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The Expanded Maxwellian Space Geometry and the Photon Fundamental LC Equation

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Abstract:- Description of a new space geometry that allows explaining the existence of all stable physically scatterable particles solely from Maxwell's electromagnetic theory. This expanded space geometry leads to an electromagnetic mechanics of particles involving a seamless series of clearly defined interaction sequences providing an uninterrupted path of causality from 1) the unquantized quantities of unidirectional kinetic energy induced in particles by natural acceleration through Coulomb or gravitational interaction, 2) to the quantization in the form of free-moving electromagnetic photons of any quantity of this energy in excess of the quantity allowed by the local stable or metastable electromagnetic equilibrium, 3) to the creation of electron-positron pairs from the destabilization of photons of energy 1.022 MeV or more, 4) to the creation of protons and neutrons from the interaction of electrons and positrons forced into groups of three including both types in sufficiently small volumes of space with insufficient energy to escape mutual capture, 5) to the final shedding in the form of neutrino energy of momentary metastable excess rest mass (different from velocity induced extra momentary relativistic mass) as newly created overexcited massive elementary particles are forced by local electromagnetic equilibrium into lowering their mass to their lower and stable true rest mass.

Keywords:- Maxwell theory, Maxwell equations, electromagnetic theory, scatterable particles, kinetic energy, causality, acceleration, electron-positron pairs, 1.022 MeV, neutrino, photon LC equation, 3-spaces.

I. THE NEGLECTED CLASSICAL MAXWELLIAN SPACE GEOMETRY

Maxwell's theory has traditionally been considered strictly from the mathematical viewpoint offered by his famous equations and understood within the restrictive perspective of plane wave treatment, which resulted in the space geometry that mandatorily must underlie it to generally remain obscured.

Table I: Maxwell Equations

Maxwell Equations		
	Integral Form	**Differential Form**
1	$\oint \mathbf{E}\cdot d\mathbf{S} = {}^{q}/_{\varepsilon_0} = \Phi_E$	$\nabla\cdot\mathbf{E} = \rho/\varepsilon_0$
2	$\oint \mathbf{E}\cdot d\mathbf{l} = -d(\int \mathbf{B}\cdot\hat{n}\,dS)/dt = -d\Phi_B/dt$	$\nabla\times\mathbf{E} = -\partial\mathbf{B}/\partial t$
3	$\oint \mathbf{B}\cdot d\mathbf{S} = 0$	$\nabla\cdot\mathbf{B} = 0$
4	$\oint \mathbf{B}\cdot d\mathbf{l} = \mu_o(i + \varepsilon_o d(\Phi_E)/dt)$	$\nabla\times\mathbf{B} = \mu_o\left(\mathbf{J} + \frac{\varepsilon_o\partial\mathbf{E}}{\partial t}\right)$

This classical Maxwellian space geometry is of course the traditional Euclidian 3-dimensional flat space geometry to which the time dimension is added to justify motion.

A fundamental aspect of his theory is his conclusion regarding the state of orthogonality between the electric and magnetic fields of free moving electromagnetic energy, both normal to the phase velocity vector that identifies the direction of motion of any point considered on the wave front. Experimental reality reveals that this also directly applies to charged particles moving in straight line.

Indeed, any elementary textbook on electricity and electromagnetism explains how the vectorial cross product of an electric force and a magnetic force being applied to a charged particle will generate a velocity vector in straight line forcing the particle to move in a direction perpendicular to both applied forces, which is represented in classical electrodynamics from the Lorentz equation, by this well known relation

$$v = \frac{\mathbf{E}}{\mathbf{B}}$$

or rather, in the present context, under the form of a vectorial cross product

$$\mathbf{E}\hat{\mathbf{j}}\times\left(\frac{-1}{\mathbf{B}}\right)\hat{\mathbf{k}} = \mathbf{E}\left(\frac{-1}{\mathbf{B}}\right)\cos\theta\hat{\mathbf{i}},$$

and since θ must be equal to 90o by definition in the present case:

$$\mathbf{E}\hat{\mathbf{j}}\times\left(\frac{-1}{\mathbf{B}}\right)\hat{\mathbf{k}} = v\hat{\mathbf{i}}$$

The following orthogonal basis will be used in this paper: **a)** 3-D rectangular coordinate system, and corresponding rectangular vectorial base and **b)** the corresponding rectangular electromagnetic fields vs velocity vector base

Fig.1: Orthogonal bases used in this document.

It must be clearly understood also that despite the precision of the calculations that Maxwell's theory allows at the general level, his theory is deemed unable to directly describe photons as discrete localized moving electromagnetic particles since it is grounded on the notion that electromagnetic energy is a continuous wave phenomenon.

Maxwell's theory, as a matter of fact, was designed to account for electromagnetic energy behavior at the macroscopic level without the need to take quantization into account (which had not been clarified in Maxwell's time), that is, by treating electromagnetic energy as a general energy density per unit volume or general energy flow per unit surface rather than by adding the energy of localized moving electromagnetic particles (photons) enclosed in a unit volume or flowing through a unit surface, that could account just as well for observed phenomena at the macroscopic level.

II. THE NEED FOR A NEW SPACE GEOMETRY

This leads to attempting to clarify why an acceptable description of electromagnetic photons as permanently localized moving particles cannot be reconciled with the verified aspects of Maxwell's theory since Planck hypothesized them more than a century ago as he analyzed Wien's experimental data; a hypothesis that was then experimentally confirmed by Einstein (his Nobel winning photoelectric proof), and then generally described by Louis de Broglie ([4]),

According to Maxwell's theory, the electric and magnetic aspects of a wave must of necessity always be in phase (Fig.2) at the wavefront, that is, at maximum at the same moment for the wave to exist at all and propagate.

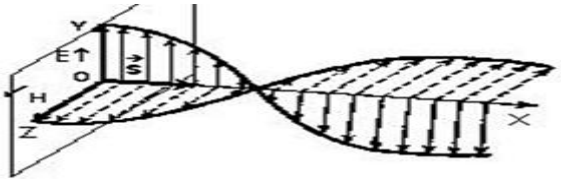

Fig.2: Electric and magnetic fields in phase or 180o out of phase in classical electromagnetism.

When both aspects are 90o out of phase, we obtain a standing wave (Fig.3). But as an intriguing dead end, when both aspects are set 180o out of phase, we end up with the exact equivalent of both aspects being in phase (Fig.2)!

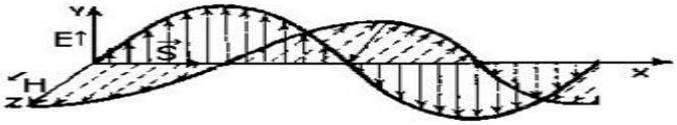

Fig.3: Electric and magnetic field 90o out of phase in classical electromagnetism.

Also, it is the conjunction of both fields, in phase and at right angle with each other at all points of the wavefront that is deemed to maintain the intensity of the energy of the wave at every points of the wavefront, despite the inherent spherical spread involved from the mandatorily point-like origin of such a wave. This issue is of course familiar to all in the physics community but is accepted as being a yet unexplained and unavoidable axiom.

Mathematically speaking, when any local point of the curved spherical wavefront surface is considered, this surface can be locally approximated to a plane surface at the infinitesimal level and this is the origin of the "plane wave" equations set.

But space being three-dimensional, treatment with the plane wave analogy can of course only be a mathematical approximation, an approximation that easily obscures the fact that physically, if such an electromagnetic wave really existed as such, it could only be in spherical expansion in vacuum from its point of origin, assuming unbounded isotropic expansion in deep space. So Maxwell's equations currently describe the electromagnetic interaction only once such a wave would already be in full swing after it would have begun to propagate.

But if electromagnetic waves such as Maxwell imagined really existed, the geometry of their propagation would of necessity be much more similar to the spherical expansion of sound waves in the air than to the propagation of waves on a plane liquid surface, and it then becomes very difficult to logically accept the idea that the initial intensity at the point source of the wave could be arbitrarily multiplied in such a way that it could be measured as equal to the energy of the source at any point of the spherical wavefront at any arbitrary distance from the source as plane wave treatment seems to indicate.

III. APPLYING EM PROPERTIES TO MAXWELL'S WAVE POINT-LIKE SOURCE

Consequently, always dealing with the state of orthogonality of both fields with respect to each other and to the direction of motion in space at any point of the wavefront always leaves in the background the fact that the spherically expanding electromagnetic wave imagined by Maxwell can only be a single event originating from a single source.

Now, if such an electromagnetic event really is single event, could it not be imagined that after appearing at its point-like origin, it could remain locally point-like as it starts moving, like a local harmonically oscillating standing wave, instead of spherically expanding? This would imply a precise trajectory being followed by this point-like event (an electromagnetic photon) from emission to capture, which would be totally conform to observation and would also directly explain why the initial intensity is maintained.

The idea naturally comes to mind then that the state of fundamental orthogonality of both fields could possibly be served just as well if it was defined with respect to the very point of origin of this electromagnetic event instead of with respect to any given points of the spherically expanding surface of Maxwell's wavefront.

But the apparently insurmountable problem of this approach is the assumed infinite energy associated to such punctual electromagnetic events in classical electrodynamics.

Another problematic issue with the idea of mathematizing EM energy at its point-like source is the fact that both fields can be orthogonal to no particular direction in space at the very moment of punctual coming into being. This leads directly to the conclusion that at such a point-like source, both fields of the EM punctual event could be orthogonal only to 3-D space itself, despite the strangeness of the idea.

Let us consider however that such an idea is no stranger than this one, recognized for over a century, that sets time itself as being orthogonal to tri-dimensional space in Minkowski's space geometry, foundation of Einstein's General Relativity Theory, and it is precisely the avenue that we are going to explore here.

IV. EXPANDING THE SPACE GEOMETRY

Obviously, the intersection of a magnetic field and an electric field at right angle with each other at the point of origin of the EM event, that is, with respect to 3-D space itself at its point of origin, is far from easy to visualize. But as we will see further on, an easily mastered metaphor can be used to circumvent this issue.

For example, as an intermediate step in this process of expanding the 3-D space geometry, let us represent the magnetic field as a plane that would correspond to the horizontal major Z-axis of a superset major coordinate system, and the electric field as a plane corresponding to the vertical major Y-axis. Normal space will then be represented by a horizontal major X-axis normal to the Z-axis and to the Y-axis of this superset coordinate system. We will now proceed to a very special mental exercise to succeed in seeing normal 3-D space as the major X-axis of this superset coordinate system.

We must now imagine the 3 familiar x-y-z orthogonal dimensions describing normal 3-D space as if they were the ribs of an open 3-ribs metaphorical umbrella, the apex of which would be located at the origin. If we mentally fold the umbrella, we can now visualize the folded umbrella as if it was this linear major X-axis of the expanded coordinates superset.

Having now this representation of both Y and Z planes intersecting only along the major X-axis, if we visualize these two planes moving at the speed of light along the X-axis, we have a representation of a plane-wave electromagnetic event now tentatively point-like and still in phase moving at the speed of light along this major X-axis representing normal 3-D space, in conformity with Maxwell's theory.

To visualize now the spherical expansion of the wavefront, we only need to mentally open the X-axis "umbrella" while visualizing the Z-Y plane moving at the speed of light along its length, which allows clearly visualizing the spherically expanding wavefront in our 3-D space as the major X-axis umbrella progressively opens to eventual full 90o extension.

But this already expanded space geometry, no doubt surprising to many by its extension, is still insufficient to describe localized photons in motion, as we will soon see.

V. EXPANDING BEYOND 3-D SPACE GEOMETRY

We are now going to give its final expansion to the already expanded second stage XYZ space geometry that we just described, to end up with the new space geometry that will allow quantized kinetic energy to cyclically alternate between electric and magnetic states without changing in nature.

Instead of considering two Y and Z extra-spatial planes respectively for the electric and magnetic aspects, we will now fully expand these planes to extra 3-D spaces of their own, to have come into being an entirely new local space geometry that will ultimately allow reconciling de Broglie's permanently localized dual-particles photon with Maxwell's theory.

If we imagine the observed electric behavior as being caused by the incompressible energy of the photon being momentarily present in a 3D-space that allows such behavior, and the magnetic behavior being caused by the same energy being momentarily present in alternance in a different 3D-space that allows such behavior, each space being governed by the same laws of motion as normal 3D-space, the same capacitance and inductance, and each space normal to each other and allowing quantized energy not to change in fundamental nature, it will become possible to visualize completely the localized photon dynamic standing motion much more clearly.

In order to easily refer to these new spaces, let us name **electrostatic space** the Y-space into which quantized kinetic energy displays electric behavior, and **magnetostatic space** the Z-space into which it displays magnetic behavior.

In this space geometry, a junction point (or passage point) between these two spaces (three, counting normal space that would be orthogonal to the other two) would be located at the geometric center of each photon, and it is this junction point (point-like by structure) that would be moving point-like at the speed of light in normal 3D-space, along the major X axis of this expanded geometry (Fig.4).

The photon itself now appears as a discrete amount of quantized energy, half of which unidirectional and moving in normal space, propelling the other half that would be pulsating non-stop through this junction point by orthogonal translation between electrostatic space and magnetostatic space at the frequency determined by the photon's energy.

VI. APPLYING PLANE WAVE TREATMENT TO THE LOCALIZED PHOTON

It is particularly interesting to note that such a dynamic cyclic energy structure would be totally conform to the conventional definition of a plane wave, given that at any given instant the fields would be uniform over a plane intersecting that junction point, perpendicularly to the direction of propagation of the photon.

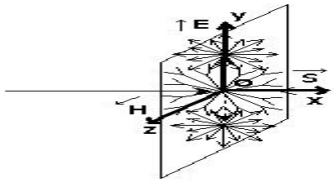

Fig.4: Plane wave applied to a permanently localized photon.

The energy of the photon would of course behave with respect to that moving plane as if it were stationary, as it actually is in the reference frame of the junction point, but a stationary wave that locally adopts the beautiful symmetry so enticing in the QFT vacuum fluctuations concept, with the advantage that this plane, just like the junction point, can regardless continue moving at the speed of light in normal 3-D space (along the major X-axis).

Also, we can observe that the product of the projections on the transverse plane of the electric and magnetic pulsating energy is constant and consequently does not fluctuate over time as is the case with classical in-phase plane waves.

In this model, the magnitude of the Poynting vector will thus be constant all through the electromagnetic cycle of any localized photon at the following value

$$\mathbf{S} = \frac{EB}{2\mu_0}$$

instead of fluctuating over time as in classical electromagnetism to average out at this same value, since one more characteristic of plane wave treatment applied to the moving localized photon is that the value of S obtained corresponds by structure very precisely to the average value calculated in classical electromagnetism, and which gives directly the measurable *intensity* of the "wave" ([7], p.987). See Section XXI further on for the analysis of the discrete LC oscillation equation that explains the stability of the Poynting vector in this model.

Let us note here that this measurable *intensity* is directly reconcilable with the conclusion of this model according to which only half of the energy of a photon pulsates to and fro between electrostatic and magnetostatic spaces while the other half is not pulsating but moves unidirectionally and simply serves to propel the pulsating half at the speed of light in vacuum, as explained in a separate paper ([11]).

VII. IDENTIFYING THE REQUIRED 9 SPATIAL DIMENSIONS

For coherence, we will identify normal, electrostatic and magnetostatic spaces as being X-space, Y-space and Z-space respectively. Within normal space, let us rename the three minor spatial dimensions: X-x, X-y and X-z. Likewise, for electrostatic and magnetostatic spaces Y-x, Y-y, Y-z and X-x, X-y, X-z. Let's assume furthermore that the minor x-axes of all three spaces are mutually parallel in a direction corresponding to the conventional direction of motion of energy in normal space in plane wave treatment. Of course, when x, y and z dimensions are mentioned without major axis prefix they will by default refer to the usual normal 3-D space x, y and z dimensions.

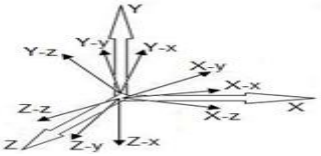

Fig.5: Orthogonal structure of the 3-spaces model.

Referring to the accompanying dimensions drawing (Fig.5), remember the 3-ribs umbrella metaphor representing the opening from 0o to 90o of the inner dimensions of each space to allow easier visualization.

In this space geometry, electrostatic properties such as Coulombian inverse square interaction with distance belongs to electrostatic space, while magnetostatic inverse cube interaction belongs to magnetostatic space.

Free fall acceleration induced kinetic energy will appear massive to an observer located in normal space when it is in motion in either one of the other two spaces, but would locally be perceived as non massive. For example, as perceived from normal space, magnetostatic space and electrostatic space would be the realm of massive states, while normal space would be, as far as we observers located in this space are concerned, the realm of free fall acceleration induced unidirectional quantities of kinetic energy between bodies.

With the umbrella metaphor, it is easy now to visualize the three orthogonal spaces as three umbrellas meeting at their tips. We only need to mentally open any one of them to examine what is occurring in it at any given moment of the electromagnetic cycle.

VIII. DEFINING A MAJOR UNIT VECTORS SUPERSET

The traditional $\hat{\mathbf{i}}$, $\hat{\mathbf{j}}$ and $\hat{\mathbf{k}}$ unit vectors set was of course defined to represent vectorial properties in normal 3-D space since electromagnetic phenomena have up to now been perceived as occurring entirely within normal 3-D space. But this expanded 3-spaces geometry now involves two new spaces perpendicular to normal space, each of which requiring its own internal minor unit vectors set.

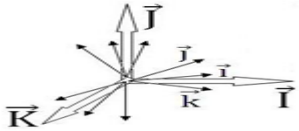

Fig.6: Major and minor unit vectors sets applicable to the 3-spaces model.

The three mutually orthogonal spaces (normal, electrostatic and magnetostatic) also need to have a unit vectors set, so let's define a new superset of major unit vectors that will identify the three orthogonal spaces as $\hat{\mathbf{I}}$, $\hat{\mathbf{J}}$ and $\hat{\mathbf{K}}$, or to make notation easier, $\mathbf{I}$, $\mathbf{J}$ and $\mathbf{K}$ (**I**bar, **J**bar and **K**bar), so each local $\hat{\mathbf{i}}$, $\hat{\mathbf{j}}$ and $\hat{\mathbf{k}}$ unit vectors set becomes subordinated to the major unit vector specific to its local space, all 12 resulting unit vectors (9 minor and 3 major) being of course drawn from the same origin O (Fig.6).

Each of the three orthogonal minor unit vectors subsets (shown in the drawing as being half folded (let's remember the umbrella analogy), that is $\mathbf{I}\,\hat{\mathbf{i}}$, $\mathbf{I}\,\hat{\mathbf{j}}$, $\mathbf{I}\,\hat{\mathbf{k}}$, for normal space $\mathbf{J}\,\hat{\mathbf{i}}$, $\mathbf{J}\,\hat{\mathbf{j}}$, $\mathbf{J}\,\hat{\mathbf{k}}$ for electrostatic space and $\mathbf{K}\,\hat{\mathbf{i}}$, $\mathbf{K}\,\hat{\mathbf{j}}$, $\mathbf{K}\,\hat{\mathbf{k}}$ for magnetostatic space allows defining the vectorial magnitude of energy in any one of the three orthogonal coexisting spaces.

This is how the vectorial relation drawn from Lorentz mentioned in **Section I** becomes in this expanded space geometry

$$E\mathbf{J} \times \left(\frac{-1}{B}\right)\mathbf{K} = v\mathbf{I}$$

These three orthogonal spaces allow visualizing a system of major polar orthogonal axes, each axis of which corresponds to one of the major unit vectors that we have just defined, and that would be local to each elementary particle or energy quantum and whose origin would be located at the center of the particle. This lets the three standard minor unit vectors subsets remain available to completely describe the specific behavior of the energy in each separate space.

IX. WHAT IS KNOWN ABOUT PHOTONS AND OTHER LOCALIZED EM PARTICLES

Before establishing the photon fundamental LC equation that describes permanently localized electromagnetic photons in this expanded space geometry, we need to put in perspective a few major discoveries made after Maxwell gave us his theory more than 170 years ago. This information is required for us to elaborate our solution, taking into account all of what is now known about photons and other localized electromagnetic particles.

First, Wien's experimental observations regarding the black body and Planck's interpretation of his results, showed us more than 110 years ago that electromagnetic energy is not continuous at the microscopic level as Maxwell assumed, but discontinuous, and that what he interpreted as being waves, turns out to be in reality a perception at the macro level of a crowd effect due to the existence of innumerable discrete moving electromagnetic point-like events at the micro level, an idea that was strongly accredited by Einstein's photoelectric proof in 1905, and that were eventually named "photons", a proof that earned Einstein his Nobel Prize.

Compton and Raman added further credit to Planck's interpretation, as they experimented with other types of collisions between photons and electrons. Their findings conclusively confirmed the discrete and point-like nature of photons at the micro level. So, we know for certain that Maxwell's "waves" do not exist as such at the microscopic level.

What can be experimentally observed regarding free moving energy at the micro level always turns out to be discrete amounts of energy escaping from atoms each time either an electron or a quark releases a quantum of energy (a photon) as it goes to a lower energy state after having been momentarily excited to a higher energy state, and conversely, discrete amounts of kinetic energy being gained by electrons being hit by photons, amounts that can always be related to one discrete amount having previously been released by one or other of the photon emitting de-exciting processes previously mentioned.

No experiment however ever contradicted a critically important aspect of Maxwell's theory which is the state of orthogonality of the electric and magnetic fields of free moving energy with respect to its direction of straight line motion, which consequently also applies to localized photons.

It is now an established fact that photons always are emitted and captured as discrete and localized electromagnetic photons that very precisely obey at all times this triply orthogonal law.

X. DE BROGLIE'S HYPOTHESIS REGARDING PERMANENTLY LOCALIZED PHOTONS

In the 1930's, Louis de Broglie, whose 1924 thesis inspired Schrödinger's wave equation and earned him a Nobel prize, formulated a hypothesis on how a permanently localized photon following a least action trajectory can satisfy at the same time Bose-Einstein's statistic and Planck's Law, perfectly explain the photoelectric effect while obeying Maxwell's equations and totally conform to the properties of Dirac's theory of complementary corpuscles symmetry.

His analysis revealed that the only possible dynamic structure that can comply with all of these criteria was that the photon be made up not of a single particle, but of two particles, or half-photons, that would be complementary like the electron is complementary to the positron ([4], p.277).

From his hypothesis: "*Such a complementary couple of particles is likely to annihilate at the contact of matter by relinquishing all of its energy, which perfectly accounts for the characteristics of the photoelectric effect.*"

Furthermore, "*The photon being made up of two elementary particles of spin h/4π, it must obey the Bose-Einstein statistic as the precision of Planck's law for the black body requires.*"

Finally, he concludes that "*…this model of the photon allows the definition of an electromagnetic field linked to the probability of annihilation of the photon, a field that obeys Maxwell's equations and has all of the characteristics of electromagnetic light waves.*"

XI. INTERNAL ELECTROMAGNETIC SYMMETRY

These conclusions involve that photons have to be stable localized dynamic structures that can logically only alternate between a two components electric state with both components separating in space (an electric dipole) and a single

component magnetic state that could be dipolar in only one manner, which can consist only in a spherical magnetic expansion phase as both electric state components move towards each other, followed by a spherical magnetic regression phase as both electric state components move away from each other, both magnetic phases being normal to the electric phase at all times. This involves that the magnetic aspect of the photon will be spherical at all times and can be dipolar only along the time dimension since both expansion and regression cannot possibly occur simultaneously.

Such a dynamic structure still preserves fundamental symmetry since the space-wise moving electric dipole is counterbalanced by a related time-wise moving orthogonal magnetic dipole, with both dipoles remaining orthogonal to the direction of motion of the photon in space in agreement with Maxwell's theory.

XII. INTERNAL COULOMB INTERACTION BETWEEN HALF-PHOTONS

Let us note that de Broglie considered both half-photons as electrically neutral, that is, not being made up of opposite sign charges. But given that Quantum Electrodynamics itself implicitly recognizes the presence of Coulomb interaction between a decoupling photon and a heavy nucleus with which it interacts by representing this interaction with a virtual photon, thus implicitly recognizing the presence of charges in photons to be interacted with, we will likewise assume that the possibly electrically neutral sub-components of the photon would also be subject to Coulomb-like interaction. The interaction between both half-photons inside a photon could then also be represented by a Feynman diagram.

XIII. PHOTONS, ELECTRONS, POSITRONS, MADE UP OF KINETIC ENERGY

Consequently, simple logic leads to the conclusion that when a photon of sufficient energy (1.022 MeV or more) grazes sufficiently close another corpuscle, the destabilizing effect of such Coulomb interaction between the half-photons and the charged particles making up the corpuscle being grazed, could be the direct cause of the destabilization that initiates the decoupling process resulting in the separation of the half-photons pair, which can thereafter be observed behaving as a pair of massive electron and positron henceforth traveling separately.

This thoroughly experimentally verified process of conversion of photons (bosons) of energy 1.022 MeV or more into pairs of electron and positron (leptons) as such photons graze massive nuclei is the material proof that electrons and positrons are electromagnetic in nature just like photons and are made up of the same energy. The materialization of electron-positron pairs from gamma photons was verified for the first time by Anderson from cosmic radiation in a bubble chamber in the early 1930's and has been constantly verified ever since in high energy accelerators.

On the other hand, we also know that all photons are created by the process of "bremmsstrahlung", that is, by the quantization of quantities of kinetic energy, unidirectional by definition to start with since they are induced by particles acceleration, that electrons accumulate as they accelerate between the electrodes of a Coolidge tube for example, photons that are ultimately liberated as the electrons suddenly come to a relative stop as they are captured by the anode (or anti-cathode), or as electron beams are magnetically wiggled in particle accelerators, submitting the electrons in the beam to repeated transverse slowing-downs as the beam is forced to oscillate from side to side, producing the so-called synchrotron radiation, typically in the X-ray range, or also in storage rings, when an electron beam is repeatedly magnetically pulsed to maintain a best fit approximately circular trajectory.

The fundamental question can now be summarized as follows:

How can a quantity of kinetic energy causing a massive particle (an electron for example) to move unidirectionally in space to start with, dynamically "fold" onto itself according to the threefold orthogonal relation revealed by Maxwell's theory, to become a stable quantum of electromagnetic energy (a photon) escaping at the speed of light, while being animated by this local multidirectional pulsating motion suggested by de Broglie's conclusion, which would consist in a space-wise electric dipole cyclically morphing into a time-wise magnetic dipole, and that could also explain all electromagnetic properties of photons, and by extension, those of all other elementary electromagnetic particles, since such photons of sufficient energy can be destabilized to convert into massive electrons and positrons?

In other words, in the case of a photon, we would be dealing with a complex locally standing wave in motion, made up of kinetic energy, with two components in space-wise resonance cyclically morphing into one component in time-wise spherical resonance. Let us emphasize here that we are talking about the cyclic motion of the actual energy locally involved described by the fields of Maxwell's equations and not of the fields themselves, which are mathematical concepts.

It must be obvious by now that all electromagnetic photons have to be made up of the same material, that is, *quantized amounts of kinetic energy*, which would by nature be undifferentiated, and we will see further on that all massive elementary electromagnetic particles also have to be made up of the same substance.

It is this particular characteristic that allows demonstrating in a separate paper ([5]) the time-wise magnetic bipolarity of elementary particles by similarity with that of a very special type of permanent magnets, and to clarify by the same token the magnetic monopoles issue.

XIV. DE BROGLIE'S HYPOTHESIS OF NEUTRAL HALF-PHOTONS

De Broglie associated no sign to the two electric state particles of his localized photon hypothesis after having analyzed this possibility.

This was confirmed to me at the **Fondation Louis de Broglie** upon a specific question on my part regarding this issue, through a copy of a Note to Dominique Morenas from Georges Lochak, director of the Foundation and lifelong colleague and friend of de Broglie.

But paradoxically, it has been understood and extensively experimentally confirmed since the 1930's that any photon of energy 1.022+ MeV, which has no mass and is electrically neutral, will destabilize and convert into an electron-positron pair (massive and charged in opposition) when grazing a heavy particle such as an atom nucleus.

Could the signs then be an extrinsic property of charges, possibly a vectorial property acquired at the moment of separation of the pair? This would leave the door wide open to the possibility that the half-photons could be associated to unsigned charges, that is, fundamentally neutral charges!

The unraveling of the origin of constants **ε0** and **μ0** proposed in ([6], **Chapter 11**), also available in a separate paper ([3]), shows that the possibility of the existence of such neutral pairs of charges within photons is definitely worthy of consideration, which would effectively reduce the "sign" of a charge to a property acquired at the moment of decoupling by the previously neutral charges of the decoupling half-photons, which resolves in this model into a simple case of motion (or pressure) in opposite directions in electrostatic space (see further on).

XV. DISCRETE PARTICLES AS THE ONLY SUPPORT OF ELECTROMAGNETIC PROPERTIES

If we refer to the conclusion already discussed to the effect that if electromagnetic "waves" are only a perception at the macroscopic level of the motion of crowds of innumerable localized photons at the microscopic level, then photons cease having to be considered as singularities in a suddenly non-existent underlying fields of ether phenomenon, to individually become full-fledged electromagnetic entities on their own, which would make the whole set of these photons and their interactions, the only possible foundation for the complete Maxwellian electromagnetic structure!

Although reconciling de Broglie's localized dual-particle photon hypothesis with Maxwell's theory without resorting to the idea of an underlying electromagnetic field seems a hopeless endeavor in the restricted frame the classical 3D+time space geometry, it definitely comes within reach in this expanded space geometry.

XVI. EM OSCILLATION ENERGY-DRIVEN RATHER THAN FIELDS-DRIVEN

Keeping in mind that a photon fundamentally is a discrete quantity of kinetic energy, half of which remaining unidirectional in de Broglie's photon while the other half quantizes orthogonally in electromagnetic oscillation, it seems logical that the energy of this second half of the photon's energy would not suffer any change in nature even when quantized orthogonally to the direction of motion as it is propelled by the first unidirectional half at the speed of light in vacuum, despite our perception that it must alternately possess distinct and apparently irreconcilable magnetic and electric properties, that would be reciprocally induced by motion of the other aspect, and that this impression could be due to a cause yet more fundamental than mutual fields interaction.

For example, if kinetic energy was a material incompressible in volume on top of its fundamental property of always remaining in motion, the local oscillation between both electric and magnetic states of any quantity of this energy could be forced uniquely by the property of this energy to always remain in motion.

So, instead of a relation of mutual orthogonal induction between two fundamentally different electric and magnetic fields as Maxwell's theory assumes, this relation could be one of cyclic orthogonal translation of a the fixed amount of energy making up the photon (Fig.7).

That is an energy that would always conserve the characteristics it originally possessed even before it was quantized to become a photon, but that would, by alternating between two dynamic states, both of which orthogonal to each other and to the direction of motion in space, in accordance with Maxwell's theory, would give the impression to have all of the electrical set of characteristics, and then, all of the magnetic set of characteristics; but whose high frequency of the cyclic translation between both states would create the illusion of the simultaneous and permanent presence of both states.

Considering that magnetic interaction obeys the inverse cube law of attraction and repulsion ([5]) and that electrostatic interaction obeys the inverse square law of attraction and repulsion, make it appear illogical that quantized quantities of kinetic energy could possess both magnetic and electric properties at the same moment.

It is precisely this conclusion that mandates that half of the isolated quantum of kinetic energy making up a photon would have no choice but to locally alternate between magnetic and electric behavior while remaining unchanged in nature, metaphorically speaking like a caged tiger endlessly pacing to and fro. This however does not negate the usefulness of fields as we will see further on. Fields would simply take second seat to the more fundamental forced motion of the kinetic energy proper now operating as a prime mover, being perceived as "electric energy" as it transits in an electrostatic space and "magnetic energy" as it transits in a magnetostatic space.

It seems entirely conceivable that such a high frequency cyclic translation process of a discrete quantity of incompressible energy between two dynamic states, at the frequency of the photon, could explain all observed phenomena while underlying the traditional perception of electric and magnetic fields that would mutually induce each other in phase. We will see further on the benefits of taking into consideration this forced motion of kinetic energy as acting at a level more fundamental than fields.

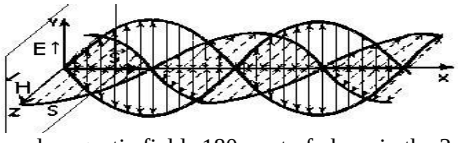

Fig.7: Electric and magnetic fields 180o out of phase in the 3-spaces model.

Maxwell's four original equations would remain totally valid in this new perspective, since his second equation (Table I) does not even mandate that both fields be in phase, since it directly accepts the opposite relation, which is that of a reciprocal interaction of both fields when out of phase by 180o as is being considered here.

XVII. THE DE BROGLIE PHOTON INVOLVES 2 CHARGES

Indeed, the new equation for free energy derived from Marmet's work in ([1], equation (11))

$$E = hf = \frac{hc}{\lambda} = \frac{e^2}{2\varepsilon_0 \alpha \lambda} \quad (1)$$

does involve by structure two charges interacting. The very form e2 reveal that both charges in a localized photon have to be identical, and can be neutral |e|2 as hypothesized by de Broglie, which leads to the logical conclusion that the opposite signs of a decoupling pair (positron + and electron -) can effectively be considered as being acquired as the pair decouples, which is currently at odds with current axiomatic beliefs, but is in perfect harmony with de Broglie's hypothesis.

It is a fact that all experimental research aimed at identifying charges in electromagnetic "waves" have failed to detect any charge in support of Maxwell's assumption of the existence of a displacement current and corresponding magnetic field as a foundation for his theory.

But Let's consider that if electromagnetic "waves" turn out to be only a convenient mathematical representation of a macroscopic perception of a crowd effect due to the presence of countless localized photons that Planck and Einstein confirmed the physical existence of, it would indeed be these photons that would display the searched for charges and would be the local sites of displacement current versus magnetic induction activity.

There simply exists no instrument sensitive enough to detect the infinitesimal fields of individual photons, with the added difficulties that they are moving at the speed of light and that any interception of a single photon simply incorporates it as an infinitesimal increase in kinetic energy of one electron of one atom of the material that the detector is made of.

XVIII. THE CREATION OF NEW PAIRS OF NEUTRAL CHARGES

When a half-photon pair decouples to convert into an electron-positron pair, it is experimentally confirmed that the residual energy in excess of the 1.022 MeV required to form the rest masses of the separating pair and that causes the now massive electron and positron to fly away from each other, can only be two very normal photons as analyzed in a separate paper ([1]), but instead of flying away at the speed of light as would be expected, are slowed down by the presence of the massive particles that they now must carry separately and whose velocity and added instantaneous relativistic mass increase they now determine.

How does the new pair of electrically neutral corpuscles of each new residual carrier-photon come into being then?

All indications lead to conclude that it would be the mere presence of energy in electrostatic space that would be perceived as corresponding to a charge when observed from normal space just like the mere presence of the very same energy in magnetostatic space is perceived as a magnetic field when observed from normal space.

This would explain very simply why all of a photon's energy can completely evacuate electrostatic space at the end of its transfer process into magnetostatic space, momentarily leaving absolutely nothing behind.

The assumed "neutral" charges of a permanently localized photon in electrostatic space would then not be fixed-dimensions "corpuscles", in the generally understood sense, but simply the energy itself that makes up the equal energy half-photons during the electrostatic phase of the cycle, whatever its total amount.

The "unit charges and opposite signs" acquired by both electron and positron upon decoupling would become fixed simply because the corresponding energy stops cycling between electrostatic and magnetic states to become fixed quantities in electrostatic space now applying unidirectional and stable "pressures" in opposite directions in normal space whose intensity depends on the decoupling radius of the pair in electrostatic space, as analyzed in a separate paper ([10]).

XIX. TRANSVERSE TRAVEL VS LONGITUDINAL TRAVEL OF A PHOTON'S ENERGY

This structural analysis highlights one more astonishing fact about electromagnetic energy, which is that its transverse integrated amplitude being subject to the speed of light as a maximum limiting velocity of the photon's internally cycling energy as the latter accelerates transversally in both electrostatic and magnetostatic spaces from velocity zero at each limit, can *de facto* only be different from the classical amplitude associated to constant longitudinal velocity at c of the photon ($\lambda/2\pi$).

Rather simple calculation show that this transverse amplitude corresponds very precisely to the integrated absolute amplitude of the particle's energy ($\lambda\alpha/2\pi$) (See [1]). Interestingly, the difference is exactly equal to the fine structure constant (α), whose origin and justification has mystified the physics community so much for the past hundred years.

So the fine structure constant (α) can now be defined as follows:

The fine structure constant is the ratio of the transverse amplitude of the transversally oscillating electromagnetic energy of a localized photon over the longitudinal amplitude of the same energy in the direction of motion of the photon at the speed of light in space.

XX. DISPLACEMENT CURRENT AS THE SOURCE OF PHOTONS' MAGNETIC FIELD

Now, considering the cyclic to and fro motion of the assumed neutral pair of charges involved in the de Broglie localized photon internal dynamic structure, it must be obvious that only displacement current could be at play here since no physically massive matter can be present to support in any way a conduction current.

It is well understood since Maxwell that displacement current can also act as a source of magnetic field and that a changing electric field (which would be the case with the cyclic symmetric dynamic motion of the pair of charges considered) in a region of space, will induce a magnetic field in neighboring regions, even when no conduction current and no matter are present (and in de Broglie's localized photon hypothesis, even if the charges are neutral).

Such an electro-magnetic relationship involving a displacement current, first proposed by Maxwell in 1865 was the foundation of his electromagnetic theory and provided the key to the theoretical understanding of electromagnetic radiation ([2], p 625), which brings us to the behavior of LC circuits

XXI. FIELDS GENERATION DUE TO ENERGY CIRCULATION

A. Macroscopic LC circuits

When an inductor coil is connected to a charged capacitor with no resistance inserted in the circuit, it is well verified experimentally that the capacitor will completely discharge into the inductor as the current in the inductor establishes a magnetic field in surrounding space.

When the potential difference between the capacitor terminals reaches zero, the magnetic field that just reached maximum about the inductor coil will now start decreasing thus inducing a current in the coil that will completely recharge the capacitor in the reverse direction until the magnetic field completely disappears and the capacitor is again fully recharged, a behavior in complete agreement with 180o out of phase electromagnetic cycling in this 3-spaces model (Fig.7).

The capacitor will now start discharging again into the coil and the process would repeat indefinitely in theory if no energy was lost, a loss that always occurs in lab experiments due to eventual heating of the coil wire. It is well understood however that if no energy was lost through heat loss from the coil wire, the total energy of the system would remain constant and be conserved, which would keep the cycle going for ever.

B. The Photon as a LC Oscillator

Let us note that an oscillating LC circuit requires no conduction current to keep operating, and that the displacement current inherent to the structure of a charged capacitor is sufficient to initiate and maintain the continuous process. Let us note here that the difference between an alternating current and a displacement current is that the latter involves a self sustaining oscillation, in close circuit so to speak, while an alternating current needs to be permanently maintained externally. The classical equation representing the maximum energy stored in the capacitor of a LC circuit at the beginning of the cycle is

$$E_E = \frac{q^2}{2C} \tag{2}$$

and the one representing the maximum energy stored in the magnetic field of the coil when the capacitor has been emptied of its charge is

$$E_B = \frac{L\, i^2}{2} \tag{3}$$

Of course, if no energy was lost in such a system through heating of the coil wire, we could equate

$$EE = EB \tag{4}$$

C. Defining the Photon Integrated Capacitance (C)

Transposing now this LC behavior to de Broglie's localized photon, which has no wire that can resist and heat up and thus can completely conserve its energy, we can now determine its integrated capacitance (C) and inductance (L), in relation to its energy. We previously determined that only half a photon's energy cyclically oscillates between electric and magnetic states (the other half moving unidirectionally to maintain the speed of light of the first half in space). So using the energy equation (1) previously mentioned derived from Marmet's work, that is:

$$E = \frac{e^2}{2\varepsilon_0 \lambda \alpha} \tag{5}$$

let us divide it by two to separate the half of a photon's energy that electromagnetically oscillates from the unidirectional half:

$$E_{EB} = \frac{E}{2} = \frac{q^2}{2C} = \frac{e^2}{4\varepsilon_0 \lambda \alpha} \tag{6}$$

Consequently, we can isolate

$$2C = 4\varepsilon_0 \lambda \alpha \tag{7}$$

and finally

$$C = 2\varepsilon_0 \lambda \alpha \quad \text{Farad} \tag{8}$$

Which allows calculating the integrated capacitance of any localized photon from its wavelength and the permittivity constant of vacuum (ε0). Now since $\boldsymbol{\varepsilon_0}$ is in reality a measure of ***transverse capacitance*** *per meter in vacuum* (Farad per meter), if we multiply $\boldsymbol{\varepsilon_0}$ by a length in meter, we obtain *de facto* a capacitance in relation with that length. So, equation (8) should fully confirm the nature of $\boldsymbol{\varepsilon_0}$ as a unit of vacuum capacitance per meter since it effectively boils down to calculating the capacitance of a photon by multiplying $\boldsymbol{\varepsilon 0}$ by a transverse wavelength (in meters)..

D. Defining the Photon Integrated Inductance (L)

We know besides that the angular frequency of a LC oscillator is obtained from the following equation

$$\omega = \sqrt{\frac{1}{LC}} \tag{9}$$

Since we can separately calculate the angular frequency of a photon's energy from $\omega=2\pi f$, or better yet, in context, from $\omega=2\pi c/\lambda$ (since we must use here the cycling frequency calculated from the absolute wavelength a localized photon's energy which is $f=c/\lambda$), we can write

$$\omega = \frac{2\pi c}{\lambda} = \sqrt{\frac{1}{LC}} \tag{10}$$

By squaring this last equation and replacing C by the value defined with equation (8), that is εo2λα, we can isolate L and define the following equation for calculating the inductance of any photon from its wavelength and the permeability constant of vacuum (μ0)

$$L = \frac{\lambda^2}{C 4\pi^2 c^2} = \frac{\lambda}{\varepsilon_0 2\alpha 4\pi^2 c^2} \tag{11}$$

Knowing also that εoc2=1/μo and substituting this value in equation (11) we can finally write:

$$L = \frac{\mu_0 \lambda}{8\pi^2 \alpha} \quad \text{Henry} \tag{12}$$

We note here in reference to the definition of the permeability constant as being a unit of transverse *inductance per meter in vacuum*, that multiplying it by a wavelength (in meters), as our last equation reveals, we obtain a very straightforward inductance.

E. Photon Maximum Displacement Current (*i*)

Knowing now how to calculate L for a localized photon and that the electromagnetically oscillating energy involved (equation (6)) amounts to half of the photon's energy (EEB), we can determine the maximum current (*i*) involved from the equation giving the maximum energy momentarily stored in the magnetic field. So, from

$$E_B = \frac{L\, i^2}{2} \tag{13}$$

we derive

$$i = \sqrt{\frac{2E_{EB}}{L}} = \frac{2\pi ec}{\lambda} \quad \text{Ampere} \tag{14}$$

F. The Photon General LC Equation

One final consideration before establishing a general dynamic equation for localized photons is that the sum of both EE and EB is permanently constant and since both values concern the very same amount of energy transferring form one form to the other. The sum of both can thus never exceed the maximum energy of either EE or EB. Consequently, we can write

$$E_{EB} = E_E + E_B = \left[2\left(\frac{e^2}{4C}\right)_Y \cos^2(\omega t) + \left(\frac{L\, i^2}{2}\right)_Z \sin^2(\omega t) \right] \tag{15}$$

Where t is the time for one cycle to be completed and corresponds to 1/*f*, or when defined as a function of λ as required here, t=λ/c, and where the electric aspect of course splits into two equal quantities moving in opposite directions.

Since this energy corresponds to only half of the energy of a photon, we must finally add the other half which is the permanently unidirectional kinetic energy that propels the oscillating half at the speed of light. Let's now introduce the correct set of directed unit vectors to completely represent the various directions of motion of the energy within the photon structure:

$$E\,\vec{\mathbf{I}}\,\vec{\mathbf{i}} = \left(\frac{hc}{2\lambda}\right)_X \vec{\mathbf{I}}\,\vec{\mathbf{i}} + \left[2\left(\frac{e^2}{4C}\right)_Y (\vec{\mathbf{J}}\,\vec{\mathbf{j}}, \vec{\mathbf{J}}\,\vec{\mathbf{j}}) \cos^2(\omega t) + \left(\frac{L\, i^2}{2}\right)_Z \overleftrightarrow{\mathbf{K}} \sin^2(\omega t) \right] \tag{16}$$

We have here the most detailed and general equation, all terms of which being function of the single variable λ, that can possibly be established for the internally cycling energy of a localized photon, and where indices X, Y and Z respectively represent the three mutually orthogonal spaces into which the associated energy is in motion in the 3-spaces model.

Note that the vector combination (~~**Ii**~~) representing the final motion of the total energy of the photon is exactly equal to the vector combination associated to the unidirectional half of the photon's energy located in normal space (X-space) since both ~~**Jj**~~ vectors of electrostatic space (Y-space) cancel each other by structure and that the ~~**K**~~ vector of magnetostatic space (Z-space) represents energy moving omnidirectionally as it expands and then regresses within that space.

All that is required now to observe how the energy oscillates between electric and magnetic states is to cyclically vary t from 0 to λ/c.

This equation allows clearly understanding why the Poynting vector is totally stable when de Broglie's hypothesis is taken into account, at a value equal to the averaged out value of this vector in classical Maxwell. This stability is due to the fact that at any given moment, the sum of capacitance energy and inductance energy is always exactly equal to half a photon's energy, which means that the electromagnetic oscillation behaves very precisely like a simple harmonic oscillator.

XXII. UNDERLYING KINETIC ENERGY CIRCULATION

G. Differentiating between fundamental energy and EM fields

We just clarified how the energy of a localized photon can be represented as a cyclically oscillating magnetic and electric fields state (involving a displacement current) in accordance with deBroglie's internal photon structure hypothesis. This allowed defining a general LC equation for photons of any energy (Equation (16)).

We will now describe how a photon's fundamental energy needs to move between the 3 spaces of this expanded Maxwellian geometry to generate these two fields.

H. Energy Circulation Trough the Trispatial Junction

1) ***Energy transfer from electrostatic to magnetostatic space***: Referring to the local cyclic oscillation of a photon's energy in the 3-spaces geometry (See Section V), let us consider the pair of half-photons of de Broglie's hypothesis (neutral electric charges) as they reach the farthest distance that they can possibly reach on either side of their junction in electrostatic space, that is, the maximum electrostatic amplitude of their cyclic motion (Fig.8).

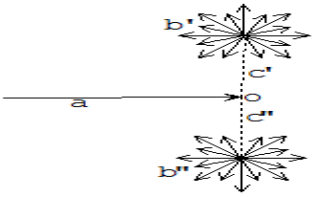

Fig.8: Half-photons having reached the farthest distance of their reach in electrostatic space.

Given the assumed attraction exerted on them by the central junction, they will immediately start accelerating back in free-fall back towards this junction, according to the inverse square law.

In **Figure 8**, vector **a** represents the quantity of kinetic energy in unidirectional motion in normal space required to maintain the speed of the photon in that space. A separate paper explains why this quantity needs to be at all times exactly equal to the quantity permanently oscillating between electrostatic and magnetic spaces for the speed of light of the photon to be maintained.

Dotted lines **c'** et **c"** represent the occurrences of attraction that permanently seek to attract half-photons **b'** and **b"** towards trispatial junction **o** within electrostatic space.

Note that the representation of half-photons **b'** and **b"** as two vectorial spheres is only an ad hoc metaphor to help visualizing later their conversion into an electron/positron pair, the decoupling of which is analyzed in a separate paper ([10]) for photons of energy 1.022+ MeV. The energy of each half-photon would no doubt be much more precisely represented in context by a vectorial arrow pointing away from the junction, during its expansion phase, and pointing towards the junction in its return phase.

Since Coulomb force free-fall acceleration increases progressively the kinetic energy in bodies accelerating towards each other in normal space, and assuming that the same fundamental law applies in electrostatic and magnetostatic spaces, it can be expected that kinetic energy would also increase locally between the half-photons accelerating towards each other in electrostatic space.

It could also be intuitively expected that when both half-photons finally come together, they would form a mathematically punctual single quantity possessing an infinite amount of energy, as is assumed from Maxwell's theory and Coulomb interaction in dipoles ([7], p.199). There seems to exist no other possibility in traditional 3-dimensional space.

However, referring to verified behavior of photons, we know that any given photon's energy is stable as perceived from normal space, and never peaks to infinity in this manner. Consequently, if de Broglie's hypothesis on the internal mechanics of the photon matches reality, Nature has found a way for this not to occur. And this is precisely what the 3-spaces expanded geometry allows!

Instead of piling up at the junction point as would intuitively be expected in traditional 3-dimentional space, the energy simply starts crossing over to magnetostatic space as both charges start moving towards each other (Fig.9). Since there is ample reason to believe that fundamental energy behaves as an incompressible fluid (see **Section I** further on), it is logically easier for it to flow through the junction instead of piling up in electrostatic space.

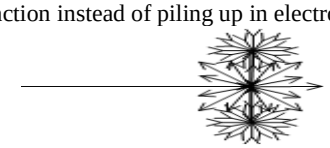

Fig.9: Half-photons closing in toward each other in electrostatic space as their energy starts transferring to magnetostatic space.

Once engaged into the junction, it might be expected that the energy would indiscriminately flow into both normal and magnetostatic space. But since photons already are moving at the speed of light in normal space and that it has been exhaustively verified that electromagnetic energy cannot move any faster in vacuum, we emphatically know that none of this energy will flow into normal space, since the slightest such inflow in that space would result in an increase in the speed of the photon, which is experimentally verified never to happen!

Certainty is thus established in this expanded geometry that all of the photon's energy initially present in electrostatic space will flow into the only other space available to it at that moment, which is magnetostatic space, which happens to not locally be saturated at that precise moment.

Since we know that magnetic fields cannot be split into opposite quantities, we can expect that the photon's energy will gather into a single quantity in magnetostatic space (See Fig.10). So, irrespective of the fact that both half-photons had opposite directions of motion towards each other in electrostatic space, it seems reasonable to expect that the half-photons' energy will fuse together as it flows into magnetostatic space, diffusing omnidirectionally in spherical expansion about the junction point, as if the material was metaphorically attempting to get away from the junction in all possible directions.

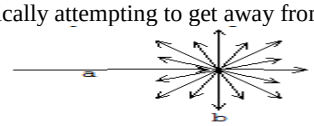

Fig.10: The total complement of energy of the 2 half-photons has now completely crossed over into magnetostatic space.

Sphere **b**, which is localized in magnetostatic space, is thus made up of the combined sum of the energies of **b'** and **b"** (See Fig.8 and Fig.9) during the brief moment of the cycle when that energy has completely evacuated electrostatic space.

Such omnidirectional expansion being perfectly symmetrical by nature, perfectly balances the also perfectly symmetrical bi-directional resorption of the half-photons that are in the process of leaving electrostatic space.

As both half-photons are leaving electrostatic space, the intensity of their interaction must have been increasing according to the inverse square law as they were approaching the junction. But instead of its strength increasing to infinity as both half-photons reach the junction, this intensity will gradually decrease as the quantity of substance of both particles present in electrostatic space progressively leave this space, to finally have completely evacuated this space when all the energy has momentarily crossed over into magnetostatic space.

2) ***What happens to the neutral charges of the two half-photons***: At this point, one will definitely wonder what happens to the two charges, presumably neutral, that must be related to the two half-photons when all of their energy has completely left electrostatic space.

What are they really to start with? Are they still identifiable entities, energyless when they were farthest away from the junction point, to then accumulate kinetic energy as they accelerate towards the junction? Do they cease to exist when all of their energy has completely crossed over to magnetostatic space?

These are some of the issues that still need to be completely analyzed and that this model is attempting to address at least in part.

3) ***The Required Electro-Magnetic Equilibrium***: One could now wonder at what happens in magnetostatic space once both half-photons have completely left electrostatic space.

We have already reflected on the fact that within electrostatic space, the attraction between both half-photons is of necessity an extrinsic property of kinetic energy due to the simple fact that it acts between separate quantities of kinetic energy and a 3-spatial junction. It is thus a relative characteristic whose intensity varies with the distance between these separate quantities of energy.

The situation is different in magnetostatic space. We are locally dealing here with a single quantity of kinetic energy, and to explain the state of dynamic internal equilibrium of the photon, this unique component located in magnetostatic space must succeed on its own in symmetrically complementing the two components that mutually interact in electrostatic space.

Since the electromagnetically oscillating energy is now regrouped as a single quantity in magnetostatic space, its dual-component counterpart in electrostatic space having momentarily completely ceased to exist; it is now impossible that a relative property could be involved in magnetostatic space in the restricted reference frame of the existence of the photon itself to force the energy to return to electrostatic space, since there momentarily exists no other component to interact with.

Three possibilities then come to light: 1) the kinetic energy now totally transferred into magnetostatic space has an intrinsic property that will then force it to return to electrostatic space without external help; or 2) the three spaces structure itself acts as a set of communicating vessels through the central junction offering zero resistance at the junction to the passage of energy and that always allows the energy of the photon to reach and maintain electromagnetic equilibrium; or finally 3) a combination of the first two possibilities.

This is of course just a hypothesis at this point, but the second possibility seems more simple and logical and will turn out to be the most productive when we address the decoupling mechanics of photons of energy 1.022 MeV or more into pairs of electron-positron in a separate paper ([10]).

On the other hand, if kinetic energy possessed an intrinsic property that could force the magnetic quantity to return to electrostatic space, it could only be a property of self-repulsion of the kinetic energy itself, a property not incompatible with the idea that the kinetic energy would locally spread in spherical expansion about the tri-spatial junction within magnetostatic space as it enters it. That is, a property such that kinetic energy, by its very nature, would constantly tend to divide since each of its parts would be behaving as if it repelled all other parts.

4) ***Energy Transfer From Magnetostatic Space to Electrostatic Space***: So, from the moment when all of the energy has completely crossed over into magnetostatic space, given that the total quantity of energy involved is fixed and incompressible, it must be concluded that the previously expanding energy sphere in magnetostatic space will have no other possibility but to stop growing. The length of the vectorial representations of the motion of all its parts previously in spherical expansion will have no other choice then but to fall to zero in all directions at that precise moment.

In the perspective that electrostatic and magnetostatic spaces would act as communicating vessels, all of these vectors should now naturally orient towards the central junction and consequently, the photon's energy will have no other way to go but to start crossing in reverse direction the junction located by structure at the geometric center of the local magnetic sphere, towards the now empty electrostatic space.

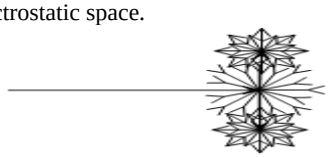

Fig.11: The energy present in magnetostatic space starts crossing over towards electrostatic space.

We can now visualize the energy sphere decreasing in volume in magnetostatic space as two half-quantities begin to move away from each other and from point zero in diametrically opposite directions on the Y-y/Y-z plane within electrostatic space, thus maintaining perfect equilibrium. The end result of this last stage is a return to the first step described in Figure 8.

The whole dynamic sequence can now be visualized in Figure 12:

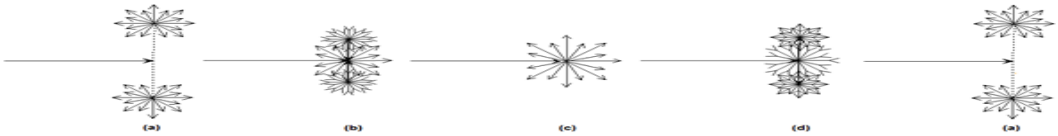

Fig.12: The complete cycle of energy circulation within the dynamic structure of the de Broglie photon.

Referring here to the following dimensions drawing (Fig.13), the reader needs to remember the 3-ribs umbrella metaphor representing the opening from 0o to 90o of the inner dimensions of each space to allow easier visualization.

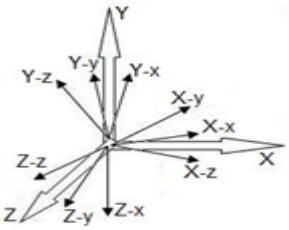

Fig.13: Orthogonal structure of the 3-Spaces model.

Having already explored the behavior of half-photons in electrostatic space, it is easy now to understand that an interaction will begin to exist between the two budding half-photons as they start growing into that space, and that when they reach again the farthest point from the junction that their energy allows, they will once again locally free fall accelerate back towards the central junction, thus initiating the next cycle.

To summarize the complete oscillating cycle, doesn't it look like the photon's energy behaves exactly like a perfectly normal and totally stable discrete LC oscillator as described previously?

I. Energy Behavior as an Incompressible Material

The frequency of a photon depending solely on the amount of energy that it carries, the simple fact that a photon possessing twice the energy of another, requires a distance twice shorter in normal space to complete its cycle, is sufficient in and of itself to demonstrate that the photon's energy locally behaves as a totally incompressible material. It can thus be said that the quantity of energy carried by a photon is inversely proportional to the distance it must travel in vacuum for one cycle to be completed, which can be represented by the following relational equation:

$$E = \frac{1}{\lambda}$$, meaning that product λE is constant.

J. A Distance-Related Counterpart to Planck's Time-Related Constant

It was determined in a separate paper (**[1], Equation (11)**) that this constant, not currently in use as such in physics, and that we will temporarily name the ***electromagnetic intensity constant***, is equal to a very precise set of well known traditional fundamental constants that allow spherical integration of the energy of a photon:

$$H = \lambda E = \frac{e^2}{2\varepsilon_0 \alpha} = 1.98644544E-25\ J \bullet m \tag{17}$$

Interestingly, if we divide this constant by c (the speed of light), we have the surprise to obtain Planck's constant (6.626068759E-34 J•s)! So this new constant turns out to be the distance-based counterpart (or more precisely the transverse-amplitude-based counterpart, as we will see further on) of time-based Planck's constant (whose symbol is **h** and whose units are J•s (Joules second) as opposed to J•m (Joules meter) and that we will study more closely in a coming paper. So it seems appropriate to define this new constant for the needs of the current analysis since this model is distance-based, and to symbolize it with capital **H**, by similarity with Planck constant's lower case **h**. So:

$$H = hc = \lambda E = \frac{e^2}{2\varepsilon_0 \alpha} = 1.98644544E-25\ J \bullet m \tag{17a}$$

Then, if the energy of a photon is the known factor, its wavelength can easily be obtained by dividing this constant by energy E; that is by isolating λ in equation (17):

$$\lambda = \frac{hc}{E} = \frac{H}{E} \tag{18}$$

or if the photon wavelength is the known factor, obtain its energy by dividing constant H by its wavelength, that is by isolating E in equation (17):

$$E = \frac{hc}{\lambda} = \frac{H}{\lambda} \tag{19}$$

K. Transverse Travel of a Photon's Energy Within Electrostatic Space

As to the transverse distance traveled within electrostatic space at right angles with respect to normal space (the transverse amplitude) by the half-photons of a photon whose energy is double that of another, the simple harmonic motion equations (which are obeyed by light) show that the transverse distance reached in electrostatic space will be half that of half as energetic a photon.

In this regard, real scatterable electromagnetic photons seem to often be confused with the virtual photons of QED, and it seems to be the norm to treat real photons with the wave function, as is done with electrons in atoms. Is there any need to emphasize the major difference between electrons, that have a fixed amount of rest mass energy and can only occupy discrete quantum levels in atoms, and true photons, whose total complement of energy typically progressively drifts as they red shift or blue shift in reaction to gravitational interaction?

So it may well be that treatment with the wave function is not ideal for photons, since this treatment implies that photons cannot be localized as they move, which is contradicted by the simple fact that the starlight reaching us allows analyzing the composition of the matter making up these stars, and that such information could not possibly reach us if localized photons did not continuously exist during transit to carry that information about the emitting atoms making up these stars to us. We will thus proceed to a classical analysis of the internal motion of the energy of real photons and we will see where this leads us.

Regarding transverse amplitude A of a photon, that is its amplitude within electrostatic and magnetostatic spaces, we will derive an equation that will allow obtaining it from a fundamental equation of light, that is λf=c, where λ is the wavelength of the photon considered, *f* is its frequency also symbolized by **ν** (the Greek letter ***nu***), and finally c, the speed of light.

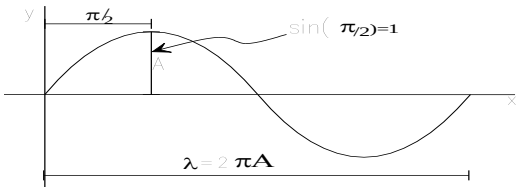

Fig.14: Wavelength and amplitude of a photon's energy.

Since any cyclic motion can be graphically represented by a sine wave, a photon's wavelength λ can be equated to $2\pi A$. Substituting in the previous equation, we can thus isolate A:

$$A = \frac{c}{2\pi f} \quad \text{or} \quad A = \frac{c}{\omega} \qquad \text{(where } \omega \text{ (omega) is the angular velocity)} \tag{20}$$

We observe from Figure 14 that maximum amplitude is reached at a quarter of the cycle, and also when a quarter of the time to complete a cycle has elapsed. Consequently, we can derive

$$A = \frac{c}{\omega \times 1} = \frac{c}{\omega \sin(\pi/2)} = \frac{c}{\omega \sin(2\pi f \times 1/4\, f)} = \frac{v}{\omega \sin(\omega t)} \tag{21}$$

the latter being the standard equation for obtaining the amplitude of simple harmonic motion as can be verified in any basic textbook.

We are now able to calculate the transverse amplitude of the energy of any photon. If this sine wave was used to describe the harmonic oscillation of a particle submitted to a force acting transversally to its direction of motion, the transverse velocity of the particle would of course be zero when amplitude reaches maximum in either opposite direction on the Y-y/Y-z plane, and would be at maximum when the amplitude equals zero.

But given that we are describing the pulsating motion of incompressible energy translating cyclically between two maximum limits, the velocity of the transversally moving energy will be zero at maximum amplitude in both spaces as expected, but it will also be zero when amplitude reaches zero in either space on account of the transverse velocity of the energy tending towards zero as its amplitude tends towards maximum in the other space.

This allows understanding that maximum transverse velocity will be reached when half of the energy has left either electrostatic or magnetostatic space, which means that it is reached at 1/8th the time it takes for one cycle to be completed.

This means also that maximum transverse velocity will be reached 4 times during each cycle of the sine wave representation of the cyclic motion of the photon's energy, that is at 1/8th, 3/8th, 5/8th and 7/8th. In physical reality however, only two such velocity peaks are possible since 3/8th and 5/8th will coincide, as well as 7/8th and 1/8th of the next cycle due to the incompressibility of the fundamental material. We will calculate this velocity in a coming paper.

We can also see that the product of the wavelength **λ** by frequency ***f*** is a constant, known to be the speed of light:

$$\lambda f = c \tag{22}$$

XXIII. THE ELECTROSTATIC RECALL CONSTANT

Why not now do some verifying with a real wavelength to clarify the last remaining hanging threads? We will use the well known electron Compton wavelength (λC=2.426310215E-12 J) since it exactly coincides with the absolute wavelength of a photon of same energy as is captive in an electron rest mass, and that all related data are well known and verified. Let us first determine the ***electrostatic recall constant*** (k) for the LC transverse oscillation for the Compton wavelength related energy (which is of course EC/2= 4.09355207E-14 Joules). From Hooke's law, $E = -kA^2/2$, where A is the related amplitude $\lambda C\alpha/2\pi$, and E is the energy related to the oscillation E = EC/2. Consequently:

$$K = \frac{2E}{A^2} = \frac{4\pi^2 E_C}{\lambda_C{}^2 \alpha^2} = 1.03101917\text{E}16 \ \text{N/m} \tag{23}$$

Now, since F = -k x (x being a distance in meter), the recall force at maximum transverse extent will be

$$F = kA = k\lambda C\alpha/2\pi = 29.05350473 \text{ Newton} \tag{24}$$

Now how can we verify that this figure is correct?

Since F is proportional to kA, if we multiply the equation by α (The fine structure constant), we get the corresponding force for the longitudinal Compton wavelength:

$$F\ \alpha = k\lambda C\alpha^2/2\pi = 0.212013666 \text{ Newton} \quad (25)$$

We know also that the energy induced at the Bohr rest orbital is equal to the electron rest mass energy multiplied by α^2. Since force is proportional to energy, we can further find the force associated with a photon of same energy as the Bohr rest orbital energy by further multiplying by α^2

$$F\ \alpha\ \alpha^2 = k\lambda C\alpha^4/2\pi = 1.12900148E\text{-}5 \text{ Newton} \quad (26)$$

Now, this is the force for a photon of same energy as is induced at the Bohr rest orbital, but that photon is obviously moving at c. We know also that force is proportional to velocity. And we further know that the velocity at the Bohr rest orbital is equal to c multiplied by α. Consequently, a final multiplication by α should give us the well known force associated with the Bohr rest state

$$F\ \alpha\ \alpha^2\ \alpha = k\lambda C\alpha^5/2\pi = 8.238721808E\text{-}8 \text{ Newton} \quad (27)$$

Which is effectively the well known force associated to the Bohr rest orbital.

Doesn't this confirm that the Force / Energy / K / C / L / i / ω parameters of the double-particles photon LC equation of de Broglie's hypothesis are mathematically self consistent?

XXIV. CONCLUSION

First described in a popularization work ([8]) in 1999, a summary overview of this new space geometry was formally presented at **CONGRESS-2000, "Fundamental Problems of Natural Sciences"** ([9]), St. Petersburg State University, St. Petersburg, Russia on July 5 of year 2000.

The complete model based on this expanded geometry with appropriate mathematical support was then the object of a book ([6]) made available in 2004. The fundamental geometry of the model is now presented in this separate paper. All other aspects of the model are also available as separate papers.

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