

De Broglie's Double-Particle Photon (Expanded republication PI)

André Michaud

Service de Recherche Pédagogique

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Abstract: Establishment of an LC equation and of a local fields equation describing permanently localized photons from the analysis of kinetic energy circulation within the energy structure of the double-particle photon that Louis de Broglie hypothesized in the early 1930's. Among other interesting features, these equations provide a mechanical explanation to the localized photon properties of self-propelling at the speed of light and of self-guiding in straight line when no external interaction tends to deflect its trajectory. This paper summarizes the seminal considerations that led to the establishment of the mechanical conversion processes involving electromagnetic energy and mass from electromagnetic photon emission to nucleon construction from the trispatial geometry perspective.

Keywords: - electromagnetic theory, kinetic energy, photon, acceleration, electron-positron pairs, 1.022 MeV, LC equation, trispatial geometry.

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As a tribute to the contribution of Paul Marmet to the development of the electromagnetic mechanics of elementary particles, an **Appendix A** was added to the version republished in 2021, highlighting his contribution to science and incidentally the "high esteem" that was manifested for the accomplishments of this outstanding researcher and experimentalist by his colleagues and the authorities of the *University of Ottawa*, and by the *Natural Science and Engineering Research Council of Canada*:

De Broglie's Double-Particle Photon

André Michaud^{1*}

DOI:

ABSTRACT

Establishment of an LC equation and of a local fields equation describing permanently localized photons from the analysis of kinetic energy circulation within the energy structure of the double-particle photon that Louis de Broglie hypothesized in the early 1930's. Among other interesting features, these equations provide a mechanical explanation to the localized photon properties of self-propelling at the speed of light and of self-guiding in straight line when no external interaction tends to deflect its trajectory. This paper summarizes the seminal considerations that led to the establishment of the mechanical conversion processes involving electromagnetic energy and mass from electromagnetic photon emission to nucleon construction from the trispatial geometry perspective.

Keywords: Electromagnetic theory; kinetic energy; photon; acceleration; electron-positron pairs; 1.022 MeV; LC equation; trispatial geometry.

1. INTRODUCTION

The first integrated representation of electromagnetic energy was provided by Maxwell in the 1860's as a continuous wave phenomenon that would be due to interacting electric and magnetic fields inducing each other while remaining perpendicular to each other and whose transverse oscillation frequency between both states reveals the amount of energy transported by the wave, which led to the hypothesis of the existence of a whole spectrum of electromagnetic energy frequencies that would extend above and below the visible spectrum range. This hypothesis was confirmed 20 years later by Herz as he experimentally generated electromagnetic energy in the invisible radio frequencies range that were confirmed being of the same nature as visible light. Then came Planck's analysis of Wien's experimental data on black body radiation that established electromagnetic energy as always being captured as frequency dependent discrete amounts.

Einstein's definition of the localized light quantum later named *photon* and his photoelectric proof then confirmed Planck's hypothesis shortly afterwards by demonstrating that photons do behave as if they were separate localized quanta when absorbed in atomic structures while also demonstrating that they possess longitudinal inertia, which eventually earned them both Nobel prizes. Compton and Raman then added further experimental confirmation of Planck's conclusion, while experimenting with other types of collisions between photons and electrons stabilized in atomic structures.

These findings conclusively confirmed the discrete point-like behavior of photons when being absorbed. We must also keep in mind that an interaction cross-section always larger than zero must be assumed for all point-like behaving particles during scattering experiments to correctly account for the observed recorded traces, whence the use of the term *point-like* to emphasize the idea that in physical reality, we know that they do not behave as if they were dimensionless *points* in the idealized geometric and mathematical sense, even if their motion can be calculated as if they were; just like the trajectory of the Moon about the Earth can be calculated as if their masses were concentrated in a single idealized dimensionless *point* located in the center of each body.

The point-like behavior of photons upon emission was also subsequently understood and verified, which we will have a look at further on. So, we know for certain that Maxwell's continuous waves do

¹Service de Recherche Pédagogique, Canada.

*Corresponding author: E-mail: srp2@srpinc.org;

not exist as such at the subatomic level, despite the fact that his equations allow successful calculation of all electromagnetic manifestations with the utmost precision when electromagnetic energy is treated as being continuous waves as observable from our macroscopic perspective.

In fact, what these discoveries reveal is that we are in the very same situation with respect to electromagnetic energy that we are in with respect to solid materials, as it closely parallels the fact that although we can observe that the surface of a polished diamond has a flawlessly smooth finish from our macroscopic perspective, for example, we can also alternately observe that this same surface is granular and bumpy when the scattering particles of an electron microscope reveal the outlines of the individual atoms making up the crystal surface at the submicroscopic level.

In the latter case however, we have a rather extensive understanding of the small volumes and even of the inner structure of the atoms involved, but to this date, the inner structure of photons at the subatomic magnitude level, which is as far below the atomic magnitude level that the atomic level is below our macroscopic level, is still the object of speculation because our only means of exploration for this ultimate magnitude level of physical reality seems to be plain and simple reverse engineering from the restricted set of their characteristics that are detectable from their interactions with atoms.

For the past century, there has been a deeply ingrained conception in the case of light that it sometimes behaves as a wave and sometimes as a particle, two types of behavior that are incompatible for a number of reasons and that gave rise to the concept of *wave-particle behavior* and *wave-particle duality* to characterize the photon.

Close examination of the concept in light of the macroscopic-subatomic comparison just put in perspective leads to the view that generally speaking, our perception of *wave behavior* could simply result from the behavior of crowds of discrete photons that our macroscopic instruments generally deal with which would not be in contradiction with the possibility that *particle behavior* would be the natural behavior of individual photons at the subatomic level. This would go a long way in removing the inherent incompatibility of the *wave-particle behavior* concept, by replacing it with a *macroscopic-wave behavior vs subatomic particle behavior* concept.

But we will see further on that with the model proposed here, even at the subatomic level, the localized photon can display both types of behavior without any conflict by associating their standing *transverse wave-like behavior* with their *longitudinal particle behavior*.

Also, despite its systematic point-like behavior in all scattering and capture experiments, behavior typical of elementary particles, the photon was suspected early on of not being elementary because light can be polarized, which cannot be explained if the photon is made of a single point-like behaving particle.

This was clarified by Louis de Broglie after the concept of spin was introduced, that associated a spin of $1/2$ to point-like behaving particles that were proven out of any doubt to really be elementary, such as the electron and the positron, and consequently a spin of 1 to the photon, thus hypothesizing that if it was made of two particles, this would directly explain why light can be polarized ([1], p. 307).

Louis de Broglie was the first to elaborate a comprehensive theory on the possible internal structure of photons. According to his hypothesis as proposed in the 1930's, a permanently localized photon following a least action trajectory can satisfy at the same time the Bose-Einstein's statistic and Planck's Law, perfectly explain the photoelectric effect while obeying Maxwell's equations and remain totally conform to the properties of Dirac's theory of complementary corpuscles symmetry, only if it involves two particles, or half-photons of spin $1/2$, "... *that must be complementary with respect to each other in the same manner that the positive electron [the positron] is complementary to the negative electron in the Dirac Hole Theory*" ([2], p.277).

The following other quotes from the same reference summarize 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 of two elementary particles of spin $h/4\pi$, will obey the Bose-Einstein statistic as required by the precision of Planck's law for the black body."

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 the characteristics of electromagnetic light waves."

Over the course of the 1930's and 1940's, de Broglie and his students progressively came up with an interesting and workable solution based on wave mechanics, that involved both corpuscles being singularities in an underlying wave phenomenon ([1], p. 464). After Quantum Chromodynamics was developed in the 1970's an alternate model was developed, involving a mix of quark-antiquark pairs and gluons [3] based on this new theory and Quantum Mechanics, which also is an interesting and workable approach.

A few other models have been proposed since, but all approaches have the same downside with respect to Maxwell's theory of treating the two separate electric and magnetic fields, either explicitly or implicitly, as being a single *electromagnetic field*, in accordance with the Lorenz gauge perspective, which turns out to be somehow internally featureless at the general level (the electromagnetic tensor), which distracts from permanent awareness that both fields are of equal and separate importance in Maxwell's theory, with different and irreconcilable characteristics, besides mutually inducing each other.

It is to be noted that the Lorenz gauge perspective conceptually leaves no precise function being assigned to the *magnetic* aspect of electromagnetic energy in a possible mechanics of mutual induction that would also involve the two separate charges, which are the *electric* components of the photon, a mechanics that would explain why photons can maintain sufficient local unity to account for their systematic and verifiable point-like behavior during scattering or absorption encounters, however long they may have travelled from their point of emission, which hints at the possibility that they may constantly remain localized all along the way from their point of emission, which includes all photons that we know have been emitted from the farthest reaches detectable in the universe, after having traveled towards us for countless years.

Indeed, the twin *electric* particles end up in both models as having an existence separate from the electric aspect of the electromagnetic energy that the localized photon is meant to represent, which introduces the required twin particles in a manner that does not incorporate them into the sequence of the electric vs magnetic mutual induction cycle that they theoretically are meant to enhance, according to de Broglie's initial hypothesis:

"... it seemed to me that to obtain a clear image, in agreement with the classical concepts of the wave-particle dualism with respect to space and time, it was required to succeed in incorporating the particles into the wave" ([1], p. 466).

But it seems that the non-deterministic trend that prevailed after the 1927 Solvey Congress confronted him with such difficulties that he ended up renouncing this ultimate goal ([1], p. 469).

Generalizing the electromagnetic interaction as a single tensor as Lorenz did is a fine approach to obtain global perspectives, but it seems that looking for ever more detailed descriptions always favored deeper understanding of physical issues. This paper is then an attempt at exploring deeper

even than the already interestingly detailed separate electric and magnetic fields as described by Maxwell's theory.

2. THE REQUIRED INTERNAL ELECTROMAGNETIC SYMMETRY

As it stands, if the photon's double-component electric aspect is to remain coherent with its point-like behavior at the moments of emission and capture (or scattering), however long the time elapsed and the distance covered between both events, the two separate *electric* half-photons have to unite in some fashion during each cycle of the photon's frequency to maintain point-like localization and most importantly to incorporate in the mechanical process the other half of the electromagnetic relation, that is, its magnetic aspect.

Doesn't the induction of an increasing magnetic field inseparable from a changing current due to moving charges immediately come to mind at this point? In the case of photons, this brings displacement current into the picture, which would involve local motion of the postulated double charges that would cause the required change in the local electric field within the photon quantum, a current that would come into being without the presence of matter in this case, a process that interestingly was first proposed by Maxwell himself in 1865 and was the foundation of his electromagnetic theory ([4], p. 625). This in turn hints at the possibility of an internal oscillation of the photon's energy related to its frequency.

Let's keep in mind here that the term *frequency* applies to any sort of cyclic motion, be it rotational, translational on a closed orbit and any other type of oscillatory motion, from simple sinusoidal harmonic motion and finally to the stationary resonance motion due to the cyclic translational reciprocating *swing* between two states that will be considered here and that we will term *oscillation* for simplicity's sake. This means that all aspects of angular momentum that we naturally associate to rotary motion can also be applied to reciprocating motion, which in turn allows the *magnetic spin* of elementary particles to be hypothesized as possibly corresponding to two phases of the reciprocating motion of the energy involved, without changing in any way the equations that already account for elementary particles' spin.

It is a fact that all experimental research aimed at identifying charges in electromagnetic waves has failed to detect any in support of Maxwell's assumption. But let's consider that if electromagnetic waves as Maxwell conceived them really turn out to be only a convenient mathematical representation of a macroscopic perception of a crowd effect due to the presence of a plenum of countless localized photons in motion in all directions at the subatomic level, it would indeed be these individual photons that would display the searched for charges and would be the local sites of displacement current versus magnetic induction activity.

There exists however no instrument sensitive enough to detect the infinitesimal fields of individual photons, with the added difficulties that they all move at the speed of light and that any interception of a single photon simply incorporates its energy as an infinitesimal kinetic energy increment to one electron in one atom of the material that the detector is made of. But since this postulate was such a fruitful foundation in the elaboration of Maxwell's theory, which in turn allows such precise calculation of electromagnetic energy at our macroscopic level, there seems to be no reason to do away with it now.

The double-particle photon hypothesis would then involve that photons have to be stable localized moving electromagnetic structures whose energy quantum could logically only alternate between a two components electric state, with both components separating in space (an electric dipole), and a magnetic state involving only one component to explain permanent localization, a single component that could consequently be dipolar in only one manner.

Total symmetry of such a single component magnetic aspect can be obtained, if permanent localization of the photon is to be maintained, only if it consists in a single *spherical expanding energy phase* as both electric components move towards each other, followed by a *spherical energy contraction phase* as both electric components move away from each other; both magnetic expansion

and contraction sequences of the magnetic component being normal to the electric phase at all times. This also means that the single magnetic component of the photon *can be dipolar only along the time dimension* since both expansion and contraction sequences of the spherical magnetic energy component cannot possibly occur simultaneously.

Such a dynamic structure would still preserve the required fundamental symmetry since the *space-wise* moving electric dipole would be permanently counterbalanced by a related *time-wise* perpendicularly moving magnetic dipole, with both dipoles remaining perpendicular to the direction of motion of the photon in space, thus obeying the triple orthogonal relation required for plane wave treatment in Maxwell's theory's for straight line motion of electromagnetic energy.

3. INTERNAL COULOMB INTERACTION BETWEEN THE HALF-PHOTONS

Let us note here that de Broglie eventually concluded that both half-photons had to be neutrinos ([5], page 158), that is, not being charged negatively for one and positively for the other. But by the same token, he also discarded the possibility that Coulomb interaction could be involved in the process since he considered that the Coulomb force could be in action only between charged particles *signed* negatively or/and positively, a conclusion that was confirmed to me by his lifelong friend and colleague Georges Lochak, in correspondence initiated by me with the *Fondation Louis de Broglie* precisely to clarify this issue, which is why the research that he carried out did not take this possibility into consideration.

Another possibility exists however, considering that both half-photons could be charged in opposition, while not assuming that these charges would be invariant at the unit charge value of the electron, with the pair behaving as if neutral, just like non-ionized atoms appear neutral even though all elementary particles making up their structure are charged. This is the possibility that will be analyzed in this paper.

Paradoxically, it has been understood and extensively experimentally confirmed since the 1930's that any photon of energy 1.022 MeV or more, that has no rest mass and is electrically neutral, will destabilize and convert to a pair of electron-positron, massive and charged in opposition, when grazing a heavy particle such as an atomic nucleus.

Could then the *signs* be an *extrinsic property* of elementary particles' charges, possibly vectorial, that would be acquired during the separation process of the pair? This would leave the door wide open to the possibility that some form of Coulomb-like interaction might be involved at a level more fundamental than that of the acquisition of the opposite *signs* by the charges of the separating elementary particles. So let's dwell for a moment on what considering the electric *signs* of elementary particles as a property separate from their *charges* allows visualizing.

From this perspective, the very existence of *fractional signs*, so to speak, for the charges of the up and down quarks making up the inner scatterable structure of nucleons means that other *stable sign intensity levels* do exist besides the otherwise universal *unit sign intensity level* of the charges of electrons and positrons.

Note that this comparison is by no means meant to hint at the possible origin of up and down quarks, which is still unresolved, but only to highlight the idea that different degrees of *sign intensity* do exist for stable particles, which allows considering that *sign intensity acquisition* for charges could possibly be a progressive process from null, for initially neutral photon charges as perceived from our observer perspective, to maximum stable *unit sign intensity* for the charges of the electron and positron, with intermediate stable levels corresponding to the up and down quarks' stable *fractional sign intensities*.

The opposite *unit sign intensities* of the electron and positron could then be progressively acquired during the mother photon's destabilization process, possibly induced in the photon's initially possibly neutral charges by the very presence of the *signs* of the charges of the destabilizing particle that the photon grazes, from neutral at the beginning of the process to maximum and stable opposite *unit sign intensity* for the separated charges if the destabilization sequence succeeds in separating the pair, or

eventual regression back towards neutrality of the photon charges if the conversion process fails for whatever reason, leaving the photon moving away with charges returning to neutral without decoupling for photons not energetic enough, or flying by too far from the destabilizing particle for the process to complete, in the case of sufficiently energetic photons.

4. ELECTROSTATICALLY DESTABILIZING TRAJECTORIES INTERSECTIONS

It must be considered also that Quantum Electrodynamics implicitly recognizes the presence of Coulomb interaction between a decoupling photon and a heavy nucleus, since it incorporates a Feynman's *virtual photon* into the pair production process representation (Fig. 1), which was explicitly defined by Feynman himself as being a metaphor for Coulomb interaction [6], thus indirectly recognizing that Coulomb interaction has to be in action between the photon and the destabilizing heavy particle *even before* the pair separates, whatever the sign status of the photon's internal charges may have been.

Let's consider what is likely to occur when a photon of energy 1.022 MeV or more grazes very closely a heavy atomic nucleus. We know since de Broglie that all massive and charged elementary particles are electromagnetic in nature, since electric charges cannot be dissociated from a magnetic counterpart. This includes of course the scatterable point-like behaving massive up and down quarks making up the inner scatterable structures of nucleons (protons and neutrons) since they also possess measurable electric charges, charged quarks whose existence was not yet known when de Broglie was actively working on his hypothesis, since they were experimentally scattered against only in the late 1960's at the Stanford Linear Accelerator (SLAC) facility [7].

Destabilization leading to pair decoupling could then be explainable by the presence of these point-like behaving electromagnetic charged elementary particles of which all nucleons making up atomic nuclei are made, that can presumably enter into homo- and/or heterostatic interaction with the charges of the half-photons while the photon is in its electrostatic phase as it flies by. It becomes just as obvious then that these interactions may then become more and more intense in relation with the inverse square of the diminishing distance that separates the half-photons from these up and down quarks if a Coulomb-like law effectively applies, a process represented in Quantum Electrodynamics by the Feynman diagram shown in Fig. 1 ([8], p. 203):

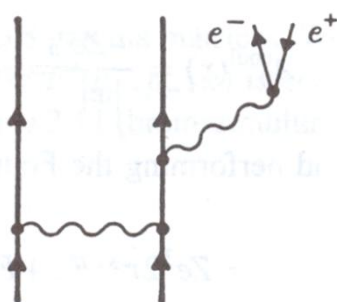


Fig. 1. Photon-nucleus grazing pair creation Feynman diagram

The fact that such decoupling can occur only during moments of very close proximity between photon and nucleus comes in support of the presence of an interaction acting as a function of the inverse square of the distance such as the Coulomb law.

Similarly, pair creation during close flybys of two photons, at least one of which exceeding the 1.022 MeV minimum energy threshold without any atomic nuclei being close by, such as was first experimentally confirmed by Kirk McDonald et al. at the Stanford Linear Accelerator in 1997 with experiment #e144 [9], is represented by the Feynman diagram shown in Fig. 2 ([8], p. 203):

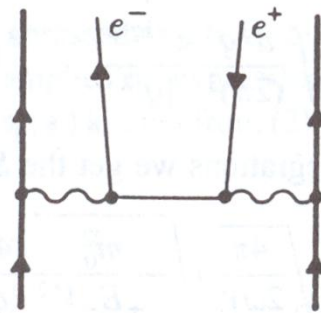


Fig. 2. Photon-photon flyby pair creation Feynman diagram

So there seems to exist sufficient supporting evidence to at least explore the possibility that Coulomb-like interaction could be at play between photons and other localized electromagnetic particles and even between the possibly neutral charges of the de Broglie double-particle photon.

5. PHOTONS, ELECTRONS, POSITRONS, EXCLUSIVELY MADE OF KINETIC ENERGY

After destabilization, the separated halves of the photon's energy can thereafter be observed behaving as one massive $0.511 \text{ MeV}/c^2$ electron plus one massive $0.511 \text{ MeV}/c^2$ positron traveling separately, whose unit charges are now observable as being signed in opposition, and whose velocity away from each other is linked to the residual energy that the mother photon possessed in excess of the 1.022 MeV energy threshold level which has now apparently *converted* into the invariant rest masses of both particles, a process first observed and confirmed by Blackett and Occhialini from the analysis of recorded cosmic radiation scattering impact traces in a bubble chamber in the early 1930's [10].

The reverse process of electron-positron pairs re-uniting to entirely convert back to various photon states was also first observed and confirmed by Blackett and Occhialini, such as in the case of positronium decay. So both reverse processes constitute the *de facto* irrefutable material proof that electrons and positrons are made of the very same energy and are of the very same electromagnetic nature as photons.

In addition to this process of massive electron-positron pairs converting back to free moving electromagnetic energy photon state, we know that electromagnetic photons are created in a variety of other circumstances. But on final analysis, they all turn out to involve the emission of an electromagnetic photon when a charged particle, such as an electron, is suddenly stopped in its motion towards the oppositely signed nucleus of an ionized atom, for example, or similar processes involving metastable partons or events inside nuclei.

If we take the process of a photon being emitted as an electron is being captured by an ionized atom for example [11], the photon that then escapes verifiably carries away part or all of the momentum kinetic energy that the incoming electron was endowed with upon arrival, which is the momentum kinetic energy that it accumulated during its Coulomb force related freefall acceleration towards the location of its brutal relative stop en route towards the attracting atomic nucleus, a location where it is captured in some overwhelming local electromagnetic equilibrium resonance state in some allowed orbital about the nucleus, where it is left with only the exact amount of energy allowed in this new equilibrium state, an amount related to the distance now separating it from the oppositely signed nucleus.

Besides this case of free moving electrons being captured by ionized atoms generating photons in the UV range, all other familiar cases of photon emission involve electrons having moved further away from a nucleus after having been momentarily excited to a metastable higher energy state, that return to a least action energy state as they return to an orbital closer to the nucleus, at which point a photon

is emitted releasing the momentum kinetic energy that now becomes in excess for this closer location. It is from this inner shuffling between electronic orbitals within atoms that the whole range of visible light frequencies is generated.

This motion of an electron being momentarily sufficiently excited to move to a metastable orbital further away from an atomic nucleus, or to outright completely escape from the atom, is always due to this electron having been excited away from its rest orbital through conduction or convection transmitted kinetic energy when in gaseous, liquid or solid materials, or having absorbed a discrete amount of kinetic energy from being collided with by an incoming photon, the latter sometimes being completely absorbed in the process, sometimes relinquishing only part of its energy and moving on with the remainder as a less energetic photon, such as in Compton or Raman scattering.

Photons can thus carry away a whole range of discrete amounts of kinetic energy depending on local circumstances, whose individual frequencies cover the complete gamut of the electromagnetic spectrum, from the longest radio wavelengths to the shortest gamma wavelengths, the latter due to similar emission processes at the level of atomic nuclei. The whole collection of these photons is of course what allows us to see the universe as they hit the sensory cells in our retinas and/or the sensors of our instruments, allowing us in turn to observe and understand our surroundings up to and including determining the composition of stars.

The process of kinetic energy accumulation by charged particles during Coulomb force induced freefall acceleration can easily be verified experimentally at our macroscopic level in a number of ways; with Coolidge tubes for example, as photons are liberated carrying away the exact amount of momentum kinetic energy accumulated during the acceleration phase between the electrodes by electrons that suddenly come to a brutal stop (bremsstrahlung) as they are captured by ionized atoms located on the anode (or anti-cathode).

The emission of photons due to sudden stop of accelerating particles can also be verified with electron beams that are magnetically wiggled in particle accelerators, submitting the electrons in the beam to cyclic transverse accelerations and slowing-downs as the beam is forced to oscillate from side to side, producing so-called synchrotron *radiation*, typically in the X-ray range; or in high energy accelerator storage rings, where beams of charged particles are repeatedly forced by magnetic pulses to maintain a best fit approximately circular trajectory.

Now, the issue always remained unclear as to how unidirectional momentum kinetic energy (aka *translational energy*) accumulating through acceleration of massive and charged particles can *become* electromagnetic when liberated as a photon. Let us recall that the electric and magnetic *fields* of Maxwell's theory was only meant by Gauss to be *idealized geometric/mathematical representations* meant to allow us to better visualize and describe the observed behavior of electromagnetic energy at our macroscopic level, despite the fact that they eventually came to be *assumed* by most in the community as corresponding to the traditional *aether* concept since mathematically treating electromagnetic energy as propagating in such an ambient medium always was so successful.

Indeed, there is no *prima facie* reason for this unidirectional momentum kinetic energy *to change in nature* during the various processes that we examined, particularly since we directly recuperate it as the plain unidirectional momentum kinetic energy that initially apparently converted to electromagnetic photon state as a bremsstrahlung photon was being *emitted* by a decelerating electron, or when a mother photon's residual energy in excess of the 1.022 MeV going into the rest masses of a separating pair is observed precisely defining the velocity away from each other of both particles as unidirectional momentum kinetic energy.

If kinetic energy does not change in nature during these various processes, this also possibly means that what we perceive and measure as *charges* could also be a relative property that could become perceivable only as the unidirectional momentum kinetic energy is in process of separating to escape as a free moving photon, just like the opposite signs of isolated massive particles (electron and positron) could be relative properties that would be acquired as the particles come into being as the mother photon decouples.

So, let us then keep in mind as we move on that we will be attempting to explain how and why discrete quanta of this intriguing *substance* that we name *kinetic energy* can possibly move freely at the speed of light as discrete *electromagnetic* quantities *without changing in nature*. It doesn't seem unreasonable either to think that this *substance* that we identify as *kinetic energy* may have some form of *physical presence*, since its quantized manifestations (photons, electrons, positrons, for example) can verifiably be mutually scattered against each other.

Before proceeding further, let's define more precisely what *physical presence* could mean in the present context. We do not know and may never know what this *substance* or *fluid* really exactly is that we name *kinetic energy*. It may be possible however to come to terms with a usable *nearest possible approximation* of what its physical presence could be. De Broglie on his part thought of electromagnetic energy in terms of a *virtual fluid* ([1], p. 465):

"If we suppose known the form of the wave linked to a particle, the intensity of this wave at each point and at each instant (given by $|\psi|^2$) can be considered as defining the density of a virtual fluid (un fluide fictif) moving in space as time progresses and then the quantity of this fluid contained in an element of volume will give the probability for the particle to be present within this element of volume."

We will be going one step further here considering the apparent identity in nature that seems to exist between fundamental electromagnetic energy and unidirectional momentum kinetic energy that accumulates by means of acceleration, if the latter does not change in nature during the various changes of states that we examined.

If we consider a rotating fan for example, there is no doubt that the incompressible volume of space cyclically visited by the translating blades can be measured and studied, even though we know that the actual volume occupied by the material of which the blades are made and the nature of this material have no relation at all with any of the measurable characteristics of the incompressible volume that the moving blades visit.

If the blades of this fan were invisible to us and if we had no idea even of their existence, we nevertheless could study and measure the incompressible volume that the invisible translating blades cyclically visit, due to the simple fact that trying to touch this volume would have physical consequences that we could then measure and that would allow us to try ascertaining the properties of this volume, even if the actual properties of the blades themselves would remain out of our reach to ascertain.

We would be left to wonder, forever maybe, at what could be causing this volume to exist at all with the possibly unexpected properties that our measurements seem to reveal about the volume that they visit. Indeed, how could we even ever discover the existence of the blades and the nature of the material that they are made of, given that no clue to any of their characteristics are given by our measurements?

We find ourselves in a similar predicament regarding the possible *physical presence* of kinetic energy. We can possibly measure the physical presence of a *volume* for kinetic energy and assign to it the properties required to explain its observed behavior, even though this may not reveal the actual real cause and real nature of what is causing this *volume* to exist.

For the needs of the present analysis, properties such as *incompressibility*, *fluidity*, and *elasticity* could tentatively be assigned to this *volume*, to describe the *tendency of the energy that resides in this volume to always remain in motion* within this volume as the electromagnetic oscillation suggests, and/or alternately to also constantly tend to move as unidirectional momentum energy in space when external electromagnetic equilibrium is not restraining it.

So let us proceed with this tentative *nearest possible approximate definition* of some form of *physical presence* of kinetic energy for the moment, within the frame of the state of our current knowledge about electromagnetic energy, subject to correction or completion as required.

Now, if kinetic energy doesn't change in nature as it quantizes as free moving photons, the internally oscillating motion of the kinetic energy quantum could metaphorically be immobilized. The energy of this quantum could then be theoretically reduced to the smallest spherical uniformly isotropic volume that it could occupy, for the purpose of assessing its absolute density. This volume, that could be named the *theoretical stationary isotropic volume* of the energy of a photon, however small, would depend on the local amount of this kinetic energy, an amount that can be calculated (See Reference [12], Equations (40) to (41)). We will use this volume in Subsection 17.7.

The fundamental question can now be summarized as follows:

How can a quantity of momentum kinetic energy, accumulating due to Coulomb force freefall acceleration of a massive particle (an electron for example) as the latter unidirectionally increases its velocity 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 escaping at the speed of light (a photon), while being animated with the standing local multidirectional oscillating motion suggested by de Broglie's hypothesis; a localized quantum whose energy 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 without changing in nature?

It must be obvious at this point that all photons have to be made of the same material, that is, *quantized amounts of kinetic energy*, an apparently physically existing *substance* that we still know so little about and that appears to be the only *material* of which all photons and all existing charged and massive elementary particles seem to be made of.

6. THE DISTRIBUTION OF KINETIC ENERGY WITHIN A LOCALIZED PHOTON

Now, the question comes to mind as to how this kinetic energy self-organizes within the photon to sustain a transverse electromagnetic oscillation at a particular frequency and at the same time sustain its own longitudinal motion at the speed of light in vacuum.

Clues to this internal structure were given by a brilliant analysis carried out by Dr. Paul Marmet in an article that was accepted for publication in the Kazan State University International IFNA-ANS Journal, in 2003, titled: "*Fundamental Nature of Relativistic Mass and Magnetic Fields*" [13]. See Appendix A for a short summary of Paul Marmet's lifetime achievements.

His analysis of the observed relation between the relativistic mass increase of an accelerating electron and the simultaneous increase of its transverse magnetic field eventually led to the mathematical establishment for the first time in history that both the transverse magnetic field increment and the transverse mass increment of an accelerating electron can only be due to the same amount of increasing energy traditionally measured in two different ways without this relation having become obvious before.

His discovery allowed in turn the definition of an LC equation that can describe a possible dynamic internal energy structure for the carrying energy of the electron in motion. In turn, this LC equation allowed upgrading Newton's non-relativistic kinetic energy equation $K=(mv^2)/2$ to relativistic status [14].

It is the observation that the speed of light is obtained when the mass of the electron is set to zero in this newly defined relativistic equation (See Equation (46) in Reference [14]), that leaves behind only its carrying energy, that finally reveals that free moving electromagnetic photons (carrying no massive particle) are likely to have the very same internal electromagnetic LC structure as that of the carrying energy of moving electrons (See Subsection 17.9).

Dr. Marmet obtained the following definition of current by quantizing the charge to its invariant unit value, which removed the time element from the equation as he replaced dt by dx/v , given that the velocity of electrons in a conductor remains constant if current I remains constant:

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

Where e represents the unit charge of the electron and N represents the number of electrons in one Ampere. Substituting the resulting value of I in the scalar version of the Biot-Savart equation then allowed doing away with the time element in this equation also:

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

Without going into the detail of his derivation, which is very clearly laid out from Equation (1) to Equation (26) in his paper [13], and which is also exhaustively analyzed in references [11] and [15], let us only mention that the final stage of this derivation was to spherically integrate the electron magnetic energy, whose density is mathematically deemed to vary from a minimum limit corresponding to r_e (the so-called *classical electron radius*) to a maximum limit located at infinity.

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

This electron classical radius r_e 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, he obtained:

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

which very precisely corresponds to the total instantaneous 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.

When this velocity is small with respect to the speed of light, the following classical equation is obtained, allowing clearly determining the contribution of the magnetic component to the rest mass of the electron:

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

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

$$M_0 = \frac{\mu_0 e^2}{8\pi r_e} \quad (6)$$

which is exactly half the invariant rest mass of an electron, the other half ending up corresponding by default to what could be termed its *electric mass*, since the electron is an electromagnetic particle.

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

momentum kinetic 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 momentum kinetic energy required to propel an electron with magnetic mass M at velocity v is exactly equal to the amount of energy just calculated as establishing the velocity related instantaneous relativistic mass increment $M - M_0$ of the moving electron.

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

$$E_{\text{total}} = E_{\text{translational}} + E_{\text{magnetic mass increment}} \quad (7)$$

Since energy in motion cannot be dissociated from electromagnetism, it can be forcefully asserted that an electric component must *de facto* be involved in relation with the half of this energy that clearly is *magnetic* in nature, and the only way for it to be introduced in context seems to be 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.

$$E_{\text{total}} = E_{\text{trans.}} + \left[E_{\text{elec.}} \cos^2(\omega t) + E_{\text{mag.}} \sin^2(\omega t) \right] \quad (8)$$

Such an alternance seems of course at this point to be an overly bold assumption to be made, even considering that the de Broglie hypothesis as analyzed in Section 2 seems to mandate it for the internal electromagnetic structure of his photon concept to make mechanical sense, because it involves that the magnetic field of the moving electron would not be stable, but would cyclically appear and disappear at its energy frequency.

But given that the electron always displayed point-like behavior during all recorded scattering events, such point-like location involves by structure that both poles of its intrinsic magnetic field would geometrically coincide with the center of this point-like location, which in turn also involves by structure that both poles can be present only in alternance since they cannot be simultaneously attractive and repulsive with respect to the poles of another magnetic field, which is in agreement with the idea that one polar orientation would correspond to the time-wise spherical expanding phase of this magnetic energy and that the other would correspond to the time-wise spherical contraction phase put in perspective in Section 2.

It so happens that it is possible to demonstrate the alternate presence of the poles of a magnetic field whose locations geometrically coincide even at our macroscopic level with magnets magnetized in such a way that both of their poles geometrically coincide with the geometric center of these magnets, because the data collected from an experiment involving the interaction of two such magnets published in 2013 [16] brings proof that the force that can be calculated between two such magnets amounts to precisely half the force that can be calculated between two bar magnets, whose poles within each bar are separated by a measurable distance. This same amount of force, involving by structure the alternate presence of both poles of the magnetic field of actual electrons was confirmed during the Kotler et al. experiment in a paper published 1 year later [17].

The form arrived at with Equation (8) in turn immediately suggests the following LC relation to represent the internal structure of the carrying energy of an electron in motion:

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

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

$$E_{E(\max)} = \frac{q^2}{2C} \quad \text{and} \quad E_{B(\max)} = \frac{L i^2}{2} \quad (10)$$

Equation (9) reveals that all probabilities are that the velocity of light of an isolated electromagnetic photon would be maintained by structure from the simple fact that the translational momentum half of its kinetic energy serves to propel at this velocity *an equal amount* of longitudinally inert transversely oriented kinetic energy that permanently oscillates in standing mode between an electric state and a magnetic state at the frequency determined by the total amount of kinetic energy involved as hypothesized by Maxwell in context of the establishment of his electromagnetic wave theory. This structure will be analyzed in detail further on.

7. THE NEGLECTED CLASSICAL MAXWELLIAN SPACE GEOMETRY

Maxwell's theory is traditionally considered from the mathematical viewpoint offered by his famous equations and understood within the restrictive perspective of plane wave treatment, leaving the space geometry that underlies it to be mostly taken for granted, since it is sufficient to represent electromagnetic energy as a continuous wave propagating in vacuum, which in turn is sufficient for precise calculations at the general level. This classical space geometry is of course the traditional Euclidean 3-dimensional flat space geometry to which the time dimension is added to justify motion.

Just like the habit of using the Lorenz electromagnetic tensor concept to represent a single *electromagnetic field* keeps away from immediate attention that both electric and magnetic fields are of equal and separate importance in Maxwell's theory, with different and irreconcilable characteristics, the habit of using plane wave treatment leaves in the background the fact that the wave front of an electromagnetic wave as conceived by Maxwell could only be in spherical expansion from some point-like source, a point-like source confirmed out of any doubt by the experimental point-like emission reality for any electromagnetic quanta emission, even if Maxwell's continuous waves had been proven to really exist.

Maxwell's theory is in fact the natural end result of the integration of many discoveries made previously. His first equation is Gauss' law for electricity; his second equation is derived from Faraday's law, his third from Gauss' law on magnetism and his fourth is a generalization of Ampere's law. What Maxwell did in fact was unify into one coherent integrated theory all these experimentally confirmed laws that were not clearly linked to each other previously.

But his really brilliant personal contribution was his success in mathematically linking Faraday's law and his modified Ampere's law in such a way that no doubt could remain that light was intimately linked to electricity and magnetism, as confirmed by Faraday's experiments on light polarization by magnetic fields. Linking them provided as a side benefit the only way ever devised to calculate light velocity from first principles, a velocity which is the only velocity possible from second derivatives of these equations that demonstrate that it rests on the product of only two other fundamental constants, that is, the electric permittivity and magnetic permeability constants of vacuum.

As already mentioned, a fundamental and thoroughly verified aspect of Maxwell's theory is the mandatory state of orthogonality that must exist between the electric and magnetic fields of free moving electromagnetic energy, both fields also being normal to the phase velocity vector that identifies the direction of motion of any point considered on the wave front of the hypothesized spherically propagating wave. Experimental reality reveals that this triple orthogonality also applies to the motion of charged and massive particles, such as electrons being forced to move in straight line when subjected to equal density external electric and magnetic fields.

Indeed, any elementary textbook on electricity and magnetism explains how the vector cross product of equal intensity electric and magnetic fields 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 resulting forces. The more intense the fields, the faster the particle will move, and whose varying velocity is given in classical electrodynamics from the Lorentz equation, by this well known relation:

$$\frac{\mathbf{E}}{\mathbf{B}} = v \quad (11)$$

Which resolves to the fixed speed of light c for photons, from Maxwell's 4th equation:

$$\frac{\mathbf{E}}{\mathbf{B}} = c \quad (12)$$

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

$$\mathbf{E}\hat{j} \times \left(\frac{-1}{\mathbf{B}}\right)\hat{k} = \mathbf{E}\left(\frac{-1}{\mathbf{B}}\right)\cos\theta\hat{i} \quad (13)$$

and since angle θ must be equal to 90° by definition in the case of the straight line motion that we are considering:

$$\mathbf{E}\hat{j} \times \left(\frac{-1}{\mathbf{B}}\right)\hat{k} = v\hat{i} \quad (14)$$

where v is the velocity vector.

The orthogonal bases shown in Fig. 3 will be used in this paper:

- a) 3D rectangular xyz coordinate system, and corresponding rectangular unit vectors base and
- b) The correspondingly oriented rectangular electromagnetic fields vs velocity vector base:

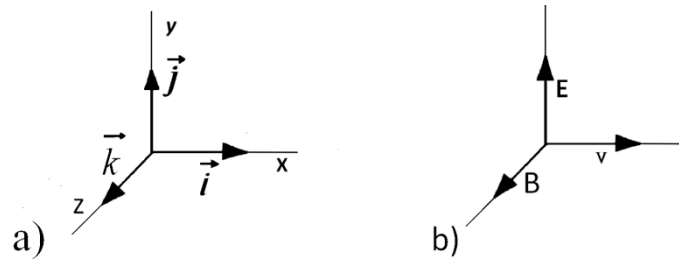


Fig. 3. Orthogonal bases used in this paper

It is generally understood also that despite the calculation precision that Maxwell's theory allows for electromagnetic energy, 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, that is, a pulse spherically propagating in an assumed underlying aether at the speed of light.

8. DISCRETE PARTICLES AS THE ONLY POSSIBLE SUPPORT OF ELECTROMAGNETIC PROPERTIES

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 yet been clarified in Maxwell's time, that is, by treating electromagnetic energy as a featureless energy density per unit volume or featureless energy flow per unit surface rather than by adding the energy of localized moving electromagnetic photons enclosed in a unit volume or flowing through a unit surface,

that would take localization into account and would represent just as well all observed electromagnetic phenomena at the macroscopic level.

Considering that the *electromagnetic waves* that Maxwell conceived of were meant to animate what was perceived from our macroscopic level as a hypothetical underlying all pervading *aether*, then if some means was found to associate to each individual localized photon all of the electric and magnetic properties that characterize the electromagnetic wave of Maxwell's theory, this would remove the theoretical need for the existence of such a supporting all pervading medium for the purpose of supporting continuous electromagnetic waves propagation, that we now know does not exist at the subatomic level.

Let us note also that a second theoretical use of the various forms of the concept of aether was for it to constitute the very substance that massive particles were made of as *singularities* developing in such all-pervading aether fields in a variety of theories. Now if kinetic energy, of which discrete localized photons can be demonstrated to be made, turns out to have *physical presence* with a *volume* that can be measured, this would altogether remove the last reason that would justify resorting to the theoretical concept of aether as a basis to explain the fundamental level of physical reality.

All the more so since it was repeatably and conclusively verified since the 1930's that massive electrons and positrons can be made from destabilizing electromagnetic photons containing at least 1.022 MeV of this kinetic energy [18]. Head-on collision experiments between beams of electrons and positrons carried out at the SLAC facility [19] even lead to suspect that protons and neutrons could be stable adiabatic equilibrium states involving triads of electrons and positrons that could have interacted in such a way that they could have locally adiabatically accelerated until they reach these two ultimate and irreversible equilibrium bound states [20].

Of course, such a possibility seems at first glance to be in total contradiction with the Principle of conservation of energy. But considering that all existing closed systems for which the Principle of conservation of energy can be verified to apply, all having previously reached some form of least action energy equilibrium state, a state that can be modified only by introducing energy in excess of this equilibrium, there exists the possibility that newly created particles, that never were chased out of some pre-existing least action equilibrium state, could accumulate new energy by means of an initial and irreversible adiabatic acceleration process that would bring them to such a first least action energy equilibrium state, after which they would of course be forever subjected to the Principle of conservation [21].

We must not forget either that even if the aether concept could finally be done away with, more and more data seems to confirm that here on Earth, we are permanently immersed in an all pervading interacting magnetic fields combination involving the Earth's magnetic field moving through the immense magnetic field of the Sun that reaches way beyond Pluto, which also interacts with the local magnetic fields of the other planets of the Solar system, and finally there seems to be little doubt that the global magnetic field of our local galaxy also interacts with the Sun's magnetic field.

So, whatever the final solution will be, it will mandatorily involve this all pervading underlying medium in what we consider as the total vacuum of space.

9. THE ISSUE OF INTENSITY CONSERVATION WITH MAXWELL'S SPHERICALLY EXPANDING WAVE CONCEPT

This leads to attempt clarifying why an acceptable description of electromagnetic photons as stable permanently localized moving particles, described as isolated *Lichtquanten* (light quanta) moving at the speed of light by Einstein in line with their point-like localization at the moments of emission and capture as demonstrated more than one century ago, has not yet been successfully reconciled with the verified aspects of Maxwell's theory, particularly after Louis de Broglie elaborated his intriguingly promising hypothesis [2].

According to electromagnetic theory, the electric and magnetic aspects of an electromagnetic wave must by necessity always be in phase at the wave front (Fig. 4), that is, at maximum at the same moment, for the wave to exist at all and propagate.

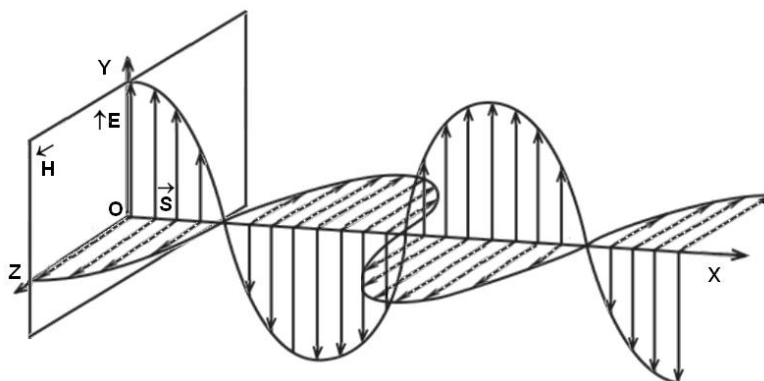


Fig. 4. Lorenz gauge inspired electric and magnetic fields relation in phase, or 180° out of phase, in classical electromagnetism

When both aspects are 90° out of phase, we obtain a standing wave (Fig. 5). But as an intriguing dead end with the Lorenz gauge inspired theory representation, when both aspects are set 180° out of phase, we end up with the exact equivalent of both aspects being in phase again (Fig. 4)! But we will see further on that far from being a dead end in physical reality, this 180° dephasing is in agreement with Maxwell's initial interpretation of mutual induction of both fields and will turn out to be in perfect harmony with the LC oscillation for which we will then give the mathematic development (Fig. 8).

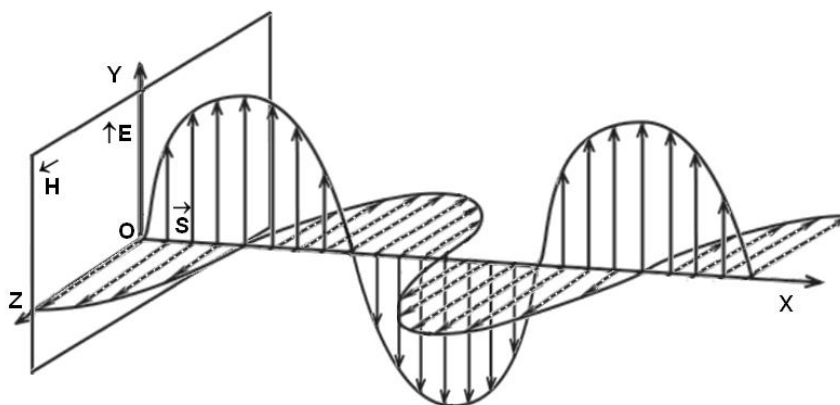


Fig. 5. Electric and magnetic fields 90° out of phase in classical electromagnetism

Also, it is the conjunction of both fields, in phase and at right angle with each other at all points of the wave front which is deemed to maintain the intensity of the energy of the wave at every points of the wave front, despite the inherent spherical spread involved from the mandatory point-like origin of such a wave, if it really existed. This issue is of course familiar to all in the physics community but is apparently seen as an unavoidable axiom, no doubt resting on the comfortable fact that plane wave treatment allows precise calculation anyway from this assumption.

Mathematically speaking, when any point of the curved spherical wavefront surface is considered, this surface can be locally approximated to a plane surface at the infinitesimal level, which is the origin of the *plane wave* equations set for propagation in straight line of any such point of the expanding wavefront.

But space being three-dimensional, such treatment with the plane wave analogy can only be a mathematical approximation obscuring the fact that if such an electromagnetic wave really physically existed, it could only be in spherical expansion from its initial point-like state as previously put in perspective, assuming unbounded isotropic expansion. So plane wave treatment applied to Maxwell's theory currently does not describe electromagnetic energy *as it starts existing* at its point-like source, but *only after* the expanding wave has begun to propagate.

Also, the geometry of such a spherically propagating wave would be much more similar to the spherical expansion of a sound wave from its point-like source in some underlying medium than to the propagation of waves on a plane liquid surface that immediately comes to mind when thinking about plane wave treatment. It then becomes very difficult to accept the idea that the initial intensity of 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 expanding spherical wave front at any arbitrary distance from the punctual source, as plane wave treatment seems to allow.

So the habit of dealing with the state of orthogonality of both fields with respect to each other and to the direction of motion in space of any point on the already expanding wavefront always leaves in the background the fact that such a spherically expanding wave, as a whole, *can only be a single electromagnetic event* originating from a single point-like source.

10. APPLYING ELECTROMAGNETIC PROPERTIES TO MAXWELL'S SPHERICALLY EXPANDING WAVE'S POINT-LIKE INITIAL STATE

Now, considering that such an electromagnetic spherically expanding wave would be a single event, could it not be imagined that after appearing at its point-like origin, it could be represented as remaining locally point-like as it starts moving, harmonically oscillating as it moves, which is what de Broglie's hypothesis implies, instead of spherically expanding as Maxwell's theory implies by definition?

This would involve a precise trajectory being followed by this electromagnetic event, which would then behave point-like from emission to capture, which would in turn be in total harmony with the verified fact of its point-like capture, however much time could have elapsed after it was emitted and whatever distance it could have covered before being captured. This would also directly explain why the initial intensity of this electromagnetic quantum is conserved, barring energy losses or gains through red or blue shifting due to gravitational interaction along the path that it would have followed.

The idea then naturally comes to mind that the state of fundamental orthogonality of both electric and magnetic fields could possibly be served just as well, if not better, by being defined with respect to this electromagnetic event immediately as it initially appears point-like at the very moment of its emission, *instead of only after its alternately assumed spherical expansion would have been under way*. But the apparently insurmountable issue with this approach in classical electrodynamics is the mathematically assumed infinite energy traditionally associated with such a punctual electromagnetic concept.

Another problematic issue also comes to light with the idea of mathematizing free moving energy at its point-like source. It is the fact that both fields of any point-like electromagnetic quantum (a photon) which is in process of being emitted by a de-energizing electron, can be orthogonal to no particular direction in space at the very moment of point-like separation, which leads to the intriguing conclusion that at the very moment of separation from the emitting stabilizing electron, both fields of the new photon could be orthogonal only to 3D space proper, despite the strangeness of the idea.

Considering also that electric force interaction obeys the inverse square law of electrostatic attraction and repulsion between the charges of elementary particles and that the magnetic interaction between the same particles obeys the inverse cube law of magnetostatic attraction and repulsion [16,17] makes it appear illogical, and even impossible, that quantized quantities of kinetic energy could possess both electric and magnetic properties at the same moment, or even in alternance, *while not changing in nature*.

The inverse square interaction law between electrically charged elementary particles, that is, the Coulomb law, is very familiar, but the inverse cube law between the magnetic aspects of the same point-like behaving elementary particles is much less familiar. A direct confirmation of this inverse cube relation was very recently obtained by Shlomi Kotler and his team between the magnetic aspects of two electrons, as reported in *Nature* magazine in April 2014 [17] thus confirming by the same token the validity of the lab bench experiment carried out previously and was published in 2013 [16].

It is precisely the existence of these mutually incompatible inverse square law, applying to the electric aspect of point-like behaving elementary electromagnetic particles, and of the inverse cube law, applying to their magnetic aspect, that elicits the strongest doubt on the ability of classical 4D spacetime geometry to allow the kinetic energy that the particle is made of to continue displaying these irreconcilable properties *while not changing in nature* as it electromagnetically oscillates while moving at the speed of light through vacuum, if kinetic energy is to be considered being a *physically existing substance*.

These considerations are what gave birth to the idea that the physically existing space geometry at the fundamental subatomic level may be more complex than can be directly observed from our macroscopic level, and that extra spaces could possibly be involved to allow for these possibilities, that is, a second space that would allow kinetic energy to display electric characteristics *without changing in nature*, and a third space that would allow kinetic energy to display magnetic characteristics *without changing in nature*, both extra spaces remaining permanently perpendicular to each other and to normal space at the particle level.

It is to be noted at this point that Louis de Broglie was the first to also come to the conclusion from other considerations that it was impossible to exactly represent elementary particles in the restricted frame of continuous three dimensional space. Here is what he wrote in 1936:

"... the non-individuality of particles, the exclusion principle and exchange energy are three intimately related enigmas; all three are tied to the impossibility of exactly representing elementary physical entities within the frame of continuous three dimensional space (or more generally of continuous four dimensional space-time). Some day maybe, by escaping from this frame, will we better grasp the meaning, still quite cryptic today, of these major guiding principles of the new physics." ([2], p. 273).

An expanded space geometry that allows a clear definition of the de Broglie double-particle photon without its kinetic energy quantum changing in nature, and that may also allow resolving some of the issues raised by de Broglie, was first introduced during *Congress-2000* held in July 2000 at Saint Petersburg State University [22]. This new space geometry will now be described before proceeding to build the LC and local fields equations that can represent the permanently localized de Broglie double-particle photon in this expanded space geometry.

11. EXPANDING THE SPACE GEOMETRY BEYOND NORMAL 3D SPACE

As previously done with the proposed idea of a possibly usable *nearest possible approximate definition* for the *physical presence* of kinetic energy as a being a *physically existing substance*, we may think of such an expanded space geometry as a possibly usable *nearest possible approximate definition* of the required space geometry, within the framework of the current state of our knowledge about electromagnetic energy.

If we imagine the observed electric behavior of charges as being due to the momentary presence of the incompressible energy of a photon in a separate 3D-space that allows such behavior, and its observed magnetic behavior as being due to the alternate momentary presence of the same amount of energy 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, both spaces remaining permanently perpendicular to each other and to normal space, and *that would allow the circulating kinetic energy not to change in fundamental nature*, it will become possible to visualize much more

clearly the internal oscillation of the kinetic energy of the localized double-particle photon of de Broglie's hypothesis.

In order to more easily refer to these new spaces, let us name *electrostatic space* the space into which kinetic energy displays electric behavior, and *magnetostatic space* the space into which it displays magnetic behavior. For coherence, we will identify normal, electrostatic and magnetostatic spaces as being X-space, Y-space and Z-space respectively. Within normal X-space, let us rename the three minor spatial dimensions: X-x, X-y and X-z and likewise, for electrostatic and magnetostatic Y- and Z-spaces: Y-x, Y-y, Y-z and Z-x, Z-y, Z-z. Of course, when the x, y and z dimensions are used without major axis prefix, they refer as usual to normal 3D space (Fig. 6).

Let us assume furthermore that the minor x-axes of all 3 spaces are mutually parallel to each other in a direction corresponding to the conventional direction of motion of energy in normal space in plane wave treatment.

In this space geometry, a *point-like junction* (representing a "passage point" in physical reality, not a "dimensionless point" in the mathematical sense, whence the best-fit representation phrase "point-like" being used, which does not exclude the possibility of a local very small "volume" or "area", however small, being involved) between these three orthogonal spaces would be located at the geometric center of each photon, and it is this *point-like junction* that would be moving point-like at the speed of light in normal X-space, that is, along the X-x axis of this expanded geometry in plane wave treatment (Figs. 6 and 10).

To be able to mentally visualize the locally standing motion of kinetic energy in this 3-spaces structure, an easily mastered technique can be used. It suffices to imagine the 3 familiar minor x-y-z orthogonal dimensions of normal 3D space as if they were the ribs of an open 3-ribs metaphorical umbrella, the apex of which would be located at the origin (i.e. the point-like passage point where the 3 spaces meet). If we mentally fold the umbrella, we can now visualize the folded umbrella as if it was the linear major X-axis of this expanded coordinates superset.

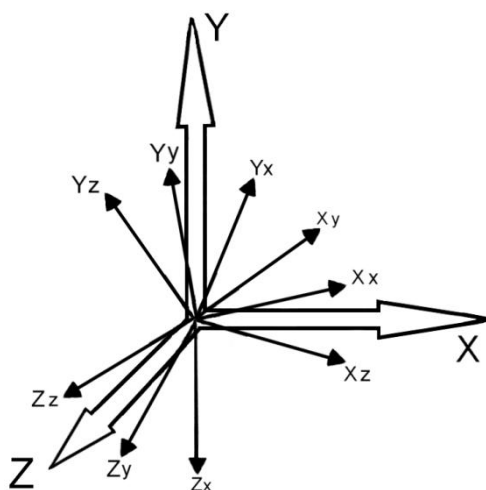


Fig. 6. The orthogonal structure of the 3-spaces model

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

As observed from within normal X-space, which will be our observer's viewpoint during this analysis, free fall acceleration induced unidirectional momentum kinetic energy accumulating within the same

normal X-space will be locally perceived as having longitudinal inertia *but no transverse inertia* for a reason that will be analyzed in detail in Subsection 17.9.

To summarily put this in perspective, the longitudinal inertia of electromagnetic photons was experimentally confirmed more than one century ago by the same photoelectric proof due to Einstein that confirmed that electromagnetic energy behaves as discrete localized quanta and not as a continuous wave phenomenon. And the absence of transverse inertia for unidirectional momentum kinetic energy on its part was also experimentally demonstrated more than one century ago by Walter Kaufmann [23] as he demonstrated that the transverse inertia of electrons accelerated to relativistic velocities was lower than their longitudinal inertia.

From within normal X-space again, all energy present within electrostatic and magnetostatic Y- and Z-spaces at any given moment of the electromagnetic cycle will appear to possess both longitudinal and transverse inertia, that is, *omnidirectional inertia*. In other words, it will appear to possess *electromagnetic mass*. Metaphorically speaking, the energy present in these two extra spaces would behave as if it was captive inside some invisible *container* that will resist being pushed around from any direction from within normal X-space. Although photons are known not to have a rest mass, they are also known to possess an electromagnetic mass that can be interacted with gravitationally as observed during Solar eclipses since 1919 (See Subsection 17.9).

The photon itself will now appear as a discrete amount of kinetic energy, half of which remaining unidirectional as momentum energy moving in normal X-space as determined in **Section 6**, propelling the other half that would be transversely oscillating cyclically through the point-like junction between electrostatic and magnetostatic Y- and Z-spaces at the frequency determined by the photon's energy but that would be longitudinally inert as perceived from orthogonally oriented X-space, its forward motion within X-space being accounted for by the related unidirectional momentum energy half pushing against the trispatial point-like junction. A separate analysis explains why half of any localized photon's energy quantum (that is, the photon's translational momentum energy) has no option but to remain unidirectional within the photon's inner structure, even without invoking the 3-spaces concept and the double-particle concept, to propel the other half of a localized electromagnetic photon's energy at the speed of light [14].

The properties of unbounded *elasticity* and *fluidity* tentatively assigned previously to the kinetic energy *substance* can even allow for both half-photons to possibly never be *completely separated* from each other nor from the portion moving unidirectionally in normal X-space as they separate as two half quantities within electrostatic Y-space, or as they transfer to magnetostatic Z-space as a single quantity. The complete amount of the photon's kinetic energy quantum could then continue remaining a single continuous quantity permanently linked through the central point-like junction between the 3 spaces.

This model of the double-particle photon can now be seen as displaying transverse wave behavior with a frequency related to the amount of energy that its quantum possesses, while at the same time displaying longitudinal particle behavior with longitudinal inertia related to the total amount of energy that its quantum possesses and transverse inertia related to half this amount, which is conform to all experimentally observed characteristics of the photon.

12. DEFINING THE MAJOR UNIT VECTORS SUPERSET

The traditional \hat{i} , \hat{j} and \hat{k} unit vectors previously mentioned in Section 7 were of course defined to represent vectorial properties in normal 3D X-space. But in this expanded 3-spaces geometry, both new spaces also require their own internal minor unit vectors set.

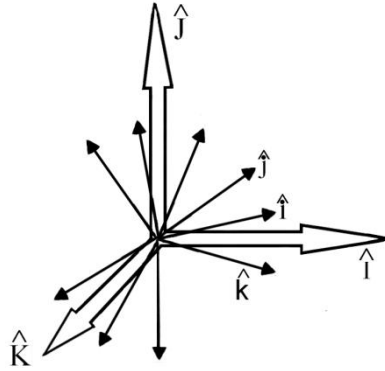


Fig. 7. Major and minor unit vectors sets applicable to the 3-spaces model

So let's define a new superset of major unit vectors that will identify the three orthogonal spaces with capital letters as $\hat{\mathbf{I}}$, $\hat{\mathbf{J}}$ and $\hat{\mathbf{K}}$, so that each minor 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 (3 major and 9 minor) being of course drawn from the same origin O corresponding to the point-like junction between the 3 spaces (Fig. 7).

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 $\hat{\mathbf{I}}-\hat{\mathbf{i}}, \hat{\mathbf{I}}-\hat{\mathbf{j}}, \hat{\mathbf{I}}-\hat{\mathbf{k}}$ for normal X-space, $\hat{\mathbf{J}}-\hat{\mathbf{i}}, \hat{\mathbf{J}}-\hat{\mathbf{j}}, \hat{\mathbf{J}}-\hat{\mathbf{k}}$ for electrostatic Y-space and $\hat{\mathbf{K}}-\hat{\mathbf{i}}, \hat{\mathbf{K}}-\hat{\mathbf{j}}, \hat{\mathbf{K}}-\hat{\mathbf{k}}$ for magnetostatic Z-space, allows defining the vectorial magnitude of the energy of a particle in any one of the three orthogonal coexisting spaces at any given moment.

This is how the vectorial relation drawn from Lorentz mentioned in Section 7 becomes in this expanded space geometry:

$$\mathbf{E}\vec{\mathbf{J}} \times \left(\frac{-1}{\mathbf{B}} \right) \vec{\mathbf{K}} = v\vec{\mathbf{I}} \quad (15)$$

13. ELECTROMAGNETIC OSCILLATION ENERGY-DRIVEN RATHER THAN FIELDS-DRIVEN

Now that we can view the photon kinetic energy quantum as a single continuous quantity permanently linked through the central point-like junction between the 3 spaces, comes into question the issue that the part of this amount that oscillates between electrostatic and magnetostatic Y- and Z-spaces must display distinct and apparently irreconcilable electric and magnetic properties that must continue to be representable as being reciprocally induced by the other aspect as in classical electromagnetism according to Maxwell's initial interpretation, that is, by means of apparent mutual *fields* interaction.

For example, if kinetic energy actually is a *material substance* that consequently occupies a *physical volume* in space and possesses the properties of *incompressibility*, *fluidity* and *elasticity* that were tentatively assigned to it in Section 5, then to explain why the transversely oriented half of a photon's energy can remain in continuous standing oscillation mode between both electrostatic and magnetostatic Y- and Z-spaces as confirmed by the known constant transverse standing oscillation of electromagnetic energy, a fourth property must also be tentatively assigned to this material substance, which would be a property of *always-tending-to-remain-in-motion*.

Such a property would explain by structure why the transverse oscillation between the two Y- and Z-spaces as well as within both spaces can only be entirely symmetric, given that in the absence of any external *fulcrum* to push against, the energy quantum can only naturally start moving by symmetry

with respect to its own inner center of presence if it really possesses this property of *always-tending-to-remain-in-motion*.

For example, when a magnetic pulse is emitted by a fixed length dipole antenna each time the antenna is overloaded with energy, at the very moment of separation, this energy pulse ends up on its own with respect to its environment. Its immediate forward motion as it separates already has to cause part of its substance to self-orient unidirectionally as its initial momentum component to account for this initial separation velocity.

For symmetry to be maintained, and in complete accordance with Newton's third law of motion that *for every action in nature there is an equal and opposite reaction*, an equal amount of the quantum's substance has to become translationally inert, which will cause resistance to the rectilinear motion now sustained by the initial momentum component, thus creating a *fulcrum* for this initial unidirectional momentum energy component to push against.

The only mechanical way for this equal amount of the quantum's substance to become translationally inert in opposition to the longitudinal pressure of the initial unidirectional momentum energy component is to orient itself transversely with respect to the direction of motion of this initial unidirectional energy component, and for this now transversely re-oriented energy component to symmetrically remain in motion transversely in accordance with the principle of symmetry is to first separate into two parts moving in opposite directions on this transverse plane.

As long as all of the quantum's energy is not completely symmetrically distributed longitudinally and transversely, this process is bound to continue, its velocity in space increasing as its unidirectional momentum component's energy increases, until all of the quantum's energy is oriented either longitudinally or transversely, at which point, the quantum's equilibrium velocity of light is established by half its energy longitudinally oriented providing the momentum energy that propels its equal amount of translationally oriented inert other half [11,14].

At the precise moment when all of the quantum's energy has been reoriented as two halves perpendicularly oriented with respect to each other (See **Fig. 9a**), the energy that separated as two components moving in opposite directions on the transverse plane already establishes the electric aspect of the related electromagnetic oscillation. Having reached the farthest distance from each other that this transverse amount of energy can reach, since no more un-oriented energy is available, the only possibility for these two separate transverse components to remain in motion will then be to start symmetrically moving backwards towards their common center of presence.

Since the now symmetric equal separation of the quantum's energy between propelling momentum energy and propelled half prevents this energy returning towards the now common fulcrum from adding to the momentum component, the only mechanical way that the incompressibility property of the energy substance will allow this returning energy to continue moving will be for it to start moving symmetrically in a third direction by expanding omnidirectionally as an energy sphere (Fig. 9b) until all of the moving energy stops moving again (Fig. 9c), establishing the magnetic aspect of the electromagnetic oscillation, at which point the only possible way for this energy to remain in motion will then be to spherically regress as it separates again as two components moving in opposite directions on the initial transverse plane (|Fig. 9d) until all of the energy again reached the maximum distance it can possibly reach in opposite directions (Fig. 9a), which will initiate the next cycle, thus establishing the permanent standing transverse oscillation of electromagnetic energy that Maxwell first suspected to be a property of light, all of this in complete accordance with the principle of symmetry formulated by Newton in 1687 as his third law of motion, if a property of *always-tending-to-remain-in-motion* is assumed for the kinetic energy *substance*.

Given that the energy of the whole quantum has now acquired the LC structure defining its unidirectional momentum half as propelling an equal amount of translationally inert transversely oscillating half, the resulting velocity of the quantum can only be the equilibrium speed of light by structure as demonstrated in Reference [14]. More on this equilibrium velocity in Subsection 17.8.

In other words, this fourth property being assigned to *physically existing* kinetic energy of *always-tending-to-remain-in-motion* sets this property of kinetic energy as *the ultimate component of the causality chain in the universe* because on top of becoming the single cause of *motion of free moving electromagnetic energy and of massive elementary electromagnetic particles*, when motion of the momentum energy of the latter, of which all matter in the universe is made of is impeded, its tendency to remain in motion can only result in a *pressure* being applied in the same vectorial direction against the fulcrum offered by the trispatial junctions within these electromagnetic particles, a permanently applied *pressure* that can easily be related to gravitation [15], which also sets this property as *the ultimate cause of gravitation in the universe*.

So, instead of a relation of mutual orthogonal induction of two fundamentally different electric and magnetic *fields* according to Maxwell's initial interpretation, this relation would be one of cyclic self-induced translation of the transversely oriented energy *not changing in nature* between both orthogonal Y- and Z- extra spaces (Fig. 8).

That is, an energy that would always conserve the same four characteristics of *incompressibility, fluidity, elasticity* and *always-tending-to-remain-in-motion* that it initially possessed before it was quantized to become a photon, but that would give the impression of having alternately all of the electric set of characteristics when momentarily present in electrostatic Y-space, and then, all of the magnetic set of characteristics when momentarily present in magnetostatic Z-space; but whose high frequency cyclic translation between the two states (between the two spaces in reality) would create the impression at our macroscopic level of the simultaneous and permanent presence of both fields of Maxwell's theory inducing each other.

This would in no way negate the usefulness of fields representations however. Fields would simply take second seat to the now self-induced motion of the kinetic energy proper becoming more fundamental, operating as a primary cause of the electromagnetic oscillation, being perceived momentarily as *electric energy* as it transits within electrostatic Y-space and momentarily as *magnetic energy* as it transits within magnetostatic Z-space.

It seems entirely conceivable that such a high frequency cyclic translation process of a discrete quantity of incompressible energy between these two spaces, could explain the frequency of the photon and of all other observed phenomena while preserving the usefulness of the traditional perception of the so convenient and precise electric and magnetic fields that would mutually induce each other or would be seen as peaking to maximum as conceived of by Lorenz, but would also open up an entirely new range of possibilities, a few of which will be discussed in Subsections 17.8 and 17.9.

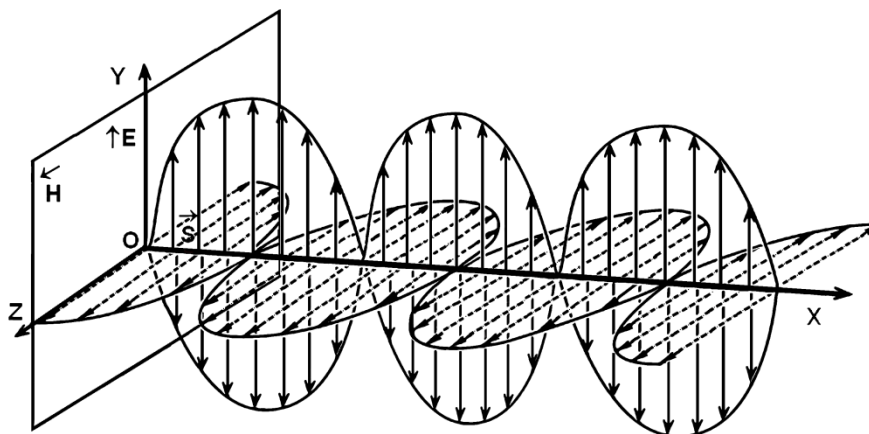


Fig. 8. Electric and magnetic fields 180° out of phase in the 3-spaces model according to Maxwell's initial interpretation

Maxwell's four original equations remain entirely valid from this new perspective, since his second equation ($\nabla \times \mathbf{E} = -\dot{\mathbf{B}}$) derived from Faraday's induction law, does not mandate that both fields be in phase as in Lorenz's interpretation, since it also directly accepts the opposite relation, that of reciprocating mutual induction of both fields when out of phase by 180° as being considered here.

14. UNDERLYING KINETIC ENERGY CIRCULATION

Let us now summarize the inner motion of kinetic energy within the structure of the double-particle photon.

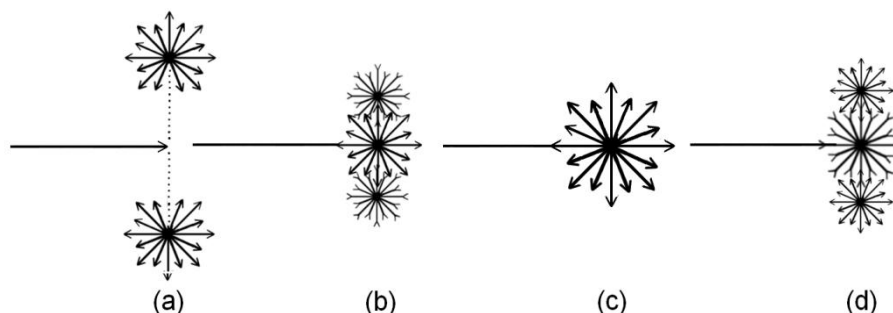


Fig. 9. The complete cycle of kinetic energy circulation within the structure of the double-particle photon

This motion can be summarized as 4 distinct steps:

- (a) The two half-photons having reached the farthest distance that they can reach within electrostatic Y-space.
- (b) The two half-photons closing in towards each other in electrostatic Y-space as their energy begins to transfer omnidirectionally into magnetostatic Z-space.
- (c) The total complement of the two half-photons' energy having now completely crossed over into magnetostatic Z-space, now making up the single spherical magnetic Z-space component.
- (d) The energy present in magnetostatic Z-space starting to cross over back into electrostatic Y-space as two separate half-photons.

(a) and (a) again as the cycle completes, poised to start the whole sequence again at the frequency mandated by the amount of kinetic energy making up the photon's energy quantum.

All through this process, the other half of the photon's energy, which is permanently located within normal X-space, remains in stable unidirectional motion, propelling the transversely oscillating half of the photon's energy at the speed of light in normal X-space vacuum by applying *pressure* against the fulcrum offered by the trispatial junction.

15. APPLYING PLANE WAVE TREATMENT TO THE PERMANENTLY LOCALIZED DOUBLE PARTICLE PHOTON

A point of particular interest with this internal photon structure is that it allows continued use of the plane wave analogy, but in which at any given instant of the cycle, the product of the electric and magnetic fields remain constant over the plane intersecting the central junction, perpendicularly to the direction of propagation of the photon (Fig. 10).

The energy of the photon would behave with respect to this plane as if it was stationary, as it actually is in the reference frame of the moving point-like junction, with the associated benefit that this plane, just like the point-like junction, can regardless continue moving at the speed of light in normal 3D X-space (along the X-x axis). See Section 17.8.

Also, we can observe that the product of the projections on the transverse plane of the electric and magnetic oscillating energy will be constant and consequently will not fluctuate over time as is the case with classical Lorenz gauge inspired in-phase wave front plane wave treatment.

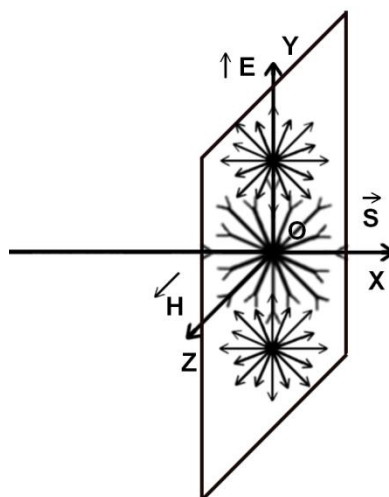


Fig. 10. The plane wave concept being applied to a permanently localized photon

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

$$\mathbf{S} = \frac{\mathbf{E}\mathbf{B}}{2\mu_0} \quad (16)$$

instead of fluctuating over time as in classical electromagnetism, since one other characteristic of the application of plane wave treatment to the double-particle photon in motion is that the value of \mathbf{S} corresponds by structure very precisely to the average value of the *intensity* of the *wave* as calculated from the classical electromagnetism perspective ([24], p.989).

Let us note here that this measured *intensity* is directly reconcilable with the conclusion of this model according to which only half of the energy of a photon would be oscillating to and fro between electrostatic and magnetostatic states while the other half would not be oscillating but would remain stable and moving unidirectionally to simply propel the oscillating half by applying pressure against the trispatial junction.

16. THE DOUBLE-PARTICLE PHOTON INVOLVES 2 CHARGES

It is highly interesting to note that the new generalized form of the Coulomb equation applicable to energy calculation that does not require using Planck's constant, inspired by the manner in which Marmet derived the magnetic energy of the accelerating electron, as described in a separate analysis (See Reference [12], Equation (11)) involves by structure two interacting charges:

$$E = hf = \frac{hc}{\lambda} = \frac{e^2}{2\epsilon_0\alpha\lambda} \quad (17)$$

The very form e^2 reveals that both charges associated to a free moving electromagnetic energy quantum allows defining them as identical and symmetric, so that they can also effectively appear to be neutral $|e|^2$ as perceived from normal X-space as hypothesized by de Broglie. This is what leads to the conclusion that it is possible that the opposite signs of a decoupling pair (positron + and electron -)

observable from within normal X-space could be acquired as the pair decouples [18], which is definitely at odds with current axiomatic beliefs, but is in perfect harmony with de Broglie's conclusion that the double-particle photon charges should be neutral (in context: as perceived from normal X-space).

Let us also note that in this equation, the fine structure constant α is related to *the maximum transverse amplitude* within electrostatic Y-space of the electromagnetically oscillating half of the double-particle photon energy, an amplitude which in turn directly relates to the lower limit of spherical integration of the energy of a discrete localized electromagnetic particle ([12], Extended Abstract, and Equations (1) to (11)).

17. DEFINING THE DOUBLE-PARTICLE PHOTON LC EQUATION AND LOCAL FIELDS EQUATION

17.1 Macroscopic LRC Circuits

When an inductor coil is connected to a charged capacitor to establish an LRC electromagnetic oscillating system, it is well verified experimentally that the capacitor will completely discharge into the inductor coil as the current in the coil wire establishes a magnetic field in the 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 reverse current in the coil wire that will have completely recharged the capacitor when the magnetic field has completely disappeared, a behavior in complete agreement with 180° out of phase electromagnetic cycling in this 3-spaces model and in perfect harmony with Maxwell's initial interpretation (Fig. 8).

The capacitor will now start discharging again into the inductor coil and the process would repeat indefinitely in theory if no energy was lost in the process in such a physically establish LRC system, due to the resistance and eventual heating of the coil wire and radiating of this energy into surrounding space. It is well understood however that if no energy was lost due to the coil wire resistance, the total amount of energy in the system would remain stable and be permanently conserved, which would keep the cycle going forever.

17.2 The Photon as a LC Oscillator

Let us now transpose this well known and understood LRC behavior to the LC behavior suggested by Equation (9) for the double-particle photon, previously established from considerations inspired by de Broglie's hypothesis and Marmet's derivation. Contrary to the coil wire of a LRC circuit, made of a capacitor and an inductor coil, it can be assumed that the point-like junction between the three spaces of the expanded 3-spaces geometry will offer no resistance to the passage of the photon's oscillating energy, since it is well established that a photon's energy remains constant from emission to capture, however long the time elapsed since its emission and whatever distance it could have traveled, barring losses due to red shifting, gains due to blue shifting and losses due to gravity induced changes in direction and considering that the complete amount of the photon's energy remains a *single amount of physically existing substance* due to the properties of unbounded *elasticity* and *fluidity* tentatively assigned previously.

The classical equation representing the maximum energy stored in the capacitor of a LRC circuit at the beginning of the cycle is:

$$E_{E(\max)} = \frac{q^2}{2C} \quad (18)$$

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

$$E_{B(\max)} = \frac{L i^2}{2} \quad (19)$$

In the context of LC behavior applied to a localized photon's energy, where no energy can be lost through heating of a non-existent coil wire and considering that both quantities represent the same half quantum of the photon's energy that oscillates between these two maxima, we can then equate:

$$E_{E(\max)} = E_{B(\max)} = E_E + E_B = E_{EB} \quad (20)$$

17.3 Defining the Photon Capacitance (C)

As established in a separate analysis [14], only half of a photon's energy cyclically oscillates between electric and magnetic states. So making use of the free energy equation previously mentioned derived from Marmet's work ([12], Equation (11)), that is:

$$E = \frac{e^2}{2\epsilon_0\alpha\lambda} \quad (21)$$

that we will divide by 2, to represent only the oscillating half of the photon's energy, and equate to Equation (18) for capacitance, which represents the same half the photon's energy, that is, the two charges of the photon at their maximum value, we obtain:

$$E_{E(\max)} = \frac{E}{2} = \frac{q^2}{2C} = \frac{e^2}{4\epsilon_0\alpha\lambda} \quad (22)$$

We can then isolate:

$$2C = 4\epsilon_0\alpha\lambda \quad (23)$$

and finally obtain:

$$C = 2\epsilon_0\alpha\lambda \quad \text{Farad} \quad (24)$$

which allows calculating the capacitance of any localized photon from its wavelength and the permittivity constant of vacuum (ϵ_0).

17.4 Defining the Photon Inductance (L)

Since the angular frequency of a LRC oscillator is obtained from the following equation:

$$\omega = \sqrt{\frac{1}{LC}} \quad (25)$$

we can separately calculate the angular frequency of a localized photon's energy from $\omega=2\pi f/a$, or better yet, in context, from $\omega=2\pi c/a\lambda$ (since we must use here *the a related transverse amplitude* (See Section 16) of the cycling frequency calculated from the wavelength of a localized photon's energy which is $f=c/\lambda$). So we can write:

$$\omega = \frac{2\pi c}{\alpha\lambda} = \sqrt{\frac{1}{LC}} \quad (26)$$

By squaring this last equation and replacing C by its value defined with Equation (24) as $2\varepsilon_0\alpha\lambda$, we can isolate L in Equation (26) and define the following equation:

$$L = \frac{\alpha^2 \lambda^2}{C 4\pi^2 c^2} = \frac{\alpha\lambda}{\varepsilon_0 8\pi^2 c^2} \quad (27)$$

Knowing that $\varepsilon_0 c^2 = 1/\mu_0$ and substituting this value into Equation (27) to introduce permeability constant μ_0 , we finally obtain:

$$L = \frac{\mu_0 \alpha \lambda}{8\pi^2} \quad \text{Henry} \quad (28)$$

which allows calculating the inductance of any localized photon from its wavelength and the permeability constant of vacuum (μ_0)

17.5 The Photon Maximum Displacement Current (i)

Having established how to calculate inductance L for a localized photon, we can now determine the maximum current i involved from the equation giving the maximum energy momentarily stored in the magnetic field. So, from Equation (19):

$$E_{\mathbf{B}(\max)} = \frac{L i^2}{2} \quad (29)$$

we can isolate i , and knowing that $E_{\mathbf{B}(\max)} = E_{\mathbf{EB}}$ from Equation (20), the value of L from Equation (28), and knowing also that $\varepsilon_0 \mu_0 = 1/c^2$, we can derive the localized photon's maximum displacement current:

$$\begin{aligned} i &= \sqrt{\frac{2E_{\mathbf{EB}}}{L}} = \sqrt{2 \frac{e^2}{4\varepsilon_0 \lambda \alpha} \frac{8\pi^2}{\mu_0 \lambda \alpha}} \\ &= \sqrt{\frac{4\pi^2 e^2}{\varepsilon_0 \mu_0 \alpha^2 \lambda^2}} = \sqrt{\frac{4\pi^2 e^2 c^2}{\alpha^2 \lambda^2}} = \frac{2\pi e c}{\alpha \lambda} \quad \text{Ampere} \end{aligned} \quad (30)$$

17.6 The Photon General LC Equation

Remembering that the sum of $E_{\mathbf{E}}$ and $E_{\mathbf{B}}$ is permanently constant as established with Equation (20), we can now write:

$$\begin{aligned} E_{\mathbf{EB}} &= E_{\mathbf{E}} + E_{\mathbf{B}} \\ &= \left[2 \left(\frac{e^2}{4C} \right)_Y \cos^2(\omega t) + \left(\frac{L i^2}{2} \right)_Z \sin^2(\omega t) \right] \end{aligned} \quad (31)$$

Where t is the time for one cycle, corresponding to $1/f$, or when defined as a function of λ as required here, corresponding to $t=\lambda/c$, and where the electric aspect needs by structure to be split into two equal quantities moving in opposite directions within electrostatic Y-space.

Since this energy corresponds to only half of the energy of the photon, we must finally add the other half, which is unidirectional momentum energy component permanently localized within normal X-space to obtain the total energy of the photon. Let's now also introduce the required set of directed unit vectors to completely represent the various directions of motion of the energy within the 3-spaces structure:

$$E \vec{I} \vec{i} = \left(\frac{hc}{2\lambda} \right)_X \vec{I} \vec{i} + \left[\begin{array}{l} 2 \left(\frac{e^2}{4C} \right)_Y (\vec{J} \vec{j}, \vec{J} \vec{j}) \cos^2(\omega t) \\ + \left(\frac{L i^2}{2} \right)_Z \vec{K} \sin^2(\omega t) \end{array} \right] \quad (32)$$

Equation (32) is the most detailed and general equation, all terms of which being function of a single variable, that is, the photon wavelength λ , that can be established for the internally cycling energy of the permanently localized double-particle photon of de Broglie's hypothesis in this expanded space geometry, and where indices X, Y and Z represent the three mutually orthogonal spaces into which the kinetic energy quantum remains in standing motion. 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 becomes totally stable when de Broglie's hypothesis is taken into account, at a value equal to the average value of this vector in classical Maxwell. This stability is due to the fact that at any given moment, the sum of capacitance and inductance energies is always exactly equal to half a photon's energy.

17.7 The Photon General Local Fields Equation

Equation (32), making use of the less familiar energy inductance and capacitance that were required to describe the double-particle photon kinetic energy electromagnetic oscillation, would gain in handiness if converted to use the more familiar electric \mathbf{E} and magnetic \mathbf{B} fields expressions for energy.

For a photon moving in straight line, it is well established that both electric and magnetic aspects of its internal energy have to be of equal density as described in ([12], Equation (35)):

$$\mathbf{u}_B = \mathbf{u}_E = \frac{\mathbf{B}^2}{2\mu_0} = \frac{\varepsilon_0 \mathbf{E}^2}{2} \quad (33)$$

Given that an energy density is an energy value divided by a volume, the fields related expressions for a photon's energy can be recovered by multiplying these density expressions by the related *theoretical stationary isotropic volume* that this incompressible oscillating kinetic energy quantum would occupy if it was immobilized as a theoretical sphere of isotropic density ([12], Equation (40h)):

$$V = \frac{\alpha^5 \lambda^3}{2\pi^2} \quad (34)$$

which, when multiplying the \mathbf{u}_B and \mathbf{u}_E fields energy density values provided in Equation (33) by this volume, will provide the required fields related energy values:

$$E_E = \frac{\varepsilon_0 \mathbf{E}^2}{2} V \quad \text{and} \quad E_B = \frac{\mathbf{B}^2}{2\mu_0} V \quad (35)$$

This in turn allows the following conversion of Equation (32) to a more familiar fields expression:

$$E \vec{I} \vec{i} = \left(\frac{hc}{2\lambda} \right)_X \vec{I} \vec{i} + \left[\begin{array}{l} 2 \left(\frac{\epsilon_0 \mathbf{E}^2}{4} \right)_Y (\vec{J} \vec{j}, \vec{J} \vec{j}) \cos^2(\omega t) \\ + \left(\frac{\mathbf{B}^2}{2\mu_0} \right)_Z \vec{K} \sin^2(\omega t) \end{array} \right] V \quad (36)$$

where the photon electric field is expressed as:

$$\mathbf{E} = \frac{\pi e}{\epsilon_0 \alpha^3 \lambda^2} \quad \text{from ([12], Equation (40))} \quad (37)$$

and the photon magnetic field is expressed as:

$$\mathbf{B} = \frac{\mu_0 \pi e c}{\alpha^3 \lambda^2} \quad \text{from ([12], Equation (34))} \quad (38)$$

Finally let's note that the only variable required to solve both Equations (32) and (36) is the wavelength of the photon energy λ .

17.8 The Photon Default Self-Guiding in Straight Line and Self-Propelling at the Speed of Light

It is quite interesting to observe that the default equal densities by structure of both electric and magnetic fields of the double-particle photon directly explains why photons self-guide in straight lines when no outside force is acting on them, in conformity with Maxwell's fourth equation.

The manner in which the trajectories of elementary electromagnetic particles can be very precisely programmed, by causing the default equal densities of both ambient electric and magnetic fields to vary from their equilibrium state, is completely described in any good textbook on high energy accelerators, such as the wonderfully made *Principles of Charged Particle Acceleration* by Stanley Humphries Jr. [25].

The mechanics of the natural variation of this default equilibrium of the density of both fields in the 3-spaces model for electromagnetic particles subjected to transverse interaction is described in a separate paper [26].

In addition to providing the previously described constant magnitude for the Poynting vector, it is also interesting to observe that this internal structure also provides a mechanical explanation to the stability of the speed of light of free moving electromagnetic energy in vacuum.

As mentioned previously, a separate analysis ([14], Section XI) mathematically demonstrates why the speed of light of localized photons can be explained only if its kinetic energy is distributed as one half unidirectionally oriented in X-space as momentum energy propelling an equal amount of energy captive in transverse electromagnetic oscillation within Y- and Z-spaces.

It can be hypothesized that the 3-spaces structure itself acts as a *set of communicating vessels* through the common central junction, which would be offering zero resistance to the passage of energy through this central junction, since objective reality shows that no energy is lost during free moving energy electromagnetic oscillation, and that this junction always allows the energy of the photon to remain in some form of permanent equilibrium between the 3 spaces, an equilibrium that

would constantly seek to keep the photon's energy split into two equal amounts between X-space and YZ-spaces, even during energy losses or gains events related to red and blue shifting due to gravitational interaction.

When energy is lost by a photon as witnessed by a displacement towards the red of its frequency or gained as witnessed by a displacement towards the blue of its frequency, the half-half X vs YZ equilibrium would be maintained by the required amount of kinetic energy seeping through the X-YZ junction in the direction required to constantly restore this equilibrium. This would directly explain why all photons self-propel, so to speak, at the same constant *equilibrium* velocity, which is of course the speed of light.

This now conjures up the long standing issue of what reference frame this *equilibrium* constant velocity of photons in vacuum (free moving kinetic energy) is relative to in reality.

The long standing habit of hypothesizing inertial reference frames in countless attempts to make sense of the experimentally obtained data became deeply ingrained in the community since the beginning of the 20th century. The fundamental question that this method was meant to address is the following:

What is the motion of masses relative to in physical reality? Is it relative to some underlying medium? To the point of emission? To the point of absorption? To the observer? To this or that reference frame, or multiple reference frames, inertial, non inertial, Galilean, moving or not? etc.? The very same issue obviously applies to the velocity of electromagnetic photons.

But in physical reality, considering the possibility brought to light by this analysis that momentum energy could be a *physically existing substance*, motion in the universe can be relative only to the constantly measurable amount of momentum energy that each charged particle locally possesses (in its own reference frame) at any given instant and velocity could depend on only one criterion, that is, *the actual presence of translational momentum kinetic energy*. If translational momentum kinetic energy is permanently present as hypothesized as a conclusion of this analysis in each electromagnetic photon and in each carrying energy amount induced in excess of the invariant rest mass of elementary massive and charged particles, and if the local electromagnetic equilibrium allows it in the latter case, there will be velocity in vacuum, relative to there being absence of translational momentum kinetic energy, irrespective of any hypothesized reference frame or frames other than each particle's own reference frame.

From the classical perspective, it is traditionally assumed that in its own reference frame, an elementary particle such as an electron or a photon has no velocity, which implies that its momentum has to be null, but if it doesn't fall to zero and keeps on applying constant pressure instead as hypothesized here, the state of *absolute motion* of the particle can be continuously determined strictly from the amount of momentum energy that would be measurable directly within its own reference frame.

Moreover, from within charged and massive elementary particles such as the electrons' own reference frames, the variation over time of the total amount of the particle's carrying energy will reveal its state of *absolute motion* with respect to its environment, and therefore *its state of absolute motion in the universe*. Rapid increases and decreases of its total amount of energy will reveal that it is stabilized in some stationary action resonance state for example, in some stable orbital in some atom in the universe. Slow cyclic increases and decreases of its maximum amount of carrying energy over longer periods of time will reveal that it belongs to an atom which is part of a macroscopic mass stabilized on an elliptic macroscopic orbit in some planetary system, and so on.

The absolute lower velocity limit, from this perspective, would be an electron possessing zero translational momentum kinetic energy in excess the energy making up its invariant rest mass. But such an electron totally deprived of translational momentum kinetic energy can only be theoretical since all charged particles are subject to electrodynamic acceleration in physical reality from the moment they start existing, and it is then not physically possible for them not to be induced with some amount of carrying energy by the ambient Coulomb interaction.

The absolute upper velocity limit involving electromagnetic oscillation is reached when an amount of translational momentum kinetic energy propels an equal amount of kinetic energy captive in transverse electromagnetic oscillation, that is, a free moving electromagnetic photon moving at the speed of light as described in this paper.

The only other possible case between these two limits, still involving electromagnetic oscillation, applies to an amount of kinetic energy captive in transverse electromagnetic oscillation being propelled by a lesser amount of translational momentum kinetic energy, such as the kinetic energy making up the rest mass of an electron, plus the transversely oscillating half of its carrier-photon's kinetic energy, both quantities being propelled by the unidirectional half of the carrier-photon's quantum of kinetic energy. The velocity of such a system will mandatorily lie between zero and asymptotically close to the speed of light, a process whose mechanics is described in a separate paper [14].

Finally, there remains one case of unidirectional kinetic energy whose motion seems not to be related to any transverse electromagnetic oscillation, and for which there consequently also seems not exist any limiting factor on momentum energy velocity since no trispatial junction can then be present to provide the resistance to motion of a translationally inert transverse amount of energy. It is the case for escaping *neutrino energy*, whose mechanics of liberation in the trispatial model is described in separate Reference [27].

17.9 The Deflection Angle of Photons' Trajectories

All of these considerations bring us to re-examine the case of light deflection experimentally verified for the first time in 1919 by Eddington and many others afterwards, during solar eclipses ([28], p.194), to confirm Einstein's prediction to the effect that light from far stars can be deflected by gravity and that this deflection could be measured, for example, as light closely grazes the mass of the Sun.

According to Newton's theory, the inertia of all bodies is deemed to be omnidirectional, meaning that a material body resists any change in its state of motion with the same intensity to a force acting on it, whichever direction it is being applied from. Associating mass to the energy of discrete photons for the purpose of calculation, Einstein then applied the same logic *to their total energy*, assuming that *the total complement of a photon's energy* is subject to transverse interaction when flying by a celestial body as a function of the inverse square of the distance between them.

His calculation then gave an estimated deflection angle of 0"83 arc second as mentioned in a paper [29] that he published in 1911, that is, an angle twice shallower than the actual angle that will be observed in reality, which seemed to invalidate Newton's mechanics at the fundamental particles' level. Of course, he afterwards provided a different calculation, which gave the estimated double deflection angle of 1"75 arc second which is closer to reality, the supplementary deflection angle increment being considered an effect of the space-time curvature of his General Relativity Theory and a proof of the soundness of the theory.

Interestingly, as demonstrated in a separate analysis [14], the unidirectional momentum half of the energy of the double-particle photon that must remain within normal X-space by structure, can only be *impervious to transverse interaction*, which can be linked to experiments carried out by Walter Kaufmann at the beginning of the 20th century, during which he induced varying amounts of kinetic energy into electrons [23].

When the trajectories of the moving electrons were not deflected (observations made by means of a bubble chamber), he found of course that the total longitudinal inertia of the particle involved the energy making up the rest mass of the electron plus the total amount of the added kinetic energy provided to the particle.

But when the trajectories were deflected while moving at relativistic velocities, he discovered that the transverse inertia of the particle involved less energy than this sum, which gave rise to the debate

regarding *longitudinal mass* and *transverse mass*, which led to the conclusion that mass was electromagnetic in nature, because the fields that can cause electrons to accelerate and be deflected are the electromagnetic **E** and **B** fields that Kaufmann used to control the trajectories and velocities of the electrons, which still is the only method available to control free moving charged particles in all modern instruments up to and including high energy particles accelerators.

At low non-relativistic velocities, the transverse and longitudinal inertia of electrons do not reveal any measurable difference due to the infinitesimal contribution of such low amounts of added kinetic energy. However, Kaufmann's experiments with much higher amounts of additional kinetic energy do reveal that the difference has to be linked to the electron carrying energy, since the rest mass of the electron is invariant.

In 2003, Paul Marmet successfully linked the velocity related relativistic mass increase of electrons to the simultaneous increase of their transverse magnetic field [13]. Specific calculations then showed that the difference between the electron rest mass and its relativistic mass at any velocity corresponds to an increase in mass equal to half of the induced kinetic energy divided by the square of the speed of light, which is exactly equal to the velocity related *magnetic mass increment* that can be calculated from Marmet's discovery (see Equation (9)).

Since this added *magnetic mass* displays the same omnidirectional inertia as the electron rest mass to which it must be added and can thus also be measured by transverse interaction, this leaves as the only possible candidate to explain this difference, the conclusion that the translational momentum half of the kinetic energy provided to the electron, that propels the total velocity related instantaneous total mass of the electron, *is impervious to transverse interaction*.

This means also that the instantaneous total relativistic mass of a moving particle can be measured directly only by means of transverse interaction since longitudinal inertia includes the inertia of both its momentum energy and of its magnetic field increment energy on top of its invariant rest mass energy, and consequently does not allow distinguishing the rest mass of the particle from the velocity related mass contribution of half of its carrying energy.

This gave rise to the development of a new set of relativistic equations derived from electromagnetism, which is complementary to that related to the Special Relativity Theory [14]. This new set can be summarized as follows in a form easy to manipulate with any pocket scientific calculator, from which the full range of all relativistic velocities can be obtained. For example:

$$f(x) = c \frac{\sqrt{4ax + x^2}}{2a + x} \quad (39)$$

Where $f(x)$ is the relativistic velocity, a is the energy in joules making up the invariant rest mass of the electron ($8.18710414E-14$ joules), x is the total amount of carrying kinetic energy provided in joules and c is of course the speed of light in meters per second.

From Equation (39) can be derived the following equation that allows calculating the total amount of kinetic energy that must be communicated to an electron for it to move at relativistic velocity v , when only this velocity is known:

$$x = 2a(\gamma - 1) \quad (40)$$

Where x is the total amount of added kinetic energy, a is the energy making up the invariant rest mass of the electron and γ is the Lorentz gamma factor. Any relativistic velocity plugged into the gamma factor will allow obtaining the total amount of kinetic energy required for the particle to move at this velocity.

As a note to simplify calculations with pocket scientific calculators, let's mention that the gamma factor would be much handier to deal with if it was simplified to the following form, leaving only one fraction in the expression:

$$\gamma = \frac{1}{\sqrt{1 - v^2/c^2}} = \sqrt{\frac{c^2}{c^2 - v^2}} = \frac{c}{\sqrt{c^2 - v^2}} \quad (41)$$

With the velocity related total amount of kinetic energy calculated with Equation (40), the following equation allows calculating the instantaneous relativistic mass of the particle for this relativistic velocity:

$$m_{(rel)} = m_0 + \frac{x}{2c^2} \quad (42)$$

The full range of relativistic velocities can also be obtained from the following equation by using the wavelengths of the energies involved:

$$f(x) = c \frac{\sqrt{4ax + a^2}}{2x + a} \quad (43)$$

where $f(x)$ is the relativistic velocity, a is the electron Compton wavelength (2.426310215E-12 m) and x is the wavelength of the total amount of kinetic energy provided to the particle.

Finally, similarly to Equation (40) being derived from Equation (39), the following equation derived from Equation (43) allows calculating the wavelength of the total amount of kinetic energy that must be communicated to an electron for it to move at relativistic velocity v , when only this velocity is known:

$$\lambda = \frac{\lambda_c}{2(\gamma - 1)} \quad (44)$$

Where λ is the wavelength of the total amount of communicated kinetic energy, λ_c is the electron Compton wavelength and γ is the Lorentz factor.

In relation with the analysis carried out in Section 6, when the energy making up the rest mass of the electron is set to zero in Equation (39), or rather, in its electromagnetic version ([14], Equation (33)), we can observe that the only velocity that can be obtained is c , that is, the speed of light. This means that the remaining transversely measurable mass increment plus the transversely undetectable but equal translational momentum other half of the added energy involved *behaves like a free moving photon*, displaying a longitudinal inertia corresponding to the total amount of energy involved, but a transverse inertia corresponding to only half of the total amount of energy involved, as demonstrated by the deflexion angle of light grazing the Sun during solar eclipses.

This observation with regard to the electron's carrying energy comes in support of the conclusion reached in this paper to the effect that free moving electromagnetic photons would, by similarity, have the same internal electromagnetic structure as massive particles' total amount of induced carrying energy.

Consequently, if Einstein's calculations had been made using the *mass* of only the electromagnetically oscillating half of the photon's energy with regards to photons' trajectories deflection by celestial bodies, that is, the only part of photons' energy that turns out to be sensitive to transverse interaction, then the 1"75 arc second deflection angle of photons flying close by the Sun

could have been directly obtained from classical mechanics without any need to resort to the General Relativity space-time curvature.

18. CONCLUSION

This paper is meant to show that it is possible to represent the permanently localized photon of de Broglie's hypothesis in a manner totally conform to Maxwell's equations.

This particular solution requires expanding the local space geometry in a manner that allows the photon's kinetic energy quantum to behave in accordance with Maxwell's initial interpretation that both the electric **E** field and the magnetic **B** field mutually induce each other without the energy represented by the fields changing in nature, while at the same time displaying the mutually exclusive properties traditionally associated to the separate electric and magnetic fields.

Since energy can be represented in a number of ways, as exemplified by the two currently available alternate approaches mentioned in the Introduction, solutions other than the one proposed here are of course possible. But hopefully, the non-exhaustive benefits mentioned in this paper that this new solution provides may help rekindle causality based fundamental research in the community, all the more so since this space geometry also allows a simple and logical mechanical explanation to the process of conversion of electromagnetic photons of energy 1.022 MeV or more to pairs of massive electron-positron [18] that also structurally possess the same dual wave-particle characteristics that characterize this model of the photon, and to the process of construction of the nucleons of which all atomic nuclei are made [20].

COMPETING INTERESTS

Author has declared that no competing interests exist.

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APPENDIX A

Summary of Paul Marmet's lifetime achievements

Paul Marmet, Ph. D. (1932-2005) was a high level physicist and experimentalist very dedicated to exploring every aspect of fundamental physics in search of any unsettled or doubtful issue, that he eventually analyzed in search of possible avenues of resolution. He then progressively offered the outcome of his analyses for consideration by the community in numerous articles either published or presented in conferences. Many of these analyses seemed to lead *outside the box*, as the saying goes, which always was the hallmark of leading edge research, *the box* being in context the current set of rigid orthodox ideas and concepts currently accepted in the physics community as being in agreement with *the Copenhagen Interpretation* philosophy.

Being well aware of this situation, as revealed by his clearly expressed opinion in this regard in a book published in 1993 [30], he always worked at these analyses as personal endeavors because it was well known that most in the physics community frown upon any type of research that questions this philosophy, and as it turns out, in some institutions in which a sufficient number of researchers share this dominant philosophy, any such research endeavors are severely repressed if not discontinued, as we will shortly see.

From the day he completed his Ph.D. thesis in 1960 at *Université Laval* that introduced a new spectrometer design, Marmet worked with his mentor Larkin Kerwin at developing further and experimenting with this new electron source, able to generate and guide thermal electrons possessing momentum energy as low as a few eV each, allowing easy exploration of the properties of negatively ionized atoms in nature, that resulted in about 70 articles on spectroscopy to eventually be published, until their pioneering work on this new electron source was published in 1987 in *Citation Classics* [31]. From 1960 to 1998, 35 articles on other issues were also published and about 200 other related papers were presented in numerous international and national meetings.

He was a member of the *Royal Society of Canada* and was more than once granted awards for his pioneering work in spectrometry before finally becoming Assistant Professor of Physics at the *University of Ottawa* in 1990.

His tenure in this institution could not be better summarized than with these few quotes taken from the website of his Estate [32]:

“Between 1978 and 1998, the author also published several other papers related to the fundamental principles in physics. Several of these papers are presented on this [web site](#). In 1997-99, physicists of the establishment showed fierce disagreement with the fact that Marmet’s research implied that the fundamental principles of physics were being questioned. Although the experimental work, which could determine the energy of numerous quantum states was highly appreciated and even honored, the physics establishment required that the author should stop questioning the fundamental principles of physics. The author was first informed by NSERC (Natural Science and Engineering Research Council of Canada) to stop doing that fundamental research despite the fact that, being theoretical, it required no research funds - all research grants were used for the experimental work needed for the electron impact apparatus. Since the fundamental research was still going on the following year, the grant was cut to zero, putting an end to experimental work using the monoenergetic electron beams.”

Then, in a move so reminiscent of Galileo's time:

“In May 1999, the head of the physics department came to Marmet’s office and said: “Ce n’est pas ton bureau que nous voulons, ton problème est que tu remets en question les principes fondamentaux de la physique.” (“We do not want your office, your problem is that you keep questioning the fundamental principles of physics.”). Three months later, a letter was sent requiring Marmet’s office to become unoccupied before the end of the month. Without

research grant and being expelled from his office, Dr. Marmet continued his research alone at home.”

Finally, the leading edge instrument that he conceived and then developed with his mentor and colleague Larkin Kerwin was apparently willfully destroyed:

“This was the irrevocable death of a unique instrument in the world, which was able to measure the electronic structure of negative ions and their ionization efficiency curve using a high resolution monoenergetic electron beam. A few months later, the instrument was destroyed. Also, this shows that physics is not only a science, it is a doctrine. Therefore, there are heretics. It's not different from Galileo's time!”

After having been so cavalierly and unjustly chased out of his tenure for doing fundamental research in the physics department of an institution supposedly dedicated to higher education and research, now liberated from the constant hostility of his immediate colleagues and of the *University of Ottawa* authorities, he found the peace of mind required to resume his personal fundamental research project. The ultimate outcome of his research was the brilliant derivation from the Biot-Savart equation previously described that explains the direct relation that he discovered between the transverse magnetic field increase of accelerating electrons and their simultaneous transverse mass increase (See Section 6), the first historical publication of which seemed not to have been welcome in any western scientific journal, but was nevertheless welcomed 4 years later in 2003 on the other side of the planet, two years before he passed away, by an engineering journal of the *Kazan State University* [13].

Fortunately, this author hit upon his paper by sheer chance, identifying his groundbreaking derivation as a major grounding element in the potential definition of a new paradigm in fundamental physics, leading to the harmonization of electromagnetism with classical/relativistic mechanics and with Quantum Mechanics at the subatomic level, now available in a series of freely downloadable articles and also as a set of two monographs synthesizing the electromagnetic mechanics of elementary particles [33,34].

There is little doubt in this author's mind that the upcoming generation will cast a harsh look at the behavior of the authorities of the *University of Ottawa* and of the *Natural Science and Engineering Research Council of Canada* for what they did to one of the top level physicist and experimentalist of the 20th century, Paul Marmet, and at the behavior of the individuals who took upon themselves to authorize the destruction of a unique instrument that did not belong to them, but to the scientific community since it gave access to the same energy range as the scanning tunneling microscope.

Biography of author(s)



André Michaud

Service de Recherche Pédagogique, Canada.

He was Born in 1944. He was Involved since 1982 in manufacturing a demonstration apparatus meant to help teaching classical mechanics. He did Translation of seminal papers for the Minkowski Institute. His Initial professional areas include Computer sciences in the domains of systems analysis, data processing, computer languages and equipment-computer interface. His Areas of scientific interest are neurolinguistics, neural networks, early literacy in children, fundamental physics. Currently, He is a administrator of the General Science Journal. His published 28 research article in International Journal.

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