuming that such a carrier-photon would display the same LC electromagnetic oscillation that characterizes "normal" electromagnetic photons in the 3-spaces model, and that consequently it could also be described by the same LC equation [8], we can pose the following equation to describe this carrier-photon:

$$E = \frac{hc}{2\lambda} + \left[2\left(\frac{e^2}{4C_\lambda}\right)\cos^2(\omega t) + \frac{L_\lambda\ i_\lambda{}^2}{2}\sin^2(\omega t) \right] \tag{28}$$

and its inertial form

$$E_\lambda = \frac{hc}{2\lambda} + \frac{L_\lambda\ i_\lambda{}^2}{2} \tag{29}$$

We can thus isolate the "magnetic" component of this carrier-photon as we did for the electron (Equation (15)), complementary to the unidirectional kinetic energy corresponding to the velocity calculated with equation (26), and make the hypothesis that if we were to add this "magnetic energy" postulated for the carrier-photon to that of the electron in equation (21), we could possibly become more conform to Marmet's conclusion. So let's add this assumed missing half of the carrier-photon's energy, that is the part ($L_\lambda i_\lambda{}^2/2$) of equation (29), to equation (21), which gives

$$\frac{hc/2\lambda}{(L_C\ i_C{}^2/2) + (L_\lambda\ i_\lambda{}^2/2)} = \frac{v^2}{c^2} \tag{30}$$

We can now observe that the magnetic mass of the electron will henceforth increase with the velocity, although we still have an un-squared energy ratio opposing a squared velocity ratio.

We now have the complete energy of the carrier-photon included in our equation. Now, considering again equation (13) with respect to equation (30), we observe that the "internal" unidirectional kinetic energy (electrostatic) <u>of the electron rest mass</u> present in equation (13), that is ($hc/2\lambda_C$), is not represented in equation (30) but certainly needs to be included since it makes up half the rest mass of the electron. So let us include it in our equation in a manner that will not change the current relation, that is, by adding it to, and subtracting it from, the unidirectional energy of the carrier photon:

$$\frac{hc/2\lambda + hc/2\lambda_C - hc/2\lambda_C}{(L_C\ i_C{}^2/2) + (L_\lambda\ i_\lambda{}^2/2)} = \frac{v^2}{c^2} \tag{31}$$

This self-cancelling insertion may seem at first glance totally useless, but let us consider that the squared velocity ratio on the other side of the equal sign reveals that a quadratic relation has to be involved on the energy side, and this indicates that this apparently self-canceling half of the electron energy statically captive in electrostatic space **[1]** must play a role in determining the actual velocity due to its inertia.

We can now simplify the extraneous divisions by 2 and since experimental evidence first brought to light by Kaufmann **[7]** shows that the complete mass of an electron is involved in transverse interaction, so we will double the value of the energy of the representation of its magnetic component ($L_C i_C^2$) to take that fact into account energy wise, and act similarly on its kinetic component (hc/λ_C) to maintain equilibrium.

$$\frac{hc/\lambda + 2hc/\lambda_C - 2hc/\lambda_C}{(2L_C\ i_C^{\ 2}) + (L_\lambda\ i_\lambda^{\ 2})} = \frac{v^2}{c^2} \tag{32}$$

Finally, Marmet's final mathematically demonstrated conclusion (his equation 23) was that "***the magnetic energy around individual electrons increases as the square of the electron velocity, just as the increase in relativistic mass***". In clear, this means that the increase in magnetic mass must also be squared. So, as a final touch, let us square the kinetic to magnetic energy ratio to finally come into harmony with the corresponding already squared velocities ratio.

$$\frac{\left(hc/\lambda + 2hc/\lambda_C\right)^2 - \left(2hc/\lambda_C\right)^2}{\left((2L_C\ i_C^{\ 2}) + (L_\lambda\ i_\lambda^{\ 2})\right)^2} = \frac{v^2}{c^2} \tag{33}$$

VIII. GENERAL RELATIVISTIC VELOCITIES EQUATION FROM CARRYING ENERGY

Resolving the kinetic energy quadratic and simplifying the kinetic energy representation will now give equation

$$\frac{(hc)^2\left(4\lambda + \lambda_C\right)}{\lambda_C\lambda^2\left((2L_C\ i_C^{\ 2}) + (L_\lambda i_\lambda^{\ 2})\right)^2} = \frac{v^2}{c^2} \tag{34}$$

A few test runs with any value of λ will show that **this equation traces a relativistic velocities curve identical to that of the famous Special Relativity equation**. Let us verify this conclusion for the well known energy of the Bohr rest orbit to clearly establish the procedure. First, we need the values of the L and i variables for the magnetic inductance of the carrier-photon energy whose wavelength (λ_B= 4.556335256 E-8 m) we determined at equation (23).

$$L_\lambda = \frac{\mu_0\alpha\lambda_\lambda}{8\pi^2} = 5.291772086 \text{ E} - 18 \text{ Henry} \tag{35}$$

and

$$i_\lambda = \frac{2\pi\, ec}{\lambda_\lambda\alpha} = 0.90767404\ 9 \text{ Ampere} \tag{36}$$

Having already calculated the inductance values for the electron magnetic energy (L_C and i_C) at equations (24) and (25) from the Compton wavelength (λ_C=2.426310215 E-12 m), we are now ready to proceed.

Isolating the velocity in equation (34), we now obtain

$$v = hc^2\sqrt{\frac{4\lambda + \lambda_C}{\lambda_C\lambda^2(2L_C i_C^{\ 2} + L_\lambda i_\lambda^{\ 2})^2}} = 2{,}187{,}647.\ 561 \text{ m/s} \tag{37}$$

which is the exact relativistic velocity associated to the Bohr rest orbit energy.

Equation (37) is rather complex however. But it can be hugely simplified if we replace the inductance variables with their definitions (Equations (24), (25), (35) and (36)) and give it the generic form required for graphing the relativistic velocities curve for the electron, we finally obtain:

$$f(x) = c\frac{\sqrt{4ax + x^2}}{2a + x} \tag{38}$$

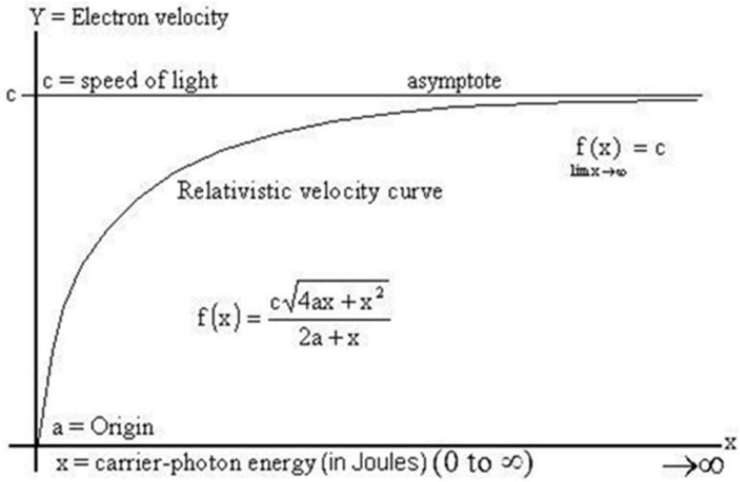

Fig.1: Relativistic velocity curve from varying carrying energy

In relation with equation (38), that can also be written:

$$v = c\frac{\sqrt{4EK + K^2}}{2E + K} \tag{39}$$

where E is the rest mass energy of the particle being considered ($E=m_oc^2$) and K is the kinetic energy that must be added to allow relativistic velocity v. There also is need to calculate the corresponding relativistic mass. This can of course be achieved by using the traditional Lorentz factor:

$$m_r = \frac{m_0 c}{\sqrt{c^2 - v^2}} \tag{40}$$

But this method requires that the particle's velocity be known in advance, which is not the case in the present 3-spaces model as we will see.

Equation (39) is particularly important considering that it also allows calculating the ***electron g factor*** from first principles (because equation (39) is drawn from the LC equation for the electron, which is itself in complete agreement with Maxwell's equations), in opposition to the current arbitrary value of the electron g factor, which is an entirelz *ad hoc* value (See separate paper [**5]**.

IX. RELATIVISTIC MASS FROM CARRYING ENERGY

This model also allows determining a particle's velocity directly from the kinetic energy that we wish to add to propel its rest mass:

$$m_r = m_0 + \frac{K}{2c^2} \tag{41}$$

Verification will show that both equations (40) and (41) provide exactly the same relativistic mass as the Special Relatvity equation, but in a much simpler manner with equation (41):

$$m_r = \frac{m_0 c}{\sqrt{c^2 - v^2}} = m_0 + \frac{K}{2c^2} \tag{42}$$

So from equation (42) we can now directly calculate the associated kinetic energy even if we know only the relativistic velocity of a particle

$$K = 2m_0c^2\left(\frac{c}{\sqrt{c^2 - v^2}} - 1\right) \quad \text{that is} \quad K = 2m_0c^2(\gamma - 1) \tag{43}$$

Alternately, from equation (41), kinetic energy K can be obtained from any known relativistic mass if we know also the particle's rest mass:

$$K = 2c^2(m_r - m_0) \tag{44}$$

So we have at our disposal four new equations, (39), (41), (43) and (44) that allow separately calculating the three variables that determine all possible states of free motion for massive particles.

Consequently, they could logically be seen as belonging to a relativistic version of Newtonian mechanics, which in this model amounts to a subset of the electromagnetic mechanics of particles, that was established by expanding the space geometry in such a manner that the solution to de Broglie's hypothesis on the permanently localized electromagnetic photon becomes compliant with Maxwell's equations **[8]**.

Note that the standard SR equation for relativistic kinetic energy is $K = m_0 c^2 (\gamma - 1)$.

However, this equation provides only the unidirectional kinetic energy required to cause the related relativistic mass to move at velocity v, <u>but does not provide the added kinetic energy from the carrier-photon that momentarily converts to the related added relativistic mass increment</u>, contrary to equation (43) of the present model.

Shouldn’t it be normal for a relativistic kinetic energy equation to provide all of the kinetic energy that must be added for a particle at rest (m_0) to move at velocity "v", since it should include, not only the unidirectional energy that sustain the velocity of the increased mass, but also the extra kinetic energy that converts to its relativistic mass increment? This is precisely why equation (43) doubles the kinetic energy provided by the standard relativistic kinetic energy equation, so that all of the extra kinetic energy required for the rest mass to reach relativistic velocity "v" is represented. In fact, we now have the proof that the standard Special Relativity equation for kinetic energy should be formulated as $K = 2m_0 c^2 (\gamma - 1)$.

X. RELATIVISTIC EQUATION VALID FOR PHOTONS AND MASSIVE PARTICLES

But let's now go back to equation (38), and see what happens when we reduce the energy provided by the carrier-photon to zero (by setting x to zero):

$$f(x) = c\frac{\sqrt{4ax + x^2}}{2a + x} = c\frac{\sqrt{0 + 0^2}}{2a + 0} = c\frac{0}{2a} = 0 \tag{45}$$

We observe that velocity ($f_{(x)} = v$) will fall to zero, which is exactly what happens when no energy is provided to an electron in excess of its rest mass energy. Considering again equation (38), let's see what happens when we reduce the rest mass energy of the electron to zero (setting **"a"** to zero):

$$f(x) = c\frac{\sqrt{4ax + x^2}}{2a + x} = c\frac{\sqrt{0 + x^2}}{0 + x} = c\frac{\sqrt{x^2}}{x} = c\frac{x}{x} = c \tag{46}$$

In this case, we observe that we are left with only the energy of the carrier-photon, that is the ratio of the unidirectional half of the photon's energy ($hc/2\lambda$) over its magnetic half ($L_\lambda i_\lambda^2/2$), and that the formula reduces to:

$$\frac{x}{x} = \frac{(hc/2\lambda)}{((L_\lambda\ i_\lambda^2/2))} = \frac{v}{c} \tag{47}$$

Verification with any value of λ will show that velocity (v) will now systematically be equal to (c), the speed of light

$$v = c\frac{(hc/2\lambda)}{((L_\lambda\ i_\lambda^2/2))} = 299{,}792{,}45\ 8\,\text{m/s} \tag{48}$$

thus proving that ***the carrying-energy which is in excess of the rest mass energy of an electron definitely accumulate by structuring itself in the same manner as that of a free-moving electromagnetic photon* [8]*, and is in fact an electromagnetic photon,*** whose velocity turns out to be slowed down only due to the fact that it has to carry, so to speak, the inert energy of the electron rest mass on addition of its own inert electromagnetic mass . If we now give again to equation (47) the general form of Newton's kinetic equation (modeled after equations (16) and (17)):

$$\frac{hc}{2\lambda} = \frac{L\ i^2}{2}\frac{c^2}{c^2} = \frac{L\ i^2}{2c^2}c^2 \qquad \text{that is} \qquad \boxed{E = m_m c^2} \tag{49}$$

we thus prove by similarity that ***the energy of a photon moving at the speed of light can truly be represented as a magnetic mass (actually a localized LC oscillating quantum of electromagnetic energy) corresponding to half its energy, that would be propelled at the speed of light by the other half of its energy***, which would remain in translational motion, that is, in unidirectional motion, in conformity with the internal electromagnetic LC structure which is imposed on the photon in the 3-spaces model **[8]**.

Haven't we just linked up Newton's mechanics with Maxwell's electromagnetic theory in a rather convincing manner? We now have a very special equation at our disposal (38) that reduces to 2 more very special forms, that is (45) and (47) that together cover the whole spectrum of all existing scatterable electromagnetic particles' velocities. The equation (45) shows an electron at rest, while equation (38) represents an electron moving at any possible relativistic velocity, and finally, equation (47) represents a photon of any energy always moving at the speed of light "c".

XI. GENERAL RELATIVISTIC VELOCITIES EQUATION FROM WAVELENGTH

The reader may have noticed that when we resolved the kinetic energy quadratic and simplified equation (33) to obtain equation (34), that this quadratic resolved to only two wavelength besides the transverse acceleration constant, which is the product of constants "h" and "c", sometimes symbolized as "H" in 3-spaces model dependant papers **[9]**. Let's now convert the magnetic representations to the same form, resolve the second quadratic and simplify. From equation (34), we have

$$\frac{(hc)^2(4\lambda+\lambda_C)}{4\lambda_C\lambda^2(hc/\lambda_C+hc/2\lambda)^2}=\frac{v^2}{c^2}\quad \text{that is}\quad \frac{(hc)^2(4\lambda+\lambda_C)}{4\lambda_C\lambda^2(hc)^2\left(\dfrac{4\lambda^2+4\lambda\lambda_C+\lambda_C{}^2}{4\lambda^2\lambda_C{}^2}\right)}=\frac{v^2}{c^2} \tag{50}$$

and simplifying, we finally get a very interesting relativistic velocities equation that requires only the wavelengths of the carrying energy and that of the electron:

$$\frac{4\lambda\lambda_C+\lambda_C{}^2}{(2\lambda+\lambda_C)^2}=\frac{v^2}{c^2} \tag{51}$$

If we now give equation (51) the generic form required to trace the relativistic velocities curve for the electron, we obtain

$$f(x)=c\frac{\sqrt{4ax+a^2}}{2x+a} \tag{52}$$

Let us compare equation (52) which is function of the carrier-photon wavelength to equation (38) which is function of the carrier-photon energy. We observe the identity of structure of both equations even though they are function of inversely related variables, an identity that let both equations calculate exactly the same relativistic velocities curve for the electron.

In addition to equation (39), equation (51) can also serve to calculate the **electron g factor**. (See paper [**5**]. But contrary to equation (39), which can be derived only from the 3-spaces model, equation (51) can also be derived from the Special Relativity Theory.

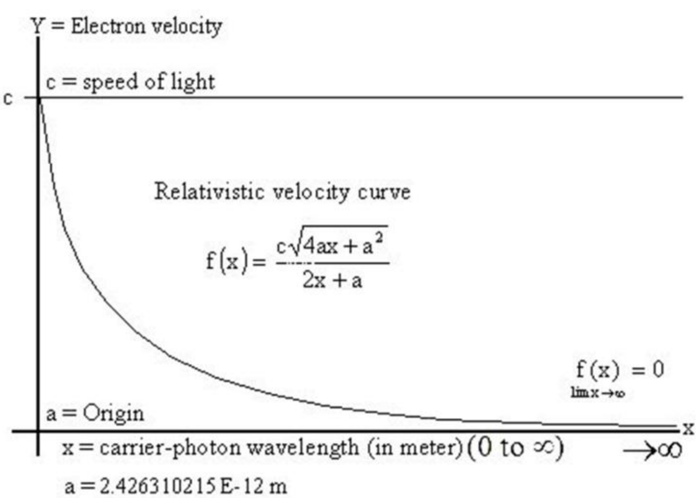

Fig.2: Relativistic velocity curve from carrying energy wavelength

A comparison of the graphs of Figure 1 and Figure 2 visually confirms the inverse relation.

XII. DERIVING THE SPECIAL RELATIVITY RELATIVISTIC MASS EQUATION AND THE LORENTZ FACTOR FROM A 3-SPACES MODEL EQUATION

We will now derive the famous Special Relativity relativistic equation ($E=\gamma m_0c^2$) from equation (51). But we must first isolate the 4 variables in this equation:

$$v = c\sqrt{\frac{4\lambda\lambda_C + \lambda_C{}^2}{(2\lambda+\lambda_C)^2}} = c\sqrt{\frac{\left(4\lambda^2 + 4\lambda\lambda_C + \lambda_C{}^2\right) - 4\lambda^2}{(2\lambda+\lambda_C)^2}} = c\sqrt{\frac{(2\lambda+\lambda_C)^2 - 4\lambda^2}{(2\lambda+\lambda_C)^2}} \tag{53}$$

$$v = c\sqrt{1 - \frac{4\lambda^2}{(2\lambda+\lambda_C)^2}} = c\sqrt{1 - \left(\frac{2\lambda}{2\lambda+\lambda_C}\right)^2} = c\sqrt{1 - \frac{1}{\left(\frac{2\lambda+\lambda_C}{2\lambda}\right)^2}} \tag{54}$$

and finally

$$v = c\sqrt{1 - \frac{1}{\left(1 + \frac{\lambda_C}{2\lambda}\right)^2}} \tag{55}$$

Now, from the definition of energy derived from the work of Marmet **[2]**, we can pose:

$$E = hf = \frac{e^2}{2\varepsilon_0\alpha\lambda} \tag{56}$$

Which means that the energy in excess of the rest mass of the particle in motion can be represented by:

$$E = \frac{e^2}{2\varepsilon_0\alpha\lambda} = \frac{e^2}{2\varepsilon_0\alpha}\frac{1}{\lambda} \tag{57}$$

And that the energy contained in the rest mass of an electron can be represented by

$$m_0c^2 = \frac{e^2}{2\varepsilon_0\alpha\lambda_C} = \frac{e^2}{2\varepsilon_0\alpha}\frac{1}{\lambda_C} \tag{58}$$

We can easily observe that all terms of both equations are constants, except for the wavelengths. What is of interest to us here is that the sets of constants in both equations (57) and (58) are identical. This means that we can multiply and divide the wavelengths terms of equation (55) by mutually reducible occurrences of that constants set without changing the value of the equation. So, let's proceed from equation (55):

$$v = c\sqrt{1 - \frac{1}{\left(1 + \frac{\lambda_C}{2\lambda}\right)^2}} = c\sqrt{1 - \frac{1}{\left(1 + \frac{2\varepsilon_0\alpha\lambda_C}{e^2}\frac{e^2}{4\varepsilon_0\alpha\lambda}\right)^2}} \tag{59}$$

Substituting now the equivalent left members of equations (57) and (58) in equation (59), we obtain:

$$v = c\sqrt{1 - \frac{1}{\left(1 + \frac{1}{m_0c^2}\frac{E}{2}\right)^2}} \tag{60}$$

We have seen previously that only half of the energy in excess of the rest mass energy of a particle in motion contributes to the relativistic increase in mass of that particle, so let's reformulate equation (60) according to this fact

$$v = c\sqrt{1-\frac{1}{\left(1+\frac{E/2}{m_0c^2}\right)^2}} = c\sqrt{1-\frac{1}{\left(\frac{m_0c^2+E/2}{m_0c^2}\right)^2}} \tag{61}$$

The final step of simplification now reveals that the velocity of the particle can be calculated from a squared ratio of the rest mass energy over the relativistic mass energy:

$$v = c\sqrt{1-\left(\frac{m_0c^2}{m_0c^2+E/2}\right)^2} = c\sqrt{1-\left(\frac{m_0c^2}{mc^2}\right)^2} \tag{62}$$

But we know that mc^2 corresponds to the total energy of the current instantaneous relativistic mass of the particle, which means that $mc^2 = E$. Substituting in equation (62), we obtain

$$v = c\sqrt{1-\left(\frac{m_0c^2}{E}\right)^2} \tag{63}$$

Squaring and rearranging equation (63)

$$\frac{v^2}{c^2} = 1-\left(\frac{m_0c^2}{E}\right)^2 \quad \text{and} \quad \left(\frac{m_0c^2}{E}\right)^2 = 1-\frac{v^2}{c^2} \tag{64}$$

Extracting the square root, we finally obtain

$$\frac{m_0c^2}{E} = \sqrt{1-\frac{v^2}{c^2}} \quad \text{and} \quad \frac{m_0c^2}{\sqrt{1-\frac{v^2}{c^2}}} = E \tag{65}$$

Which resolves to $\gamma m_0c^2 = E$, since we can now identify in equation (65) the Lorentz factor:

$$\gamma = \frac{1}{\sqrt{1-\frac{v^2}{c^2}}} \tag{66}$$

And we finally obtain the well known Special Relativity equation, which is now derived from the newly established relativistic equation (51), which was strictly drawn from electromagnetism:

$$E = \gamma m_0c^2 \tag{67}$$

An article published separately **[4]** already described how to retro-derive equation (51) from traditional equation (67) from Special Relativity, which means that we can henceforth seamlessly link up SR with Maxwell by means of the discrete LC equations set of the 3-spaces model **[9]** as defined in two separate papers **[1]** and **[3]**.

XIII. CONCLUSION

As demonstrated, the 3-Spaces model reveals four new equations, (equations (39), (41), (43) and (44) in **Section IX**) that allow separately calculating the three variables that determine all possible states of free motion for massive particles.

Furthermore, **Section X** reveals a very special equation (38) that reduces to 2 more very special forms, that is (45) and (47) that together cover the whole spectrum of all existing electromagnetic particles' velocities. Representation (45) of the equation shows an electron at rest, while representation (38) represents an electron moving at any possible relativistic velocity, while finally representation (47) represents a photon of any energy always moving at c.

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