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Electromagnetism According to Maxwell's Initial Interpretation

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Abstract

It is well established that classical electrodynamics, quantum electrodynamics (QED) as well as Quantum Field Theory (QFT) are grounded on Maxwell's wave theory and on his equations, but it is much less well understood that they are not grounded on his initial interpretation of the relation between the $\boldsymbol{E}$ and $\boldsymbol{B}$ fields, but are rather grounded on Ludvig Lorenz's interpretation of this relation, with which Maxwell disagreed. Maxwell considered that both fields had to mutually induce each other cyclically for the velocity of light to be maintained while Lorenz considered that both fields had to synchronously peak at maximum at the same time for this velocity to be maintained, both interpretations being equally consistent with the equations. Two recent breakthroughs however now allow confirming that Maxwell's interpretation was correct because, contrary to the Lorenz interpretation, it allows to seamlessly reconcile Maxwell's electromagnetic wave theory, so successfully applied at our macroscopic level, with the electromagnetic characteristics that apply at the subatomic level to localized electromagnetic photons and to all localized charged and massive elementary electromagnetic particles of which all atoms are made, and finally allows establishing a clear mechanics of electromagnetic photon emission and absorption by electrons during their interaction at the atomic level.

Keywords

Magnetic Mass, Magnetic Field, Electric Field, Electron, Photon Emission, Photon Absorption

1. Introduction

In 1845, Michael Faraday observed that by placing a glass plate between the poles of an electromagnet, the magnetic field caused the polarization plane of the

light passing through the plate to rotate. He immediately informed his friend James Clerk Maxwell of this major discovery that demonstrated for the first time the direct relation between the magnetic field and light [1].

It is therefore this specific experiment by Faraday which is at the origin of the integrated electromagnetic theory then developed by Maxwell, because, having already observed that second derivatives of the previously established equations for the electric field and the magnetic field revealed that electric energy and magnetic energy were separately associated with the speed of light [2], Maxwell concluded that light had to be electromagnetic in nature and then made the fundamental discovery that electromagnetic energy implied a three-way orthogonal relationship between its three fundamental aspects; that is, its electric and magnetic aspects, perceived as being perpendicular to each other and simultaneously inducing each other in a cyclic transverse stationary oscillating motion, with respect to the direction of motion of this energy in space (see **Figure 1**); that is, a three-way orthogonal relationship corresponding to the familiar vector cross product of the $\boldsymbol{E}$ and $\boldsymbol{B}$ fields, resulting in a third motion vector structurally perpendicular to the first two [3] [4].

The following fact may come as a surprise to many, but this solution discovered by Maxwell, who is also well known for having derived the speed of light from the relation that he established between the two fundamental constants of vacuum ε_0 and μ_0 [2], is not the only working solution that was discovered to relate both $\boldsymbol{E}$ and $\boldsymbol{B}$ fields to the speed of light.

Briefly summarized, mathematician Ludvig Lorenz established independently from Maxwell that if both $\boldsymbol{E}$ and $\boldsymbol{B}$ fields representations of free moving electromagnetic energy are mathematically made to peak to maximum synchronously at the same time, this also allows explaining the speed of light in vacuum of electromagnetic waves as well as if both fields are 180 degrees out of phase as in Maxwell's solution.

But the "*Lorenz gauge*" is a generalizing concept, that regroups both $\boldsymbol{E}$ and $\boldsymbol{B}$ aspects of fundamental energy into a "single" electromagnetic field that distracts from immediate attention the different vectorial orientations of both aspects, particularly the fact that the energy dipole represented by $\boldsymbol{E}$ becomes spacewise oriented and distributed while the energy dipole represented by $\boldsymbol{B}$ becomes

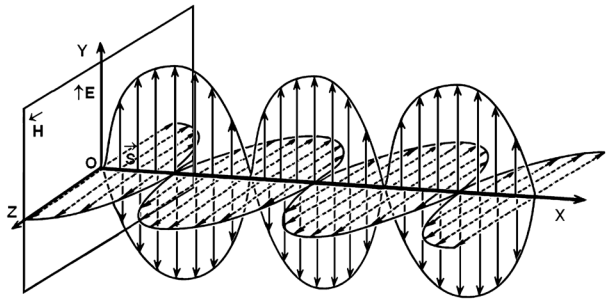

Figure 1. Mutually inducing 180˚ out of phase bipolar representation of $\boldsymbol{E}$ and $\boldsymbol{B}$ fields of Maxwell's interpretation.

timewise oriented and distributed as they cyclically mutually induce each other transversely to the vectorial direction of motion of the oscillating energy in vacuum.

The representation of **Figure 2**, which is found in all textbooks on electromagnetism, while agreeing with Maxwell's wave theory describing electromagnetic energy as a pulse propagating in an underlying aether, and which is also in agreement with his equations, is however generally and incorrectly assumed as also being Maxwell's conclusion.

Indeed, Maxwell disagreed with this approach, because the concept of "gauge" developed by Lorenz had the consequence of treating both fields $\boldsymbol{E}$ and $\boldsymbol{B}$ as *a single electromagnetic field* at the general level, without any apparent internal structure at first glance, which easily obscures the fact that both fields are of equal and separate importance in Maxwell's theory, with different and irreconcilable characteristics, in addition to mutually inducing each other, contrary to the Lorenz solution, as put in perspective in reference [3].

The fact that this second solution was developed by Lorenz, however, is not well known in the scientific community because it is specifically associated only to the so-called *Lorenz gauge* defined by him, and this, only in high level specialized reference works on electromagnetism [5], because it lends itself more easily than Maxwell's representation to various mathematical generalization processes, but the true origin of the solution represented by **Figure 2** is not clearly explained in introductory textbooks and general reference works on physics [6] [7].

Consequently, unless they specialize in electromagnetism, most physicists are not directly informed that it was not Maxwell who developed this second approach, and that classical electrodynamics and quantum field theory (QFT), from which quantum electrodynamics (QED) emerged [8] [9] are in reality grounded on Lorenz's interpretation, because this fact is nowhere clearly highlighted in reference works on electrodynamics and QFT, which were of course developed by specialists in electromagnetism for whom this fact was obvious. So contrary to established facts, the outcome is a general impression in the community that Maxwell is also the author of this second solution and that electrodynamics and QFT are grounded strictly on Maxwell's theory.

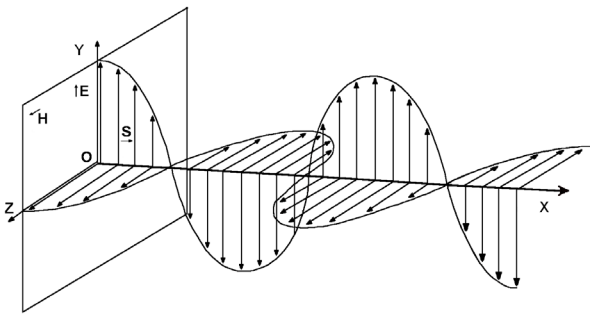

Figure 2. Standard simultaneously in phase peaking $\boldsymbol{E}$ and $\boldsymbol{B}$ fields monopolar representation of Lorenz's interpretation.

The distinction to be made is important however, because de Broglie's hypothesis about the localized double-particle photon that emerges directly from Maxwell's solution is consequently at odds with classical electrodynamics and QED, because the Lorenz approach obscures the fact that both $\boldsymbol{E}$ and $\boldsymbol{B}$ fields are of equal and separate importance. For example, the predominant role given to the electric charges in QED seems to leave no precise function to the magnetic aspect of electromagnetic energy in a possible mutual induction mechanics that would involve the two separate fields, contrary to Maxwell's interpretation. Even the fact that as formulated, QED cannot explain the mutual induction of both fields in LRC systems doesn't seem to attract attention to this issue.

2. Setting up the Perspective According to Relative Magnitude Levels

To put in correct perspective the possibility of describing the energy which is the very substance of which all localized elementary particles such as electromagnetic photons, electrons and positrons are made at the subatomic level, in a manner that would not conflict with the well established Maxwell continuous wave electromagnetic theory, which is so successfully applied at our macroscopic level, it must first be realized that all objects and processes that we can detect and measure in objective reality can be categorized as belonging to one of the following four orders of magnitude. In decreasing order of amplitude, these orders of magnitude can be defined very generally as follows:

1) *Astronomical level*: Order of magnitude exceeding the dimensions of planet Earth.

2) *Macroscopic level*: Order of magnitude in which any object or process can be directly measured at the Earth's surface and its environment.

3) *Sub-microscopic* or *atomic level*: Order of magnitude of molecules and atoms.

4) *Subatomic level*: Order of magnitude of the elementary particles of which the atoms are made, as well as the electromagnetic energy of which their substance is made, that supports their motion, determines their inertia, and that can also circulate freely in quantized form at the speed of light when not directly associated with one of these elementary particles.

The first 3 levels are generally familiar to all, but the subatomic level is not. We can directly perceive and measure objects and processes in our environment at the macroscopic level, and we indirectly perceive and measure objects and processes of other orders of magnitude with increasing precision as our instruments improve.

It may seem paradoxical to so firmly assert that electromagnetic energy can be directly defined as being quantized as localized electromagnetic photons at the subatomic level in full accordance with Maxwell's equations while remaining in complete harmony with his continuous electromagnetic waves theory which has been so successfully applied at our macroscopic level, which is an issue that has been the object of a continuous debated for the past hundred years.

It must be put in perspective here that we perceive however no paradox whatsoever with the fact that "*we directly observe*" that the image on a TV screen appears smoothly continuous as seen from a few meters, while being well aware that if we get close enough, "*we also directly observe*", directly at our macroscopic level, that in physical reality, the image is physically generated by thousands of clearly separated rows of clearly separated very small pixels.

Interestingly, we find no paradox either in treating water as a fluid without any internal structure at our macroscopic level, while being well aware that at the submicroscopic level, it is made only of localized molecules, themselves made of localized atoms, themselves made at the subatomic level of localized elementary electrically charged electrons plus nucleons, themselves made of localized electrically charged elementary particles, that all are individually massive and quantized, even if we cannot directly see these molecules at our macroscopic level as in the case of the TV screen.

The reason why we see no problem in perceiving and treating water as a fluid at the macroscopic level, even mathematically, even if we cannot directly observe the localized molecules of which its substance is made, as we can directly do with the individual pixels of the TV screen, is that we understand that what we perceive as the "*fluidity*" of water at our macroscopic level is in reality a "*crowd effect*" due to countless localized water molecules smoothly sliding against each other at the submicroscopic level. Moreover, our powerful modern instruments of electronic microscopy allow us to indirectly detect these individual molecules and the atoms of which they are made at the submicroscopic level.

In the case of electromagnetic energy, however, its granular nature at the subatomic level is far from being as obvious to perceive as in the case of the television screen, in which to approach the image by only a few meters, is sufficient, to go from the order of magnitude that lets us perceive it as an apparently uniformly fluid image to the slightly lower order of magnitude still at the macroscopic level that makes it possible to perceive the reality of its granular structure when directly observed at greater proximity; or in the case of water, whose granularity at the atomic level can be indirectly observed with our electron microscopes.

The case of water obviously requires an even greater jump in orders of magnitude towards the infinitely small scale between the perception of its fluidity at the macroscopic level and the perception of its submicroscopic granularity. To really become aware of the difference between these two orders of magnitude, it suffices to think that the atoms making up water molecules are as far away towards the extremely small submicroscopic level that the galaxies are far towards the infinitely large astronomical level with respect to our own terrestrial macroscopic level. But to perceive the subatomic granularity of electromagnetic energy, the jump from our macroscopic order of magnitude is larger yet; as far in fact, further down towards the infinitely small from the already far order of magnitude of the atomic scale than this atomic scale is far from our own macroscopic level.

To really conceptualize how far down from the atomic scale the granularity of electromagnetic energy actually is, let's consider that if the proton of an hydrogen atom, two of which are part of a water molecule, was enlarged to become as big as the sun, the electron which is stabilized in its least action orbital distance from the proton would then be as far away from this enlarged proton as the orbit of Neptune is from the Sun in the Solar system, meaning that the hydrogen atom would become as large as the entire Solar System, and that the electromagnetic photons that constitute the "granular level" of electromagnetic energy is of the same order of magnitude as the energy making up the rest mass of the electron and of the other massive elementary electrically charged electromagnetic particles that exist inside the structure of the proton and of the neutron.

The main problem that we are confronted with regarding this subatomic level of granularity of electromagnetic energy and of the energy constituting the rest masses of elementary particles of which atoms are made, is that there exists no instrument powerful enough that would allow observing even indirectly this subatomic level, unlike the deepest level at which it remains physically possible, which is the atomic order of magnitude, that allows indirectly verifying the granularity of water and of all the other material substances of our environment; in short, an indirectly verifiable granularity of all atoms of the periodic table, which is unavailable for the subatomic granularity level of electromagnetic energy.

The only physically verifiable telltales that we have of the permanent localization of elementary charged particles such as the electron and of electromagnetic energy quanta are the following:

1) We have easily reproducible experimental proof that electrons and electromagnetic photons systematically behave almost point-like during all scattering experiments (see Section 23 further on and reference [10]).

2) We have easily reproducible proof that photons have longitudinal inertia as demonstrated by Einstein photoelectric experiment, and that they have transverse inertia amounting to half their longitudinal inertia, as demonstrated by the deflexion angle of light by the Sun during numerous experiments carried out during solar eclipses [3] [11].

3) We also have experimental proof since 1933 that electromagnetic photons of 1.022 MeV or more convert into electron-positron pairs when they graze massive particles [12] and that such pairs reconvert to electromagnetic photons when meeting again; which means that we have the experimental proof that the invariant mass of electrons and positrons is made up of the same "*electromagnetic energy substance*" as electromagnetic photons. We also have experimental proof since 1997 that electromagnetic photons that exceed the 1.022 MeV energy threshold level can be destabilized into converting to electron-positron pairs by other electromagnetic photons, without any massive nuclei being close by [13].

4) We have easily reproducible experimental proof that free moving electrons have an invariant rest mass of 9.10938188E−31 kg and an invariant electric charge of 1.602176462E−19 C.

5) We have conclusive experimental evidence that electrons are elementary

particles and that the protons and neutrons that constitute the nuclei of all atoms are not elementary particles, but rather are systems of elementary particles (see **Figure 5-7**, and reference [10]).

Since the subatomic level cannot be directly nor indirectly observed, we are therefore necessarily reduced in our exploration of this level to proceed by reverse engineering [4], meaning that we must deduce the characteristics of the elementary electromagnetic particles that constitute the fundamental level of objective reality from what we can indirectly detect and understand from the behaviour of atoms, and from the behaviour of the elementary particles that can be separated from them; *i.e.* electrons whose stabilization far from the nuclei determines the volume of space occupied by atoms, and from the behaviour of protons and neutrons that constitute their nuclei by occupying smaller volumes; as well as from the behaviour of the electromagnetic energy which is emitted or absorbed by these elementary particles during their transitions between the various stationary action equilibrium states in which atoms stabilize at the atomic level.

Finally, the means we have at our disposal to observe the behavior of atoms and their separable elements is precisely the electromagnetic energy which is emitted or absorbed during these stationary action equilibrium states variations, and whose "*infinitesimal granules*", *i.e.* these localized electromagnetic photons coming from all objects in our surrounding, either directly from these objects or detected through our powerful microscopes and other sensing devices, that excite electrons from the atoms forming the photosensitive cells in our eyes, an excitation which is then progressively transmitted along our optic nerves to the brain that continuously updates the images of which we become aware from our environment and that we analyze to understand it [14].

These localized electromagnetic photons that can excite electrons sufficiently in the cells of our eyes for their arrival to be progressively signalled all along the optic nerve, can be of very variable intensities, and above a certain intensity level, succeed in separating the electrons from the atoms in our environment, and this is what allows us to study their separate behavior as well as that of the constituents of atomic nuclei, namely protons and neutrons, which can be completely separated from their electronic escorts and studied separately in the case of simple atoms such as hydrogen or helium atoms.

What was preventing us up to now from becoming as comfortable treating electromagnetic energy as being granular, that is quantized, at the subatomic level, as we are handling it as continuous electromagnetic waves at our macroscopic level, is that since about a hundred years, the quantized aspects of the subatomic level have been considered being the exclusive domain of Quantum Mechanics (QM), but that QM still has not been fully harmonized with Maxwell's electromagnetic equations, that successfully handle electromagnetic energy as a continuous wave at our macroscopic level; in other words, that treats it as a fluid, which is an incomplete harmonization that was clearly highlighted by Feyn-

man, who was the last researcher to attempt this reconciliation in the mid 20th century, as evidenced by this quote from his "*Lectures on Physics*" [15]:

"*There are difficulties associated with the ideas of Maxwell's theory which are not solved by and not directly associated with quantum mechanics... when electromagnetism is joined to quantum mechanics, the difficulties remain*".

As put in perspective in a recent article [16], all current theories mathematically treat macroscopic masses as if they had no internal granular structure, that is, as if they were made of a continuous substance uniformly spread within their whole volume, and even Quantum Mechanics currently treats the electron energy as if it was uniformly spread in the same manner within the volume defined by the Schrödinger equation. The reason for this is that the internal electromagnetic structure of the energy making up the mass of each elementary particles of which all macroscopic masses are made, such as the electron, as well as the internal electromagnetic structure of those making up the inner structures of the protons and neutrons, that constitute the nuclei of all atoms in the universe, have not yet been clearly established; and that the momentum energy as well as the energy causing the increase of the transverse magnetic field of accelerating particles have not yet been mathematically separated from the energy of which their rest masses are made.

Recently, however, new developments have made it possible to establish a coherent internal subatomic electromagnetic structure for localized electromagnetic photons and for all elementary electromagnetic particles in accordance with Maxwell's equations, which finally makes it possible to find natural the perception that all atoms are made at the subatomic level of separate and localized elementary particles stabilized in various states of stationary action electromagnetic resonance states and that free moving electromagnetic energy is quantized at the subatomic level, even if we treat it as a continuous wave at our macroscopic level.

3. Two Recent Major Breakthroughs

Already in the 1930's, Louis de Broglie proposed the hypothesis of a possible potentially quantized internal structure for localized electromagnetic photons at the subatomic level that would remain conform to Maxwell's equations, but whose elaboration, by his own admission, seemed not to be possible in the restricted frame of the 4-dimensional geometry of Minkowski's space-time [17]:

"*...la non-individualité des particules, le principe d'exclusion et l'énergie d'échange sont trois mystères intimement reliés: ils se rattachent tous trois à l'impossibilité de représenter exactement les entités physiques élémentaires dans le cadre de l'espace continu à trois dimensions* (*ou plus généralement de l'espace-temps continu à quatre dimensions*). *Peut-être un jour, en nous évadant hors de ce cadre, parviendrons-nous à mieux pénétrer le sens, encore bien obscur aujourd'hui, de ces grands principes directeurs de la nouvelle physique*" ([17], p. 273).

Translation:

"*...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*".

Two recent developments, however, made it possible to elaborate this internal electromagnetic structure of the localized photon proposed by de Broglie in full conformity with the Maxwell equations, and to eventually observe that all stable massive and electrically charged elementary particles of which all atoms are made at the subatomic level can also be described in the same Maxwell compliant manner.

The new light shed by these recent developments on the nature of fundamental electromagnetic energy then made it possible to refocus according to this new perspective the bulk of the conclusions drawn in the past from all experimental data collected to date about the subatomic level. These refocused conclusions were then explained in about twenty separate articles, each of which analyses a specific aspect of the issue, most of which will be given in reference during this final synthesis.

4. The First Major Breakthrough

The first of these two breakthroughs was the elaboration of a more extensive geometry of space, based on the three-way orthogonal relationship that Maxwell related to the three fundamental aspects of electromagnetic energy of which light is made at the subatomic level, namely its electrical and magnetic aspects perceived as being perpendicular to each other and mutually inducing each other into a standing cyclic transverse oscillation mode of the energy that these fields measure with respect to the direction of motion in vacuum of this transversely oscillating electromagnetic energy in space, that is, a direction of motion of this energy which is perpendicular to the direction of the stationary transverse oscillation of the energy represented by the two fields (see **Figure 1**).

The trispatial geometry (see **Figure 3**) required to develop the LC equation derived from the de Broglie hypothesis [3] in accordance with Maxwell's interpretation (**Figure 1**) was formally presented at the event Congress-2000 in July 2000 at St Petersburg State University [18].

This expanded space geometry at the subatomic level is fully described in reference [4], but can be briefly summarized as follows. The method consists in geometrically expanding each of the 3 standard linear electromagnetic vectors $\boldsymbol{i}$, $\boldsymbol{j}$ and $\boldsymbol{k}$ (**Figure 3(a)**), applicable to normal space, transforming them into 3 fully developed 3D vector spaces of their own (**Figure 3(b)**), each of these three spaces, now identified as spaces X, Y and Z (**Figure 3(c)**), each space remaining

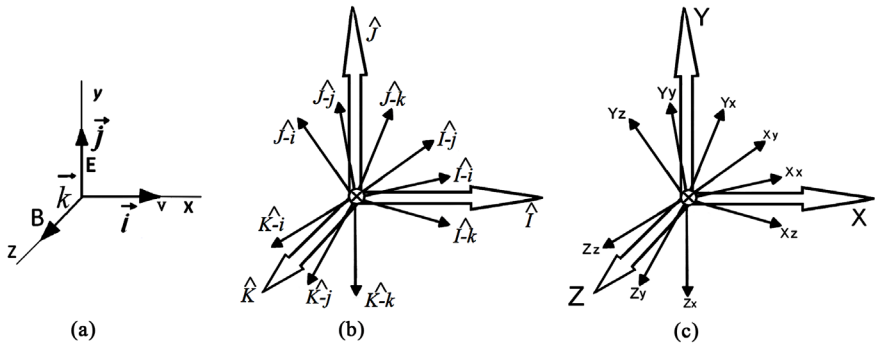

Figure 3. Major and minor vectors sets applicable to the trispatial geometry.

perpendicular to the other two and all three remaining connected via their common punctual origin.

This common centre can now be understood as serving as a passage point located at the centre of each localized electromagnetic quantum at the subatomic level, through which the "*energy substance*" of the particle would be free to circulate between the three spaces as if between communicating vessels, so as to allow the establishment of a stationary transverse oscillation of half the particle energy between its ***E*** and ***B*** aspects between the two *YZ*-spaces, as well as an equal sharing of the total energy of the particle between the transversely oscillating energy half-quantum of the ***E*** and ***B*** fields within the *YZ*-transverse-dual-space-complex, and the unidirectional energy half-quantum of the momentum of the particle residing in *X*-space.

To mentally visualize the motion of energy in this trispatial geometric complex of 9 mutually orthogonal dimensions, it suffices to imagine each of the 3 sets of minor vectors ***i***, ***j*** and ***k*** of Figure 3(b) as if they were the folded ribs of 3 metaphorical umbrellas. This allows any of them to be mentally opened at will one at a time up to full orthogonal expansion to observe and mathematically describe the behavior of energy in this fully deployed 3D space during each phase of its oscillating motion. Figure 3(b) and Figure 3(c) show the dimensions of the 3 spaces only half-deployed to allow a clear and unique identification of each of the 9 resulting internal orthogonal axes.

5. The Second Major Breakthrough

The second major development occurred a few years later, in 2003, when Paul Marmet published an important article describing a newly perceived relation between the progressive increase of the intensity of the transverse magnetic field of an accelerating electron and the simultaneous increase of its transversely measurable mass [19], that then allowed clearly distinguishing between the variable energy of the electron momentum that also increases during its acceleration, and the also variable energy of its transverse magnetic field, and also to clearly separate these two variable energy quantities from the invariant energy constituting the electron rest mass as described in an article published in 2007 in the same "*International IFNA-ANS Journal*" at Kazan State University [20].

This discovery then allowed observing that all charged elementary particles constituting atoms have the exact same internal electromagnetic LC structure in this expanded space geometry, each one being accompanied by an amount of carrying energy made of momentum energy and transverse magnetic field energy, which is structured in a manner identical to the internal electromagnetic structure described by the LC equation developed to account for localized double-particle photons as hypothesized by de Broglie [3] [21] [22] [23], which then allowed establishing their respective trispatial LC equations, as summarized in reference [4], as we will see further on.

Let us note here that this internal electromagnetic LC structure is also applicable to all of the electrically charged elementary electromagnetic particles constituting the complex unstable particles, be they electrically neutral or not, such as pions, kaons and other ephemeral complex particles resulting from destructive scattering between elementary particles [24].

We will study here however only the stable particles making up the scatterable structure of the set of atoms that can be found in the periodic table and of their nuclei, as well as positrons and free moving electromagnetic photons, because all of the unstable partons generated via destructive scattering play no role whatsoever in the establishment and stability of the universe, since they all almost instantly decay by releasing their excess energy in well known sequences of stages [25], until all that remains of them is one or other, or many of the very restricted set of stable electrically charged and massive elementary particles making up all atoms [24].

But attention must first be given to a typographical error in Equation (M-7) of Marmet's article that renders the seamlessness of his derivation difficult to perceive. For his unbroken sequence of reasoning to be made clear, his derivation down to Equation (M-7) from the Biot-Savart equation will be fully detailed here. The remainder of his derivation down to Equation (M-23) remains easy to follow directly in his article [19] and is also clearly explained and analyzed in another recently published article [4].

Although the second part of his article starting with Section 7 elaborates a personal hypothesis on a possible inner structure of the electron, which is of course subject to discussion, the first part of his article is in no way hypothetical, but rather elaborates a mathematically seamless derivation from the Biot-Savart equation, itself established directly from experimental data that can easily be re-obtained at will, that leads to the establishment of a new Equation (his equation M-23) that effectively seems to leave no doubt, quoting Marmet himself, that: "*the increase of the so-called relativistic mass* [of an accelerating electron] *is in fact nothing more than the mass of the magnetic field generated due to the electron velocity*" [19]:

$$\frac{\mu_0\left(e^-\right)^2}{8\pi}\frac{1}{r_e}\frac{v^2}{c^2}=\frac{M_e}{2}\frac{v^2}{c^2} \qquad \text{(M-23)}$$

To avoid any confusion in the numbering of equations in the present article,

all equations quoted from Marmet's paper will be prefixed with "M-" followed by the actual number of this equation in the original paper [19], so readers can directly relocate them in his paper.

Equation (M-23) suggests numerous possibilities that never were considered before, the most important of which is that it highlights an inconsistency between the Special Relativity Theory (SR) and electromagnetism that could not be noticed otherwise, because the very idea that the energy that progressively increases the transverse magnetic field of an accelerating electron, as calculated with the equations of electromagnetism, could be the same energy measurable as its transverse mass progressively increasing with velocity, as calculable with the equations of relativistic mechanics, is absent from SR for a reason that will be highlighted later.

The first clue suggesting the possibility that a single quantum of energy might be responsible at the same time for the increase of the electron's transverse magnetic field and for the increase of its transversely measurable relativistic mass, is established by the well-known fact that the magnetic field, as measured around a wire conducting a stable electric current, which is of course made of electrons circulating all at the same velocity and in the same direction in the wire, is oriented perpendicularly, that is, transversely, with respect to the direction of motion of the electrons, which is what the Biot-Savart law accounts for, as put into perspective by Marmet at the beginning of his article [19].

An important point must already be highlighted regarding the habit acquired since Maxwell to think of the familiar three-way orthogonal relationship of electromagnetic energy as involving electric and magnetic "*fields*" perpendicular to each other, that would be at the same time perpendicular to the direction of motion of the energy.

It is a fact seldom mentioned in reference works that the idealized concept of the "*electric field*" was introduced by Gauss as an "*idealized geometrical and mathematical conceptual representation*" of the Coulomb interaction diminishing omnidirectionally towards zero at infinity according to the inverse square of the distance rule, from a maximum value located at the point in space where the single test charge remaining in the Coulomb equation would be located when the second charge is removed from the equation, as highlighted in a recent article [14]. This idealized concept was then also conceptualized geometrically and mathematically to represent in the form of a "*magnetic field*" the magnetic aspect of electromagnetic energy.

It will therefore be important for the remainder of this analysis to keep in mind Gauss's original intention that these "*fields*" should be considered only as "*idealized geometrical and mathematical tools*" intended only to "*represent*" the real energy which is deemed to physically exist, and that it is the electromagnetic energy itself that physically exists that would physically self-structure, so to speak, according to this dual perpendicular pattern resulting from its transverse electromagnetic oscillation, that is, an oscillation which is transversely oriented with respect to the unidirectional momentum energy that sustains its motion in

space.

It follows that the transverse energy itself that Marmet's derivation identifies as simultaneously accounting for the transverse magnetic field increase and the measurable transverse relativistic mass increase of the accelerating electron, can therefore only be oriented perpendicularly to the direction of motion of the electrons whose circulation generates the stable current measurable via the Biot-Savart equation.

This of course means that the energy that supports the increasing momentum of an accelerating electron, that can be calculated with relativistic mechanics equation "$\Delta K = \gamma m_0 v^2/2$", can in no way be the same as the energy that perpendicularly supports its increasing transverse magnetic field that can be calculated by means of the Biot-Savart equation, the latter now presumably corresponding to the energy of the transverse relativistic mass increment computable with the relativistic mechanics equation "$\Delta E = \Delta mc^2 = \left(\gamma m_0 c^2 - m_0 c^2\right)$", because it is physically and vectorially impossible for a single energy quantum to move in both of these two perpendicular directions simultaneously, and also because the total amount of only one of these two energy quantities is insufficient to single-handedly account for the simultaneous energy increase of both its longitudinal momentum and of its transverse magnetic field at any given velocity.

On the other hand, Maxwell's first equation, which is in fact Gauss's equation previously mentioned for the electric field, and that reconverts to the simple Coulomb equation when a second charge is introduced in the "idealized field" of the test charge, reveals that the total amount of energy induced in each accelerating charge amounts to twice the energy of the longitudinal momentum "$\Delta K = \gamma m_0 v^2/2$", or alternatively, to twice the energy of the transverse relativistic-mass/magnetic-field increment "$\Delta E = \Delta m_m c^2$". More to the point, this reveals that both amounts are always equal by structure and that this sum can only be made of their simultaneously induction, in which "ΔE" also accounts for the accelerating electron transverse magnetic field increment, both quantities thus making up the total amount of energy required to account for the simultaneous increase of the velocity and of the related transverse magnetic field, that is, "$\Delta E = \Delta K + \Delta m_m c^2 = \gamma m_0 v^2/2 + \left(\gamma m_0 c^2 - m_0 c^2\right)$", as demonstrated in reference [4].

We should therefore rather speak in reality of two energy "*half-quanta*" constituting a single quantum of induced energy. The fact that this total quantum of energy calculated with the Coulomb equation varies in an infinitesimally progressive manner uniquely as a function of inverse of the distance separating two charged particles, also demonstrates that this energy varies adiabatically, and this, uniquely as a function of the inverse of the distances separating all charged particles from each other on account of to the Coulomb interaction, whether they are moving or not.

An additional clue supporting the conclusion that these two energy half-quanta have to exist simultaneously, is that to even be able to calculate the $\boldsymbol{\Delta B}$ magnetic field increment related to any velocity of an accelerating electron with the gene-

ralized form of Marmet's Equation (M-7) established in reference [20], it is the wavelength of this double amount of energy given by the Coulomb equation that must be used to obtain this correct ΔB value of the transverse magnetic field increment of the moving electron, which will be demonstrated with Equation (9) further on.

6. Historical Context of the Development of the Theory of Special Relativity

But the very fact that these two energy half-quanta are always equal in quantity initially induced confusion in the community in the absence of this new information available only since Marmet's recent derivation. This confusion led to considering that a total amount corresponding to only one of these two half-quanta was induced during the electron relativistic acceleration process, which gave rise to a famous disagreement among the theoreticians of the beginning of the 20th century.

For example, Minkowski [26], Lorentz [27] and Einstein [28] related this half-quantum of energy strictly to momentum, a conclusion which is an integral part of the Theory of Special Relativity (SR), while Abraham [29], Poincaré [30] and Planck [31] related the half-quantum of measured motion energy strictly to an increase in the transversely measurable mass.

7. The Conclusion of Minkowski, Lorentz and Einstein

By consulting a famous article by Max Planck dating from 1906 [31], it can be noted that he refers to the energy constituting the mass of a moving electron "$E = \gamma m_0 c^2$" by the terms "*lebendige Kraft*" (see his comment following Equation 8, page 140 of his text, identifying this energy by the term "*L*"), which is translated in the fundamental physics community by the terms "*kinetic force*" (or "*vibrating force*" or "*live force*" for a literal translation from German), which puts in perspective that at the beginning of the 20th century, the relation between the concept of "*force*", such as the force calculable with the Coulomb equation or with the fundamental mass acceleration equation "$F = ma$", that we conceptualize as having dimensions "*joules per meter*" [2], and the concept of "*energy induced by the Coulomb force*", which is obtained by multiplying the Coulomb force by the distance between two electric charges, and that we conceptualize as being in "*joules*" only [2], was not yet clearly established. The only reference to momentum in his text is "*Impulskoordinaten*" ("momentum coordinates"), which he does not associate with the energy that supports it in context of the ongoing debate at that time, and this at the very historical moment when this debate about the introduction of the SR Theory was raging.

By comparison, in the German fundamental physics community today, the momentum "*Impuls*" is immediately conceptualized as a quantity of kinetic energy "*kinetische Energie*" moving in a specific vectorial direction, as in the physical communities of other languages. Few today are fully aware that at the

beginning of the 20th century, the greatest advances in fundamental physics were made in Europe, and that the original articles were written mainly in German, but also in French and Italian, and that some of these founding articles have still not been formally translated to English, contrary to popular belief, and some very belatedly. For example, the text of a seminal presentation by Herman Minkowski from 1907, "*Das Relativitätsprinzip*", was only very recently translated to English in 2012 by Fritz Lewertoff [26]. Practically all of Louis de Broglie's writings, whose complete work has just been translated to Russian, have not yet been translated to English. It is therefore important to consult formal articles in their original language, to ensure that the translated versions are accurate, and more importantly to correctly put in perspective the lesser extent of the established knowledge pool at the time of their writing and on which they were grounded.

Analyzing Lorentz's article of 1904 [27], that introduced the concept of relativity by incorporating the "γ" factor into the equations of classical mechanics, which is what prompted Planck to write his 1906 paper [31] previously quoted, it can be seen that the concept of the Coulomb force is clearly defined, but that the energy of the relativistic momentum of the electron is calculated in the manner that intuitively comes to all our minds initially; that is, by simply adding the γ factor to Newton's initial non relativistic kinetic energy equation "$K = m_0 v^2/2$", but that he does not modify this equation to incorporate the half-quantum of transverse energy that supports the corresponding increment of its magnetic field, as described in reference [32], or alternatively, that he does not multiply the force obtained by means of the Coulomb equation by the distance separating the two charges to obtain the total amount of energy adiabatically induced in each charges by the Coulomb interaction at this distance, as described in reference [4].

We should therefore become fully aware that if two of the greatest discoverers of the time, Planck and Lorentz, had not become aware of the ontological relation now obvious to us between the Coulomb interaction and the induction of kinetic energy in charged particles, and of the relation between this electromagnetically induced energy and the kinetic energy causing massive bodies to move, from the classical/relativist mechanics perspective, macroscopic bodies whose masses can only be exclusively made of the sum of the masses of these electrically charged elementary particles, it necessarily means by extension that this relationship was not yet clearly established in the whole scientific community of the time, as unexpected as this may seem today.

It remains however astonishing that the great discoverers of that time were able to establish so precisely the equations of classical/relativistic mechanics without having benefited from the hindsight now provided us by a further century of experimentation, which now makes it possible to clearly perceive this relation between the so-called "*Coulomb force*", obtained by multiplying the unit charge of the electric field equation established by Gauss "$\boldsymbol{E} = e/4\pi\varepsilon_0 d^2$" [6] by

a second charge "*e*", which acts according to the rule of the inverse square of the distance between electric charges "$1/d^2$", that is "$F = e \cdot \boldsymbol{E} = e^2/4\pi\varepsilon_0 d^2$", and the amounts of *adiabatic kinetic energy* [33] that this force induces in these electric charges as a function of the simple inverse of the distance separating them "$1/d$", that is "$E = d \cdot F = e^2/4\pi\varepsilon_0 d$", which are concepts that seemed difficult to clearly correlate through the fog of uncertainty that still pervaded the relations between these electromagnetic concepts that were then not in process of being methodically explored, and that still are not today (see following section), and the classical concept of "*mass*", that belonged to the domain of classical mechanics, and that still was considered as unrelated to electromagnetism at that time.

This is what explains why the concept of "*force*" was not specifically incorporated to SR to justify the increase in energy of a moving or accelerating mass, and also why the very notion of "*force*" is simply absent from the theory of General Relativity (GR), in which it is replaced as the ontological cause of the existence of energy by an inertial motion of massive bodies caused by an assumed "*curvature*" of "*space-time*", which prevented the Coulomb equation, which is based on the concept of a "*force*" associated with the acceleration of electrically charged particles, from being conceptually associated with the acceleration of the electron "*mass*" from this perspective, because no connection is made in this theory between the concept of "*classical mass*" and the fact that all macroscopic massive bodies can only be made of electrically charged massive elementary particles [16], as will be put into perspective later.

As strange as this may seem, more than one century after Kaufman's defining experiments with electrons accelerating to relativistic velocities [34], no concept of an increase of the magnetic field of the accelerating electron mass exists in SRT, which makes it seem normal according to this theory that only the momentum energy half-quantum would be increasing with velocity, that is, a velocity apparently due to a theoretical "*inertial acceleration*".

8. The Conclusion of Planck, Poincaré and Abraham

As mentioned previously, Abraham [29], Poincaré [30] and Planck [31] related the half-quantum of measured motion energy strictly to an increase in the transversely measurable mass, without relating it however in any way to the simultaneous increase of the related transverse magnetic field. From this perspective, the momentum of a moving mass does not have a physical existence, but is considered as an impulse propagating in an underlying ether that would propel the mass, which also makes it seem normal from this second perspective that only the energy half-quantum of the transversely measurable mass increases with velocity.

This disagreement between the position of Einstein, Minkowski and Lorentz on the one hand, and that of Poincaré, Abraham and Planck on the other hand is still the object of endless discussions in the community. In both cases, no relation is established with the double amount of energy revealed by the Coulomb

equation as being ontologically induced simultaneously by the Coulomb interaction in the accelerating electron; and neither of these solutions allows even suspecting that these two half-quanta could be increasing simultaneously.

Consequently, gaining a clear awareness of the mandatory simultaneousness of the existence of both of these two energy half-quanta perpendicularly oriented with respect to each other, in light of Marmet's discovery and in relation with the Coulomb equation, is therefore required for a complete harmonization of classical/relativistic mechanics and electromagnetism to be realized.

9. The Absolute Axiomatic Principles

Let us return for a moment to the previously mentioned "*fog of uncertainty*" that surrounded the concepts of the Coulomb force and the energy induced by this force as the theory of Special Relativity was being developed at the beginning of the 20th century.

Throughout history, before the extent of the momentary accumulation of knowledge about Nature made it possible to identify absolute constants in Nature on which theories could be grounded to explain the identifiable processes observable in objective reality, the method used to ground these theories consisted in establishing absolute axiomatic "*principles*" to be used as stable references to firmly ground rational explanations about the nature of energy, mass, electric charges, etc. These principles eventually became "*idealized dogmas*" that the scientific community adopted as being reliable references to ground the theories that were in process of being developed, such as the Principle of conservation of energy, the Pauli Exclusion Principle, the Principles of stationary action and of least action, etc.

Some of these Principles are "*positive*" idealized Principles, such as the Principle of conservation of energy, that bar all possible exceptions, but that do not actively discourage research as to possible limitations of their reach or of even the very validity of a principle with respect to its applicability to physical reality, that may have been less well understood when it was initially formulated.

Indeed, in the case of this last principle, for example, the current extent of knowledge allows now to better define its reach with respect to physical reality, because we can observe that the Principle of conservation of energy remains valid for a system as long as this system previously stabilized in some stationary action equilibrium state returns to this state after having been disturbed, but that if it is led to vary in such a way as to stabilize axially into a less energetic or in a more energetic stationary action state than the initial state, this change can only be adiabatic in nature [33].

This is precisely the case for the space probes that were taken away from Earth and launched on least action escape trajectories from the solar system, for example [35] [36] [37] [38], as we will see later. When such systems stabilize in such a new state of stationary action axial equilibrium, the Principle of energy conservation applies again, but with reference to this new state of stationary action axial equilibrium. Indeed, the masses of which these probes are made will never re-

turn to the state of stationary action axial equilibrium that they had before launch.

In reality, all stationary action states allowed in objective reality are part of a hierarchy of axially distributed stationary least action electromagnetic equilibrium states, ranging from the stationary states of the subatomic order of magnitude to those of the astronomic order of magnitude, whose detailed hierarchical correlation remains to be completely established, and the only way for an elementary particle or larger mass to move axially from one of these stationary equilibrium state to another is by means of a least action trajectory involving an adiabatic change in its carrier energy. This hierarchy of stationary states will be discussed further on, but let us return for now to the main theme of this section, which is the set of historically established absolute axiomatic principles.

Among the set of historically established "*positive*" axiomatic dogmas, however, is one, the *de facto* rejected concept of "*action-at-a-distance*", also derogatively referred to as "*spooky-action-at-a-distance*", which is universally and unjustifiably associated with the Coulomb's so-called "*force*", which is a "*negative*" and "*absolute*" dogma, in the sense that it actively discouraged any research in the community in trying to study and understand the nature of the Coulomb interaction, despite the fact that it directly underlies Maxwell's first equation, that is, Gauss's equation for the electric field as previously described, which is universally accepted as valid.

The misunderstanding that apparently led to the very idea of a so-called "*action-at-a-distance*" in reference to the Coulomb "*force*" seems to have been that this so-called "*force*" was associated to the concept of an "*attraction*", as defined in Newton's macroscopic gravitational theory, instead of having been associated to a "*process of energy induction, half of which provides unidirectional momentum*" in electrically charged particles at the subatomic level, and that an assumed "*attraction*" between charged particles was wrongly considered as being due to an "*attractive force*", instead of being understood as a motion "*propelled by some unidirectional momentum energy*" of an electrically charged particle towards another electrically charged particle of opposite sign; and that an assumed "*repulsion*" wrongly interpreted as being due to a "*repulsive force*" between electrically charged particles of same sign, turns out to be in reality a motion of an electrically charged particle away from another electrically charged particle of same sign "*propelled by some unidirectional momentum energy*", with no "*force*" whatsoever being involved in the process, as analyzed in reference [16].

The concept of Coulomb interaction having now been summarily formulated in a manner more in line with reality, and in order to distance ourselves from the concept of Newtonian "*force*", which is useful at the macroscopic level, but is deceptive when dealing with massive and charged elementary particles at the subatomic level, the expressions "*Coulomb interaction*" will generally be used for the remainder of this article instead of the misleading expression "*Coulomb force*".

A hundred years now after Lorentz, Planck, Einstein, de Broglie and Schrödinger, to name only a few of the extraordinarily dedicated scientists of the time who revolutionized fundamental physics at the beginning of the 20th century, it seems that we know enough now about the subatomic level to do away with such absolute axiomatic principles and dogmas, by either clearly identifying the physical limits of their applicability, as in the case of the Principle of conservation of energy, or by simply doing away with those that ultimately turn out to just having been misguided impediments to research due to insufficient initial information having been available as to the actual possible nature of the Coulomb interaction, for example, that we now know is the actual cause of the simultaneous adiabatic induction of both perpendicular energy half-quanta in all charged elementary particles in existence, that is, a Coulomb interaction whose nature still remains to be clearly understood.

10. Inappropriate Names Given to Some Processes and States

The very names given in the past to some stable observed characteristics and processes of elementary particles, before the electromagnetic nature of the energy of which their invariant rest masses is made was understood, also heavily contributed to the persistent confusion in the community as to the real nature of these characteristics and processes.

For example, the lower limit of integration of the energy of the rest mass of the electron obtained by means of the spherical integration mathematical means, was quite inappropriately named "*the electron classical radius*", symbolized by "r_e", which constantly tends to cause many researchers "*to think*" of this value as possibly representing the true physical radius of the electron mass, in the classical mechanics sense [20].

Another much more insidious misnomer is the term "*spin*" chosen to refer to the relative magnetic polarity of mutually interacting electrons and of their interaction with the electromagnetic subcomponents of nucleons, that induces the quite inaccurate beliefs that a transverse rotation of the electron mass has to be involved during these interaction states [39].

The use of these terms is so generalized however that changing them is likely to cause even more confusion, but the real nature of the states and processes being referred to should be clearly documented in formal reference repositories such as *NIST* [40] and the *CRC Handbook of Chemistry and Physics* [41], for example.

11. The Simultaneous Induction of Both Energy Half-Quanta

This new awareness of the simultaneous existence of these two energy half-quanta, mutually perpendicular to each other, that are permanently induced in all charged elementary particles, whether they are in motion or not, and whose amount progressively varies according to the inverse of the distances between

each charged particle and all others, now allows establishing at the subatomic level an internal electromagnetic structure of the energy quantum sustaining both the longitudinal momentum increase and the increase of the transverse magnetic field of any accelerating charged elementary particles, which is identical to that suggested by Louis de Broglie in the 1930's for localized electromagnetic photons [3], which is in complete agreement with Maxwell's equations, but which is not in contradiction with the manner in which free moving electromagnetic energy has mathematically been successfully dealt with at the macroscopic level from the viewpoint of Maxwell's continuous wave theory.

12. Description of Marmet's Derivation from Equation (M-1) Down to Equation (M-6)

In electromagnetism, the Biot-Savart equation is possibly the easiest equation to confirm experimentally because it only describes the transverse uniform and invariant cylindrical magnetic field generated by a stable continuous electric current flowing in a straight electric wire [8].

Grounding his reasoning on the fact experimentally observed during high energy particles accelerators experiments that the magnetic field of an accelerating electron increases despite the also observed fact that its unit charge remains constant irrespective of its velocity, Marmet succeeded, by theoretically reducing to one electron the current flowing in the wire, to derive Equation (M-23) from the Biot-Savart equation, which allows demonstrating that the transversely measurable relativistic mass increase of an accelerating electron, is directly related to its transverse magnetic field increase.

Finally, Equation (M-24) that directly emerges from Equation (M-23), directly establishes that exactly half of the energy making up the invariant rest mass of the electron is also representable as a magnetic field, presumably also transverse by analogy, and would also be in reality an invariant amount energy that would also be physically oriented transversely:

$$\frac{\mu_0\left(e^-\right)^2}{8\pi}\frac{1}{r_e}=\frac{M_e}{2} \tag{M-24}$$

This observed characteristic of the intrinsic magnetic field of the rest mass of the electron, among many others that Marmet's discovery allows at long last to correlate in a new mutually self-consistent perspective, will be analyzed further on, as well as the "*velocity-dependence*" aspect of the accelerating electron increasing transverse magnetic field, as well as the further developments that Equation (M-23) leads to. But let us first address the hurdle presented by Equation (M-7).

He began his derivation by introducing the following form of the Biot-Savart Equation (M-1), in which the cylindrical transverse magnetic field that appears about a current carrying rectilinear metallic wire when a stable electric current is circulating, is represented as being perpendicular to the current direction in the wire, as illustrated in **Figure 1** of his paper [19], that is, as being perpendicular

to the axis along which current "I" is graphically represented as flowing:

$$\mathrm{d}\vec{B} = \frac{\mu_0 I}{4\pi}\frac{\mathrm{d}\vec{s}\times\mathrm{d}\vec{u}}{r^2} \tag{M-1}$$

He then redefined current "I" by quantizing the electron charge to its invariant unit value (e = 1.602176462E−19 C), which allowed replacing the general variable charge symbol "Q" in the standard definition of "I" by the discrete number of electrons in one ampere:

$$I = \frac{\mathrm{d}Q}{\mathrm{d}t} = \frac{\mathrm{d}\left(Ne^-\right)}{\mathrm{d}t} \tag{M-2}$$

Since the velocity of electrons in a conductor remains constant if current "I" remains constant, the time element "dt" can also be replaced by its traditional definition "dx/v":

$$\text{since}\quad v = \frac{\mathrm{d}x}{\mathrm{d}t},\ \text{then}\quad \mathrm{d}t = \frac{\mathrm{d}x}{v} \tag{M-3}$$

Replacing now "dt" of the definition of "I" as previously established with Equation (M-2) by its equivalent definition established with Equation (M-3), he obtained:

$$I = \frac{\mathrm{d}\left(Ne\right)}{\mathrm{d}t} = \frac{\mathrm{d}\left(Ne^-\right)v}{\mathrm{d}x} \tag{M-4}$$

He then introduced the scalar version of the Biot-Savart equation:

$$\mathrm{d}B = \frac{\mu_0 I}{4\pi r^2}\sin\left(\theta\right)\mathrm{d}x \tag{M-5}$$

Replacing "I" in Equation (M-5) by its new definition established with Equation (M-4) also eliminates the implied time factor from Biot-Savart equation, which can be done in context without affecting the value of the magnetic field considered since it remains constant by definition since the current remains constant:

$$\mathrm{d}B = \frac{\mu_0 I}{4\pi r^2}\sin\left(\theta\right)\mathrm{d}x = \frac{\mu_0}{4\pi r^2}\frac{\mathrm{d}\left(Ne^-\right)v}{\mathrm{d}x}\sin\left(\theta\right)\mathrm{d}x = \frac{\mu_0 v}{4\pi r^2}\sin\left(\theta\right)\mathrm{d}\left(Ne^-\right) \tag{M-5a}$$

In summary, Marmet's Equation (M-6) is now presented as follows, now involving a sum of quantized unit charges, represented by factor "Ne^-", on top of being disconnected from the time factor, since the magnetic field intensity will remain stable as long as the current remains stable, irrespective of the time elapsed:

$$\mathrm{d}B = \frac{\mu_0 v}{4\pi r^2}\sin\left(\theta\right)\mathrm{d}\left(Ne^-\right) \tag{M-6}$$

13. The Erroneous Equation (M-7) Published by Mistake

We now reach the equation that seems not to logically emerge from the seamless sequence that led to Equation (M-6) above, which is likely to have caused an undue loss of interest on the part of potentially interested researchers in reading

further, which may explain why this article has not attracted more attention up to now:

$$\text{Incorrect Equation (M-7):}\quad \mathrm{d}B_i = \frac{N\mu_0 e^- v}{4\pi r^2}\mathrm{d}\left(Ne^-\right) \tag{M-7}$$

It seems also that Paul Marmet did not become aware of this typographical error during the 2 years separating its publication in 2003 from his passing away in 2005, which would explain why he produced no *erratum* note to rectify this misprint, because it is absolutely certain that he derived the correct following form of Equation (M-7), that we will now correctly re-establish, since he used this correct form for the remainder of his derivation:

$$\text{Corrected Equation (M-7):}\quad B_i = \frac{\mu_0 e^- v}{4\pi r^2} \tag{M-7}$$

14. Re-Establishing the Correct Form of Equation (M-7)

As analyzed by Marmet in his explanatory text between Equations (M-6) and (M-7), two variables of Equation (M-6) will now be reduced to the constant value "1" by structure due to the number of electrons being brought down to a single one in Equation (M-7), in which case the charge distribution and magnetic field distribution become by structure isotropic and spherically centered on the location of this single electron, instead of being respectively conceptually linearly distributed for the charge and in transverse cylindrical distribution perpendicularly to the current direction for the magnetic field, as in the initial Biot-Savart equation. Here is then how the correct Equation (M-7) can be derived from Equation (M-6).

First, the "N" term in Equation (M-6) will become equal to "1" in Equation (M-7) since only one electron is being considered in the latter equation, so first the term "$\mathrm{d}\left(Ne^-\right)$" will become "$\mathrm{d}\left(e^-\right)$", which is the first step in transiting from Equation (M-6) to the correct form of Equation (M-7):

$$\mathrm{d}B_i = \frac{\mu_0 v}{4\pi r^2}\sin\left(\theta\right)\mathrm{d}\left(e^-\right) \tag{M-6a}$$

Since a single electron is being considered, it becomes impossible to conceptually determine a direction of continuous distribution of the electric charge, because no axis of distribution can now be defined. Consequently the "$\sin(\theta)$" factor that was related to this now non-existent linear distribution also disappears from the equation. So we now have:

$$\mathrm{d}B_i = \frac{\mu_0 v}{4\pi r^2}\mathrm{d}\left(e^-\right) \tag{M-6b}$$

Since charge "e" of the electron is invariant and thus becomes a numerical constant, calculating a derivative for Equation (M-6b) becomes meaningless. Consequently the two occurrences of the derivative operator "d" simplify out of Equation (M-6b), and we end up with the real equation that Marmet obviously meant to be published as Equation (M-7):

$$B_i = \frac{\mu_0 v}{4\pi r^2} e^- \qquad \text{(M-6c)}$$

then rearranged in the following form that he used as he proceeded with his derivation leading to Equation (M-23):

$$\text{Correct Equation (M-7):} \quad B_i = \frac{\mu_0 e^- v}{4\pi r^2} \qquad \text{(M-7)}$$

This is how Marmet succeeded in modifying the Biot-Savart equation from representing the uniform macroscopic cylindrical static magnetic field generated by a stable electric current circulating in a rectilinear metallic wire, to representing the velocity related uniform subatomic theoretically spherical transverse magnetic field increment related to the velocity of a single electron, centered on its moving point-like location as it moves at constant velocity, represented by Equation (M-7).

According to the motion mechanics of electromagnetic energy in the expanded trispatial geometry that will be clarified later, this constant velocity of all electrons in the flow of electrons in a metallic wire is due to each electron being individually "propelled", so to speak, by an amount of physically existing longitudinally oriented momentum energy ΔK, equal by structure to the transversely oriented energy making up the related transverse magnetic field increment $\boldsymbol{\Delta B}$, both amounts physically existing separately from the energy of which the invariant rest mass of the electron is made.

From this perspective, it turns out that the stable transverse and apparently stationary and uniform magnetic field d$\boldsymbol{B}$ of Biot-Savart Equation (M-1) measurable about the metallic wire simply is the sum of the individual moving transverse magnetic fields of the moving electrons, each electron dragging with it its local magnetic field. Since all electrons in the flow move in the same direction and in close proximity to each other, their individual magnetic fields are all *de facto* forced into mutual parallel magnetic spin alignment due to the inflexible triply orthogonal "*electric*/*magnetic*/*direction-of-motion-in-space*" relationship of electromagnetic energy, to which the energy of every elementary electromagnetic particle is subjected to; which explains why all of the individual magnetic fields of the electrons circulating in the wire are oriented in the same transverse direction about the wire, that results in the establishment of this cylindrical macroscopic transverse magnetic field measurable as being stable at any point along the length of a metallic wire in which a constant current is circulating. This is what the Biot-Savart equation is measuring. And this is why reducing the current to involve a single electron allows defining Equation (M-7) that can account for the velocity related subatomic magnetic field increment of a single electron.

It must be mentioned here that the same forced mutual parallel magnetic spin alignment of unpaired electrons in ferromagnetic materials is also what causes their individual magnetic fields to add up to become measurable at our macroscopic level as a single macroscopic magnetic field, as analyzed in references [39]

[42], and formally described in reference [41]. This confirms that the establishment of all macroscopically measurable magnetic fields, be they dynamic or static, can only be due to the same subatomic process, which is the forced parallel alignment of the magnetic spins of the energy of the elementary electromagnetic quanta involved.

We will see further on how Marmet's Equation (M-7) was generalized to calculate the magnetic field increment of any localized electromagnetic quantum, leading then to generalized forms allowing to calculate the velocity of any charged elementary massive electromagnetic particle by combining the intrinsic invariant magnetic field $\boldsymbol{B}$ of its rest mass with the varying magnetic field $\Delta\boldsymbol{B}$ of this energy of motion induced in electrically charged massive particles by the Coulomb interaction.

The remainder of Marmet's derivation up to his determining conclusion represented by equivalence (M-26) is available in his paper [19], and is also analyzed in detail at the beginning of reference [4]:

$$\text{Relativistic Mass} \equiv \text{Magnetic Mass} \tag{M-26}$$

15. The Implications of Marmet's Discovery

The first major consequence of the establishment of the Equation (M-23) is the establishment of electromagnetic equations that allow the calculation of the relativistic velocities of charged and massive elementary particles without any need to use the Lorentz γ factor.

16. Calculating Relativistic Velocities without the Lorentz γ Factor

Considering Equation (M-23) again, since "c" constitutes *an asymptotic velocity limit* that the electron cannot physically reach, then as "v" tends towards "c", "$M_e/2$" seems to tend towards an asymptotic transverse mass increment limit equal to "4.55469094E−31 kg", corresponding to its transverse magnetic field increment, that apparently seems, at first glance, impossible to increase further, but we will see further on that this is not the case:

$$\frac{\mu_0\left(e^-\right)^2}{8\pi}\frac{1}{r_e}\frac{v^2}{c^2}=\frac{M_e}{2}\frac{v^2}{c^2} \tag{M-23}$$

At this stage of the analysis, Equation (M-23) can thus be formulated as follows to represent the electron transverse *relativistic-mass/magnetic-field* increment:

$$\Delta m_{(v\to c)}=\frac{\mu_0 e^2}{8\pi r_e}\frac{v^2}{c^2}=\frac{m_e}{2}\frac{v^2}{c^2} \tag{1}$$

On the other hand, when "v" tends towards zero in Equation (M-23), its transverse magnetic field increment also tends towards zero. And when this velocity approaches zero, the ratio "v^2/c^2" reveals that the amount of energy of the

transverse increment of the magnetic field becomes negligible and that this ratio can then be removed from the equation, which still leaves part of the invariant rest mass an electron as being represented as a magnetic field, apparently finally revealing that exactly half of the energy making up the invariant rest mass of the electron would also be the source of its intrinsic invariant magnetic field, as represented by Equation (M-24), which is a conclusion that will be confirmed further on by the establishment of the Maxwell equation compliant LC Equation (30) that reveals the actual inner electromagnetic structure of the electron rest mass energy, that was previously established in the trispatial geometry in relation with de Broglie's hypothesis (**Figure 3**):

$$M_{e\_\text{magnetic}(v\to 0)} = \frac{\mu_0 \left(e^-\right)^2}{8\pi} \frac{1}{r_e} \frac{v^2}{c^2} = \frac{\mu_0 \left(e^-\right)^2}{8\pi} \frac{1}{r_e} = \frac{M_e}{2} \qquad \text{(M-24)}$$

Equation (M-7), on the other hand, can be formulated as follows to represent the corresponding transverse magnetic field increment that represents the same amount of increasing energy measurable as the transverse mass increment represented by Equation (1) which adds to that of the invariant magnetic field of the electron's rest mass, calculable with Equation (M-24):

$$\Delta B_{(v\to c)} = \frac{\mu_0 e v}{4\pi r^2} \qquad (2)$$

As a first step in confirming that Equations (1) and (2), both are representations of the same amount of transversely oriented energy in relation with the direction of motion of the accelerating electron, let us first resolve Equation (1) for a well known relativistic velocity, that is, velocity 2,187,647.561 m/s related to the Bohr ground orbit momentum energy in his theory about the hydrogen atom (2.179784832E−18 j), which also happens to be the real mean momentum energy given by the wave function of Quantum Mechanics for the electron ground state orbital of the hydrogen atom. This velocity will immediately confirm that Equation (1) provides the correct related relativistic mass increment:

$$\Delta m_m = \frac{\mu_0 e^2 v^2}{8\pi r_e c^2} = \frac{\mu_0 e^2 \left(2187647.561\right)^2}{8\pi r_e c^2} = 2.425337715\text{E}{-35}\ \text{kg} \qquad (3)$$

By means of Equation (2), which is, let us remember, Marmet's Equation (M-7), we must now calculate the increase in the transverse magnetic field associated with this same relativistic velocity of the electron. For this purpose, we must define the value of the second variable in Equation (2), that is, the value of "r"; and it cannot outright be assumed that it will have the same value "r_e" of Equation (1), which is a constant known as the "*classical electron radius*", used in this equation in relation with the electron rest mass.

In the case of Equation (1), that is, Marmet's Equation (M-23) combining an electromagnetic definition of the electron mass with its classical/relativistic mechanics definition, a close examination shows that the relativistic-mass/magnetic-field increment can only synchronously increase with the velocity ratio "v^2/c^2", "c" being invariant and "v" ranging from zero to asymptotically close to "c", which,

as previously mentioned, seems to reveal that the theoretical maximum possible increment of transverse relativistic-mass/magnetic-field of a free moving electron seems not to really tend towards infinity as traditionally anticipated, but would rather tend to become asymptotically close to a value equal to half the invariant mass of the electron ($\Delta m_m = m_e/2 = 4.55469094\text{E}{-31}$ kg , corresponding to the induced transverse energy half-quantum of 4.09355207E−14 j).

Let us remember at this point that the Marmet Equation (M-23) defines the relativistic-mass/magnetic-field increment as being dependent strictly on the value of the invariant half of the rest mass energy of the electron that defines its intrinsic invariant magnetic field. But a conversion to electromagnetic form of the classical Newton kinetic energy equation "$K = mv^2/2$" completed by its correction to incorporate the transverse magnetic energy identified by Marmet and that was missing in Newton's equation [32], ultimately shows that as the transverse magnetic field increases, any further increase of this transverse relativistic-mass/magnetic field increment does not depend uniquely on half the energy of the electron rest mass, as non-relativistic Equation (M-23) suggests, but depends in reality on the total amount of momentarily accumulated transverse energy, that is, on the sum of the energy making up the mass of the intrinsic magnetic field of the electron "$m_e c^2/2$" plus the energy of the momentarily accumulated transverse mass increment "$\Delta m_m c^2$".

This means that the transversely measurable relativistic mass of an accelerating electron "$m_{\text{relativistic}}$" is always equal to "$m_0 + \Delta m_m$", which allowed establishing that this sum is always equal to the invariant rest mass of the electron multiplied by the well known gamma factor "γm_0" that was established more than one century ago [32]. This is what allows calculating the whole range of relativistic velocities of the electron without using the gamma factor (known as the Lorentz factor).

For example, any relativistic velocity of an electron can be calculated with the following equation derived in reference [32], by setting "E" to "8.18710414E−14 j", that is, the energy of the invariant rest mass of the electron, and setting "K" to the sum of energy of the transverse relativistic-mass/magnetic-field increment "$\Delta m_m c^2$" plus the related momentum energy "ΔK" that we now know is always equal by structure to "$\Delta m_m c^2$", that is, "$K = \Delta K + \Delta m_m c^2$":

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

This equation can also be converted to a form making use of the wavelengths of the energies involved [32], allowing the very same calculation of the whole range of relativistic velocities of the electron strictly from the wavelengths of the energies involved:

$$v = c\frac{\sqrt{4\lambda \cdot \lambda_C + \lambda_C^2}}{2\lambda + \lambda_C} \tag{5}$$

From this equation, the gamma factor was directly derived as analyzed in ref-

erence [32], thus bringing the proof of the validity of Marmet's derivation that allowed the elaboration of these equations.

17. A Cause More Fundamental than Velocity of the Induction of Momentum and Transverse Magnetic Field Energy

Let us now return to the correlations that must be made between Equations (1) and (2). We observe in the electromagnetic definition of mass of Equation (1), that it is the "*classical radius*" of the electron "r_e" that connects this relation to the concept of mass. In the case of Equation (2), which emerges strictly from electromagnetism, it is also clear that the transverse magnetic field can only increase according to the same velocities ratio, because Marmet's demonstration clearly reveals that the energy half-quantum represented by mass increment "Δm_m" in Equation (1) is the same transversely oriented energy half-quantum which is also described by the transverse magnetic field increment $\boldsymbol{\Delta B}$; but the value that "r" must have in Equation (2) for the energy corresponding to the increase of $\boldsymbol{\Delta B}$ to coherently vary from zero to this asymptotic limit made up of the sum of the energy of the classical half-quantum of the electron's rest mass of "4.09355207E-14 j" plus the momentarily accumulated energy of $\boldsymbol{\Delta B}$, is not clearly established. To understand what this value should be, we must now understand the relation between "r_e" used in Equation (1) and the mass of the electron, or more precisely its relation with the energy constituting the invariant rest mass of the electron.

In a paper published in 2007 in the same Kazan State University International IFNA-ANS Journal [20], that describes a first wave of conclusions emerging from Marmet's discovery, it was conclusively established that "r_e" is in reality the lower limit of spherical integration of the energy making up the invariant rest mass of the electron ($E = m_e c^2$ = 8.18710414E−14 j), and that "r_e" turns out to be in reality the *transverse amplitude of electromagnetic oscillation* of the energy making up the measurable rest mass of the electron, which is obtained by multiplying the electron Compton wavelength by the fine structure constant "α" and dividing them by "2π", as determined in reference [21]:

$$r_e = \frac{\lambda_C \alpha}{2\pi} = 2.817940285\text{E}{-}15 \text{ m} \tag{6}$$

Consequently, and by similarity, the value of "r" that must be used in Equation (2) should thus also be that of the *transverse amplitude of electromagnetic oscillation* of the energy induced at the Bohr radius (4.359743805E−18 j), whose *longitudinal electromagnetic wavelength* would be (λ = 4.556335256E−8 m) if it was moving at velocity "c", but that must already be multiplied by "α" to reach the value of the *longitudinal de Broglie wavelength* corresponding, for this energy, to the length of the Bohr orbit, whose radius is (r_B = 5.291772083E−11 m), keeping in mind that this radius remains valid in Quantum Mechanics since it is exactly equal to the mean axial resonance distance of the electron within the

volume defined by Schrödinger's wave equation for the electron captive in the hydrogen ground state orbital [4]:

$$r_B = \alpha r = \frac{\alpha\lambda}{2\pi} = \frac{\lambda_B}{2\pi} = 5.291772083\text{E}{-11}\ \text{m} \tag{7}$$

By similarity to the method used with Equation (6) to define the *transverse amplitude of electromagnetic oscillation* of the electron rest mass energy by multiplying the *longitudinal electromagnetic wavelength* "λ_C" of its energy by "α", there is thus need to multiply also the *longitudinal de Broglie wavelength* "λ_B" defined in Equation (7) for the energy induced at the Bohr radius "r_B" again by "α" to finally reach the "*transverse*" value "αr_B" of the *transverse amplitude of the oscillation* of the electromagnetic energy induced at the Bohr radius (αr_B = 3.861592641E−13 m), which now makes it possible to establish the intensity of the transverse magnetic field increment $\boldsymbol{\Delta B}$ which becomes measurable by being added for the velocity considered to the invariant transverse magnetic field of the rest mass of the electron. Let's now calculate the magnetic field corresponding to relativistic velocity "2,187,647.561 m/s" and to this value of "$r = \alpha r_B$" with Equation (2):

$$\Delta B = \frac{\mu_0 ev}{4\pi\left(\alpha r_B\right)^2} = \frac{\mu_0 e\left(2187647.561\right)}{4\pi\left(\alpha \times 5.291772083\text{E}{-11}\right)^2} = 235047.0405\ \text{T} \tag{8}$$

It is interesting to note by the way that "r_e", as calculated with Equation (6), is only distant from an additional multiplication by "α" from the value of "αr_B", as established in reference [43], which suggests a possible axial resonances sequence establishing a sequence of stable stationary action electromagnetic states whose unit of axial progression seems to be the fine structure constant "α", as put in perspective in the same reference.

To confirm the validity of the value obtained with Equation (8), which is also measurable as a transverse magnetic mass increment "Δm_m" with Equation (3), let's calculate it with Equation (9) which is the generalized version of Marmet's Equation (M-7) that was established in the 2007 article [20]. Unlike Equation (M-7), it can be observed that this generalized form does not require using the velocity of the particle to obtain the intensity of its transverse magnetic field increment.

Only the *longitudinal electromagnetic wavelength* of the total carrier energy of the electron is required, that is, the energy of its momentum plus the transverse energy representable either as a magnetic mass increment "Δm_m" or as a magnetic field increment $\boldsymbol{\Delta B}$. Since the total energy induced at the Bohr orbit is (E = 4.359743805E−18 j), its *longitudinal electromagnetic wavelength* is thus ($\lambda = hc/E$ = 4.556335256E−8 m), and we obtain with this generalized equation the same value as with Equation (8):

$$\Delta B = \frac{\mu_0 \pi ec}{\alpha^3 \lambda^2} = \frac{\mu_0 \pi ec}{\alpha^3 \left(4.556335256\text{E}{-8}\right)^2} = 235051.7346\ \text{T} \tag{9}$$

We thus observe that without any need to imply any velocity, generalized Eq-

uation (9) provides in Tesla the very same transverse magnetic field increment energy density as the initial Marmet Equation (M-7) originally derived from the Biot-Savart equation, in which the intensity of the transverse magnetic field increment "*seems to depend*" on the velocity of the particle, since that in the Biot-Savart equation from which it was derived, the intensity of the increment of the magnetic field varies strictly according to the velocity of the electrons circulating in the wire.

The fundamental question that now comes to mind is the following, when considering Equation (9): "How come that it is possible, to calculate the correct intensity of the 'supposedly' velocity dependent variable transverse magnetic field increment of a moving electron, without this velocity being used to calculate it?".

18. Momentum and Transverse Magnetic Field Energy Increase without Velocity Increase

This difference between Equation (M-7), that requires the use of a velocity to calculate the related intensity of the transverse magnetic field increment of the moving electron, and its generalized version used to solve Equation (9), that does not require this velocity, draws attention to a cause more fundamental than motion to explain the induction of energy in the electron even when no velocity is involved.

It is a long established fact in classical mechanics, from direct observation, that the kinetic energy traditionally named the "*energy momentum*" of a macroscopic mass in motion depends strictly on its velocity, and that this energy is considered to be the only motion related energy that exists in excess of the energy making up the rest mass of a massive body. The amount of energy of this momentum of an accelerating macroscopic mass is consequently defined in classical mechanics as increasing linearly, potentially without limit, only due to its velocity increase, itself also potentially without limit.

This definition of the increasing kinetic momentum of an accelerating macroscopic mass is also admitted in Special Relativity with this difference that the momentum energy is defined as increasing according to a non-liner curve that we know is correct, also theoretically without limit, as the velocity increases, but that this potentially infinite value would be reached before the velocity of light is reached, this velocity being defined as an unreachable asymptotic velocity limit deemed impossible to be reached by massive bodies. Confirmation of the accuracy of equation "$K = m_0 c^2 (\gamma - 1)$" from Special Relativity was never obtained, however, by means of macroscopic masses in motion, since we do not have the technology required to accelerate macroscopic masses to relativistic velocities, but rather using the subatomic mass of the electron, with which the accuracy of this equation was confirmed by Kaufman's first experiments [34].

As put in perspective at the beginning of this article, it must be understood that as the theory of Special Relativity was being developed, the fact that the invariant rest mass of the electron "m_0 = 9.10938188E−31 kg" is also the seat of its

invariant unit electric charge "e = 1.602176462E−19 C" was not yet understood as meaning that the Coulomb interaction, that induces the energy of the momentum and of the transverse magnetic field in all electrically charged elementary particles such as electrons strictly as a function of the inverse of the distance between them, and this, even if this distance does not vary, induces it *de facto* at the same time with respect to the rest mass of these charged and massive particles, since the charge and the mass of the electron are two characteristics of the same elementary particle.

Considering that the mass of all macroscopic bodies can only be the sum of the subatomic masses of the massive elementary particles of which it is made, how then can this be reconciled the fact that no increase in the magnetic field of any moving macroscopic masses seems to ever have been measured, since this increase is easily measurable for an accelerating electron, as abundantly demonstrated experimentally since Kaufman's first experiments [34], which also provides experimental confirmation of the non-rectilinear growth of the momentum energy of an accelerating electron towards this theoretical infinite quantity that the asymptotic limit imposed by the speed limit of light suggests?

Indeed, such relativistic-mass/magnetic-field increments of macroscopic masses may well have been detected all the same for much lower velocities than those typical of electrons, but without having been recognized as such, due to the fact that the Special Relativity theory on which all analysis of relativistic effects are grounded does not recognize its existence, as previously put in perspective, and as we will now observe from experimental data.

19. The "Anomalous" Trajectories of the Pioneer 10 and 11 Space Probes

As previously mentioned, it must be realized here that it has never been possible to accelerate macroscopic masses to velocities comparable to those to which electrons are typically accelerated to at the subatomic level, that were sufficient to confirm the non linear increase of their momentum energy accounted for by SR, and that are also sufficient to confirm the simultaneous increase in transverse magnetic field energy which is not accounted for by SR.

The highest velocities reached by macroscopic projectiles launched into space have currently been reached by the Pioneer 10 and Pioneer 11 space probes, with respective approximate masses made available by NASA of 258 kg and 258.5 kg, as measured before liftoff. Their velocities varied greatly throughout their trajectories, with peaks of 132,000 km/h (36,667 m/s) for Pioneer 10, which is its peak velocity during its final acceleration by gravitational slingshot using Jupiter, and 175,000 km/h (48,611 m/s) for Pioneer 11, which is its peak velocity during its final acceleration by gravitational slingshot using Saturn.

We will analyze here more specifically the escape velocities of the two probes. The reader can make the calculations for the peak velocities mentioned above, that would reveal the increase in mass that can explain the so-called "anomalous" velocity peaks [38] observed during these acceleration phases of the two

probes, as well as during the similar phases of all other space probes subjected to gravitational slingshot acceleration, and that leave the entire astrophysical community perplexed and without explanation, because the SR theory that currently serves as the basis for any analysis of these trajectories is unable to account for them.

We will do calculations as an example with the solar system escape velocities of these two space probes, which have respectively reached escape velocities of 51,682 km/h (14,356 m/s) and 51,800 km/h (14,389 m/s), which are velocities 150 times lower than the theoretical velocity of 2,187,647.561 m/s of the electron in the theoretical Bohr's ground state orbit, for which the increment of its transverse magnetic field is just beginning to be experimentally measurable (see Equation (3)).

What is remarkable about the trajectories of these space probes, as well as about those of all other space probes launched throughout the solar system, is that an unexplained systematic anomaly has been noted. Without exception, they behave as if they were slightly more massive than their masses as measured before liftoff, showing a negative acceleration of about 8E−6 m/s towards the Sun [36] [37] [38].

But as Rainer W. Kühne mentions in a note published in 1998, the extensive publicity given to these two cases leaves the general impression that this problem concerns only space probes launched by man [44], but it is well known in the astrophysics community that the trajectories of planets Uranus, Neptune and Pluto also show similar systematic anomalies, as well as many comets already studied in 1998, such as Halley, Encke, Giacobini-Zinner and Borelli, whose trajectories undergo a systematic deviation of unknown origin.

Given the understanding now provided by Marmet's discovery, even with the relatively low velocities of the Pioneer 10 and 11 space probes with respect to the typically relativistic velocities of the electron, it becomes easy to calculate this transverse energy increment of the relativistic-mass/magnetic-field that increases the transverse inertia of these two space probes, because we know now for certain by structure that the amount of transverse energy induced at the same time as their momentum is always equal to the latter. The characteristics of the two probes being almost identical, we will use the parameters of Pioneer 10 to analyze this situation.

So, with "m = 258 kg" and "v = 14,356 m/s", we first obtain the momentum energy of Pioneer 10 for this escape velocity:

$$\Delta K = mc^2\left(\frac{c}{\sqrt{c^2-v^2}}-1\right) = 2.658722735\text{E}10 \text{ j} \tag{10}$$

Given that the energy of "Δm_m" is equal by structure to ΔK, we then obtain for Pioneer 10 a transverse increment of relativistic-mass/magnetic-field of:

$$\Delta m_m = \frac{\Delta K}{c^2} = 2.958228\text{E}{-7} \text{ kg} \tag{11}$$

Such a slight transverse inertia increase seems insufficient at first glance to ex-

plain on its own the systematic negative acceleration of about 8E−6 m/s towards the Sun of these space probes launched on escape trajectories from the solar system, but the proposal becomes much more likely if we add to it the adiabatic increase of the rest mass of each probe due to the initial phase of their trajectory away from the incommensurably larger mass of the Earth, that is, an adiabatic rest mass increase that was easily observed during the famous Hafele and Keating experiment [45] when atomic clocks were raised just 10 km from the Earth's surface, but was misinterpreted as confirming a variation in the rate of time flow [35], here again only in light of the theory of General Relativity, that doesn't take into account the involvement of the Coulomb interaction, nor the fact that all rest masses are exclusively made of electrically charged particles. This adiabatic increase in rest masses will be put in correct electromagnetic perspective further on.

20. Maximum Intensity of the Transverse Magnetic Field Increment

Coming back now to the comparison between generalized Equation (9) and Equation (8), which is actually Marmet's Equation (M-7), we observe that Equation (9) provides the same magnetic field energy density in Tesla as the initial Marmet Equation (M-7), but requires only one variable, that is, the "*longitudinal electromagnetic wavelength*" of the energy quantum involved, without any need to relate this energy with the electron velocity.

This is what makes this magnetic field equation general and appropriate for calculating the intrinsic magnetic field of any elementary electromagnetic particle, whether it is moving or not. For example, the invariant intrinsic magnetic $\boldsymbol{B}_e$ field of the electron, that accounts for half of its invariant rest mass energy, can be calculated as follows, using the electron Compton wavelength, also involving the fine structure constant that establishes the amplitude of this energy's transverse electromagnetic oscillation:

$$\boldsymbol{B}_e = \frac{\mu_0 \pi e c}{\alpha^3 \lambda_C^2} = \frac{\mu_0 \pi e c}{\alpha^3 \left(2.426310215\text{E}{-12}\right)^2} = 8.289000221\text{E}13\ \text{T} \tag{12}$$

Of course, this figure remains mostly meaningless without a solid confirmation that it really represents a physically existing "quantity", that is, a confirmation that could be obtained by showing that relativistic velocity $v = 2{,}187{,}647.561$ m/s, related to the magnetic field energy density calculated with Equation (9), for example, can really be calculated by providing only the electromagnetic wavelength of the related energy as the only variable in an equation otherwise involving only fundamental physical constants.

Such a confirmation can indeed be provided by means of the following equation, well known in high energy accelerator circles, that allows calculating the straight line relativistic velocity of an electron being accelerated by external equal intensities electric and magnetic fields:

$$v = \frac{\boldsymbol{E}}{\boldsymbol{B}} \tag{13}$$

The proper value for the required composite $\boldsymbol{B}$ field is established in a simple manner by simply adding Equations (9) and (12), as analyzed in reference [20], here calculated with the longitudinal wavelength of the energy induced at the Bohr ground state radius (λ = 4.556335256E−8 m), to account for the required $\Delta\boldsymbol{B}$ field increment, and the electron longitudinal Compton wavelength (λ_C = 2.426310215E−12 m) to account for the invariant internal $\boldsymbol{B}_e$ field of the rest mass of the electron:

$$\boldsymbol{B} = \boldsymbol{B}_e + \Delta\boldsymbol{B} = \frac{\mu_0 \pi e c}{\alpha^3 \lambda_C^2} + \frac{\mu_0 \pi e c}{\alpha^3 \lambda^2} = \frac{\mu_0 \pi e c}{\alpha^3} \frac{\left(\lambda^2 + \lambda_C^2\right)}{\lambda^2 \lambda_C^2} = 8.289000246\text{E}13\ \text{T} \tag{14}$$

Resolving Equation (13) also requires of course the establishment of the definition of the composite $\boldsymbol{E}$ field that must be set in equilibrium with this composite $\boldsymbol{B}$ field. The related general $\boldsymbol{E}$ field equation was also established in reference [20], thanks to a reformulation of the Coulomb equation established in the same article, a reformulation that was analyzed in depth in reference [4] and that allows calculating the transverse energy that generates and maintains the corresponding magnetic field in elementary electromagnetic particles, whatever state of least action motion or of electromagnetic equilibrium stationary action they may be in into atomic structures:

$$E = \int_{a_0}^{\infty} \frac{1}{4\pi\varepsilon_o} \frac{e^2}{\left(\alpha\lambda/2\pi\right)^2} \cdot \mathrm{d}r = 0 - \frac{1}{4\pi\varepsilon_o} \frac{e^2 2\pi}{\alpha\lambda} = \frac{e^2}{2\varepsilon_o \alpha\lambda} \tag{15}$$

This particular form of the Coulomb equation indeed allows calculating the energy of any electromagnetic quantum uniquely from its wavelength, without any need to use the Planck constant:

$$E = hf = \frac{e^2}{2\varepsilon_o \alpha\lambda} \tag{16}$$

This form of the Coulomb equation also allowed unifying all classical force equations in reference [46] by showing that the "$F = ma$" fundamental acceleration equation can be derived from all of them, which actually proves that the Coulomb interaction is the common denominator of all classical force equations.

The general $\boldsymbol{E}$ field equation corresponding to the general $\boldsymbol{B}$ field Equation (9) was thus established in reference [20] as follows, here resolved using the longitudinal wavelength of the energy induced at the Bohr ground state (λ = 4.556335256E−8 m), to harmonize with the $\Delta\boldsymbol{B}$ field value obtained with Equation (9):

$$\Delta\boldsymbol{E} = \frac{\pi e}{\varepsilon_0 \alpha^3 \lambda^2} = 7.046673727\text{E}13\ \text{N/C} \tag{17}$$

Consequently, the invariant $\boldsymbol{E}_e$ field related to the other half of the energy making up the invariant rest mass of the electron can be established with the electron longitudinal Compton wavelength as follows:

$$\boldsymbol{E}_e = \frac{\pi e}{\varepsilon_0 \alpha^3 \lambda_C^2} = 6.029331754\text{E}10 \text{ N/C} \tag{18}$$

But, contrary to the composite magnetic $\boldsymbol{B}$ field that must be used to calculate the relativistic velocity of the electron with Equation (13), and which is obtained from the simple addition of the electron's intrinsic invariant $\boldsymbol{B}_e$ field and of the $\Delta\boldsymbol{B}$ field of its velocity related magnetic field increment, the corresponding composite $\boldsymbol{E}$ field involving the $\boldsymbol{E}_e$ field and the $\Delta\boldsymbol{E}$ field of Equations (17) and (18), cannot be obtained in this simple manner, due to the fact that the electric dipole that induces the accompanying $\Delta\boldsymbol{B}$ field is oriented perpendicularly with respect to the monopolar $\boldsymbol{E}_e$ field of the electron rest mass within electrostatic *Y*-space, as clarified in reference [21]. As established in reference [20], this composite $\boldsymbol{E}$ field, also involving here both the wavelength of the Bohr ground state energy (λ = 4.556335256E−8 m) and the electron Compton wavelength (λ_C = 2.426310215E−12 m), will have the following value:

$$\boldsymbol{E} = \frac{\pi e}{\varepsilon_0 \alpha^3} \frac{\left(\lambda^2 + \lambda_C^2\right)\sqrt{\lambda_C\left(4\lambda + \lambda_C\right)}}{\lambda^2 \lambda_C^2 \left(2\lambda + \lambda_C\right)} = 1.813341121\text{E}20 \text{ N/C} \tag{19}$$

By means of Equation (13) the well known and exact relativistic velocity of an electron whose magnetic field is increased by an amount of $\Delta\boldsymbol{B}$ will then be obtained as follows if it is not impeded by the local electromagnetic equilibrium state:

$$v = \frac{\boldsymbol{E}}{\boldsymbol{B}} = \frac{1.813341121\text{E}20}{8.289000246\text{E}13} = 2187647.566 \text{ m/s} \tag{20}$$

Calculating with Equation (9) for the $\Delta\boldsymbol{B}$ field and with Equation (17) for the $\Delta\boldsymbol{E}$ field with any longitudinal wavelength of the carrying energy will mathematically show that by combining them with the $\boldsymbol{B}_e$ and $\boldsymbol{E}_e$ fields that account for the energy of the invariant rest mass of the electron obtained with Equations (12) and (18) to ultimately resolve Equation (20), that the whole range of all relativistic velocities up to the asymptotic limit of the speed of light, in the case of any elementary massive particle such as the electron, can be obtained, and this, for a very mechanical reason which is clearly explained in reference [32].

21. Separation of the Electron Carrying Energy from the Energy of Its Rest Mass

As analyzed in reference [20], the most significant progress resulting from Marmet's derivation was the new possibility of clearly separating the invariant energy constituting the electron's rest mass from the variable adiabatic energy supporting its motion and its transverse relativistic-mass/magnetic-field increment. After analysis, this variable adiabatic carrying energy of the electron turned out to have the same internal electromagnetic structure that Louis de Broglie proposed for the double-particle electromagnetic photon in the 1930's [3] [17] [43], as mathematically described with Equation (21), and graphically symbolized with **Figure 4**, in accordance with Maxwell's interpretation, according

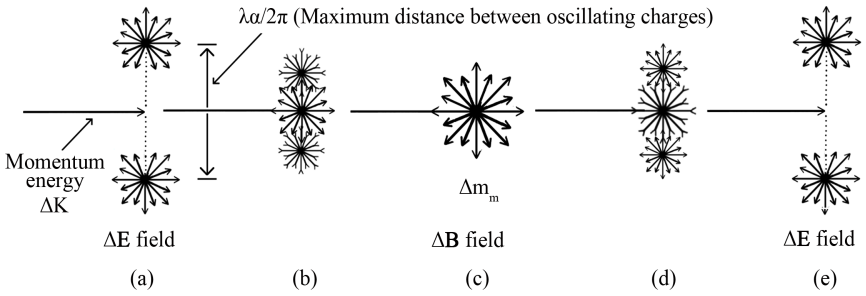

Figure 4. Representation of the transverse oscillation cycle of the electromagnetic half-quantum of the electron carrier-photon and of its unidirectional momentum energy half-quantum that propels this first half-quantum on top of also propelling the complete quantum of the electron invariant rest mass energy (the latter not illustrated).

to which the electromagnetic component of the energy of a localized photon has to be oriented transversely with respect to its momentum energy, and is captive in a standing oscillation motion causing it to cyclically transit between a state corresponding to its electric field and a state corresponding to its magnetic field.

This is what justified coining the term "*carrier-photon*" to name the carrying energy of the electron or that of any other elementary charged particle in articles describing the various consequences of integrating Marmet's discovery into electromagnetic theory on the one hand, and into classical/relativistic mechanics on the other, with the consequence that their equations can now be derived from each other [4].

The LC equation for the de Broglie double particle photon thus established in the only manner possible in the trispatial geometry proposed at the event Congress-2000 [18], and as formally published in reference [3] in complete accordance with Maxwell's equations, already made it possible to calculate from an electromagnetic photon's wavelength, the maximum intrinsic magnetic field energy of a photon structured according to Maxwell's initial interpretation that both fields induce each other, as established in reference [43]:

$$E = \frac{hc}{2\lambda} + \left[\frac{e^2}{2C_\lambda} \cos^2(\omega t) + \frac{L_\lambda i_\lambda^2}{2} \sin^2(\omega t) \right] \tag{21}$$

where

$$E_{\boldsymbol{E}(\max)} = \frac{e^2}{2C_\lambda} \quad \text{and} \quad E_{\boldsymbol{B}(\max)} = \frac{L_\lambda i_\lambda^2}{2} \tag{22}$$

and

$$C_\lambda = 2\varepsilon_0 \alpha\lambda\,, \quad L_\lambda = \frac{\mu_0 \alpha\lambda}{8\pi^2}\,, \quad i_\lambda = \frac{2\pi ec}{\alpha\lambda} \tag{23}$$

Marmet's derivation, on its part, made it possible to establish in reference [20] the generalized electric and magnetic field equations previously mentioned, that directly match the representations of their energy in the form of capacitance and inductance as illustrated by Equations (22):

$$\boldsymbol{E} = \frac{\pi e}{\varepsilon_0 \alpha^3 \lambda^2}, \quad \boldsymbol{B} = \frac{\mu_0 \pi e c}{\alpha^3 \lambda^2} \tag{24}$$

and to also establish *the theoretical stationary isotropic volume* corresponding to the maximum energy density of each of these two mutually inducing fields:

$$V = \alpha^5 \frac{\lambda^3}{2\pi^2} \tag{25}$$

which made it possible to redefine in reference [3] the LC equation initially developed in reference [20] in a form making use of the more familiar $\boldsymbol{E}$ and $\boldsymbol{B}$ fields definitions, which confirmed that the localized electromagnetic photon as de Broglie conceived it and the electron carrying energy actually have the same internal electromagnetic structure, *i.e.* one half oriented longitudinally, supporting its momentum, and the other half oriented transversely, defining its $\boldsymbol{E}$ and $\boldsymbol{B}$ fields inducing each other, this transversely oriented energy half being propelled in space by the unidirectional energy of its momentum:

$$E = \left(\frac{hc}{2\lambda}\right) + \left[2\left(\frac{\varepsilon_0 \boldsymbol{E}^2}{4}\right)\cos^2(\omega t) + \left(\frac{\boldsymbol{B}^2}{2\mu_0}\right)\sin^2(\omega t)\right]V \tag{26}$$

22. Conversion of Electromagnetic Energy into Charged and Massive Elementary Particles

We have the experimental proof since Carl David Anderson's experiments in 1933 [12] that any electromagnetic photon of energy 1.022 MeV or more, generated as a by-product of cosmic radiation, will destabilize when grazing a massive atomic nucleus, and will convert into a pair of massive elementary particles, which are one electron and one positron, whose equal rest masses of 0.511 MeV/c^2 are each made of 0.511 MeV of the destabilizing photon energy. Any energy in excess of this specific amount of 1.022 MeV that the photon had before conversion is then expressed as longitudinal momentum energy and related transverse electromagnetic energy equally shared between both elementary massive particles, which causes them to move away from each other with a velocity corresponding to this excess momentum energy [21].

The following equation describes how the energy of the incident photon is distributed between the two charged and massive particles generated, by associating the Coulomb equation with the rest mass equation of classical/relativistic mechanics [4]. It should be noted in passing that the opposite charges of the electron and the positron are meaningless in classical/relativist mechanics, and that considered according to only their mass characteristic, they are identical, which makes it possible to build the equation in the following way:

$$E_{\left(\frac{1}{\lambda_1} \geq \frac{1}{2\lambda_C}\right)} = \frac{e^2}{2\varepsilon_o \alpha}\frac{1}{\lambda_1} = 2\left(\Delta K + \Delta m_m c^2 + m_0 c^2\right) \tag{27}$$

where

$$\left(\Delta K + \Delta m_m c^2\right) = \frac{e^2}{2\varepsilon_o \alpha}\frac{1}{\lambda_2} \quad \text{in which} \quad \frac{1}{\lambda_2} = \frac{1}{2}\left(\frac{1}{\lambda_1} - \frac{1}{2\lambda_C}\right) \tag{28}$$

In Equation (27), "m_0" represents the identical individual rest masses of the electron and positron, and "λ_1" is the electromagnetic wavelength of the incident photon being destabilized, while in Equation (28), "λ_2" is the wavelength of the residual energy in excess of the energy of 1.022 MeV that just converted into the invariant rest masses of the two particles, after separation of this residual energy in equal parts between the two now separate particles.

More interesting yet, an experiment carried out in 1997 at the Stanford Linear Accelerator (SLAC), *i.e.* experiment #e144, confirmed that by converging two sufficiently concentrated electromagnetic photon beams towards a single point in space, one beam involving electromagnetic photons exceeding the 1.022 MeV threshold, massive electron/positron pairs were generated without any massive atomic nuclei being close by [13]. This last experiment opens up an entirely new perspective on the possible origin of the universe, as analyzed in reference [47].

The interest of the trispatial geometry developed from the expansion in the form of 3 perpendicular vector spaces emerging from the three-way orthogonal relationship of the vector product of the fundamental $\boldsymbol{E}$ and $\boldsymbol{B}$ vectors of electromagnetism (**Figure 3**), is that the more complete vector harnessing now applicable to Equation (26) in the following way, as analyzed in reference [3], allowed establishing for the first time in reference [21] a clear mechanics of conversion of the energy of an electromagnetic photon of 1.022 MeV or more, which is only partially oriented perpendicularly to the energy of its momentum, into the invariant energy completely oriented transversely constituting the internal structure of the individual rest masses "m_0" of the electron and positron represented in Equation (27), *i.e.* the following equation:

$$E\vec{\vec{i}} = \left(\frac{hc}{2\lambda}\right)_X \vec{\vec{I}}\vec{\vec{i}} + \left[2\left(\frac{\varepsilon_0 \boldsymbol{E}^2}{4}\right)_Y \left(\vec{J}\vec{j}, \vec{J}\vec{j}\right)\cos^2(\omega t) + \left(\frac{\boldsymbol{B}^2}{2\mu_0}\right)_Z \vec{\vec{K}}\sin^2(\omega t)\right]V \quad (29)$$

converting into the following two equations to represent the internal electromagnetic structure of the rest masses of the electron and positron:

$$m_{e_0}\vec{\mathbf{0}} = \frac{V_m}{c^2}\left\{\left[\frac{\varepsilon_0 \boldsymbol{E}^2}{2}\right]_Y \vec{\boldsymbol{J}}\vec{\boldsymbol{i}} + \left[2\left(\frac{\varepsilon_0 \boldsymbol{\nu}^2}{4}\right)_X \left(\vec{\boldsymbol{J}}\vec{\boldsymbol{j}}, \vec{\boldsymbol{J}}\vec{\boldsymbol{j}}\right)\cos^2(\omega t) + \left(\frac{\boldsymbol{B}^2}{2\mu_0}\right)_Z \vec{\boldsymbol{K}}\sin^2(\omega t)\right]\right\} \quad (30)$$

and

$$m_{p_0}\vec{\mathbf{0}} = \frac{V_m}{c^2}\left\{\left[\frac{\varepsilon_0 \boldsymbol{E}^2}{2}\right]_Y \vec{\boldsymbol{J}}\vec{\boldsymbol{i}} + \left[2\left(\frac{\varepsilon_0 \boldsymbol{\nu}^2}{4}\right)_X \left(\vec{\boldsymbol{J}}\vec{\boldsymbol{j}}, \vec{\boldsymbol{J}}\vec{\boldsymbol{j}}\right)\cos^2(\omega t) + \left(\frac{\boldsymbol{B}^2}{2\mu_0}\right)_Z \vec{\boldsymbol{K}}\sin^2(\omega t)\right]\right\} \quad (31)$$

in which (V_m = 1.497393267E−47 m^3) is the *maximum theoretical stationary isotropic volume* that the energy of the electron's intrinsic magnetic field reaches after having evacuated *X*-space during the mutual energy induction cycle that causes it to oscillate between constituting in alternance this magnetic field $\boldsymbol{B}$ and the neutrinic field "$\boldsymbol{\nu}$", which is an oscillation that replaces, in the structure of massive elementary particles [21], the oscillation between the fields $\boldsymbol{B}$ and $\boldsymbol{E}$

characteristic of electromagnetic photons [3] and of massive elementary particles carrier-photons [21] [22]:

$$V_m = \frac{\alpha^5 \lambda_C{}^3}{2\pi^2} = 1.497393267\text{E}-47\,\text{m}^3 \quad \text{and} \quad \boldsymbol{\nu} = \frac{\pi(e')}{\varepsilon_0 \alpha^3 \lambda_C^2} \tag{32}$$

The neutrinic field "$\boldsymbol{\nu}$", that the trispatial geometry allows identifying for the first time, is introduced in reference [21] and is completely analyzed in reference [23], which also analyses the emission mechanics of neutrinos in the trispatial geometry. The *theoretical stationary isotropic volume* of energy of any elementary quantum was defined in reference [20].

During the decoupling process of an electromagnetic photon of 1.022 MeV or more, the energy in excess of the exact amount of 1.022 MeV that converts into the now invariant energy constituting the separated masses of an electron and a positron, retains the LC structure of the incident double particle photon, but mechanically separates into equal parts between the two massive particles now separated as shown in Equations (27) and (28) and becomes their *carrier-photons*, propelling them in opposite directions in space at the velocity corresponding to the energy of their momentum, calculable with Equation (20), or with one of the following electromagnetic equations, developed in reference [32]:

$$v = c\frac{\sqrt{\lambda_C(4\lambda + \lambda_C)}}{(2\lambda + \lambda_C)} \quad \text{or} \quad v = c\frac{\sqrt{4EK + K^2}}{2E + K} \tag{33}$$

A particular point of interest about the latter two equations is that if the Compton wavelength of the electron ("λ_C" in the first equation) or the energy of the rest mass of the electron ("E" in the second equation) are reduced to zero, only the energy of its carrier-photon remains in the equation, and its velocity can then only be the velocity of light, thus confirming the identity of its structure with that of de Broglie's double-particle photon [3] [32].

It is very easy to verify the validity of LC Equations (30) and (31) of the electron and positron, because all of their terms are very well known invariant physical constants. For example, by multiplying the maximum energy of the magnetic field in Equation (30) by the *theoretical stationary isotropic volume* of this amount of energy defined in reference [20], we effectively obtain half the energy of the invariant rest mass of the electron, which corresponds to its intrinsic magnetic field:

$$\frac{B^2}{2\mu_0} V_m = \left(\frac{\mu_0 \pi e c}{\alpha^3 \lambda_C^2}\right)^2 \frac{1}{2\mu_0} \frac{\alpha^5 \lambda_C^3}{2\pi^2} = 4.093552068\text{E}{-}14\ \text{j} \tag{34}$$

23. Construction of Stable Complex Particles

It has been confirmed long ago that all atoms are made of only three distinct types of stable subcomponents, electrons, protons and neutrons. All three are typically regrouped under the general term "*elementary particles*" in the community, that is, a term currently "general" that induces a certain amount of confusion because of these three, only the electron has been found to truly be a

charged and massive elementary particle, that is, not made of smaller subcomponents, but is demonstrably made exclusively of the electromagnetic energy that was the "substance" of the electromagnetic photon from which it emerged, as just put in perspective, and as analyzed in detail in reference [21].

The other two subcomponents of all atoms, the proton and the neutron, were found not to be charged and massive elementary particles of the same sense as the electron, but rather *systems of such elementary particles* in a state of stable stationary action electromagnetic equilibrium, just as the solar system is not a celestial body, but a system of celestial bodies stabilized in a state of stationary action equilibrium. Historically, the first suspicions that protons and neutrons were not really elementary particles were aroused by the difference in their behavior compared to that of electrons and positrons during the first non-destructive collision experiments between these particles in the first particle accelerators (**Figure 5**).

On their side, electrons and positrons always behave during mutual collision experiments as if they had at best a "*point-like*" presence in space, meaning that in their cases, unlike protons and neutrons, no seemingly unbreachable limit is detectable by collision, no matter how close two electrons or two positrons come to each other's centers during truly frontal collisions, which is a type of backward rebound seldom observed given that such frontal collisions between electrons or positrons are similar to bringing the highly sharpened tips of sewing needles into frontal collision (**Figure 6**).

It is this "*quasi-punctual*" or "*point-like*" behavior of truly elementary particles during mutual interaction or collisions experiments such as the electron, positron and electromagnetic photons that clearly differentiates them at the subatomic level from complex particles such as the proton and neutron.

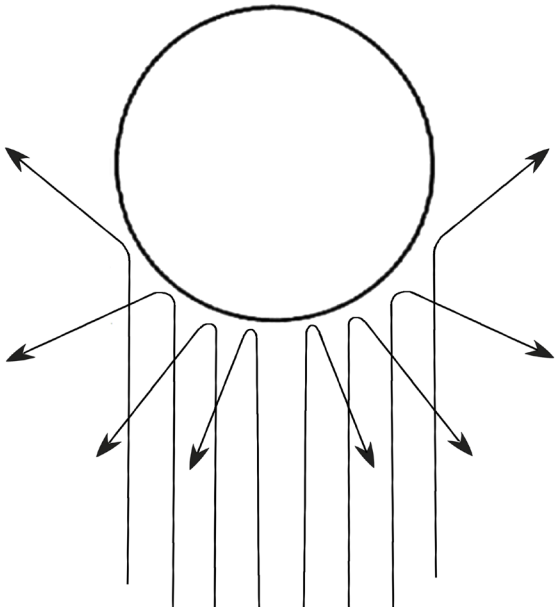

Figure 5. Perfectly elastic scattering between incident electrons and target proton.

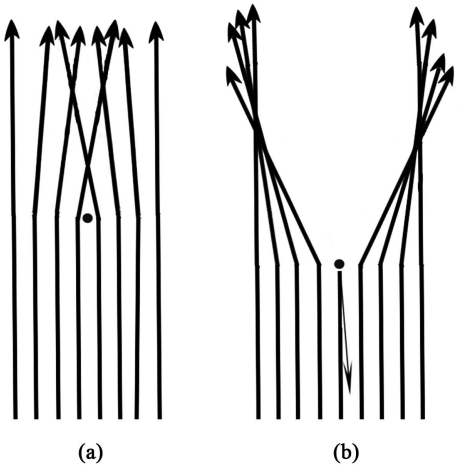

Figure 6. Non-destructive interaction between incident electrons and target positron a), and interaction and direct scattering between incident electrons and target electron b), demonstrating their point-like behavior.

What happened in the case of interactions between truly elementary charged particles was typically that incident electrons were deflected convergently as they crossed the position of positrons moving in the opposite direction, or when incident positrons crossed the path of electrons moving in opposite direction (**Figure 6(a)**); or that incident electrons were deflected divergently after crossing the positions of other electrons moving in the opposite directions or when incident positrons crossed the position of other positrons moving in the opposite direction (**Figure 6(b)**). Given the quasi-punctual behavior of the particles involved, only occasionally was one of the incident particles in an ideal situation to directly collide head-on in order to bounce back directly (**Figure 6(b)**).

While electron and positron beams launched so as to interact head-on with each other generated virtually no reverse rebounds (**Figure 6**), protons and neutrons caused the incident particles (electron or positron beams) to rebound in all directions (**Figure 5**), due to a state of permanent magnetic repulsion between the inner charged subcomponents of protons and the incoming electrons, as analyzed and described in reference [4], which revealed that they occupy a measurable volume in space, contrary to electrons and positrons, that is perfectly elastic rebound patterns identical to those that can be observed at our macroscopic level between two magnets repelling each other [39].

The study of these rebound patterns in the 1940s and 1950s led to the conclusion that the radius of this volume was of the order of 1.2E−15 m for proton and neutron [48], a volume that seemed to reveal that they could be made up of smaller particles whose interactions would determine this volume, just like the volume defined by planetary orbits determine the potential volume that the solar system can occupy in space, that is, theoretically at the time, truly elementary electromagnetic particles with *quasi-punctual* behavior of the same nature as the electron and the positron.

The first particle accelerator powerful enough to overcome the resistance of

this proton volume to penetration by sufficiently energetic electrons or positrons, the Stanford Linear Accelerator (SLAC), came into service in 1966. From 1966 to 1968, a series of high energy non-destructive scattering experiments carried out by M. Breidenbach *et al.* [10] of electrons against protons effectively revealed the presence of three quasi-punctual behaving electrically charged subcomponents (**Figure 7**), whose deflection spread patterns of the incoming electrons' trajectories and subsequent analysis allowed associating an electric charge equal to 1/3 of that of an electron to one subcomponent and a charge equal to 2/3 that of the positron to the other two subcomponents (uud). Neutrons on the other hand revealed a structure made up of one 2/3 positive charge subcomponent and two 1/3 negative charge subcomponents (udd).

Moreover, incoming electrons backscattered in a highly inelastic manner and subsequent experiments also involving positrons revealed that the 2/3 positively charged subcomponents were only slightly more massive than electrons and that the 1/3 negatively charged subcomponent was only slightly more massive than the positively charged subcomponents [22] [25].

Given that these presumably invariant rest masses were eventually confirmed as being only slightly higher than those of electrons and positrons [41], combined with the fact that these sub-components of nucleons demonstrate exactly the same quasi-punctual behavior that characterizes electrons and positrons, and the also confirmed fact that electrons and positrons are the only massive and electrically charged elementary particles that can be generated from free electromagnetic energy in a well understood and exhaustively confirmed manner [12] [13], it seemed possible that these sub-components of nucleons could actually be positrons and electrons whose masses and charges would be altered in this way by the stresses imposed by those ultimate stationary action electromagnetic equilibrium states in which electrons and positrons could become captive of, if the latter truly are the only building material that nature has at its disposal to build nucleons.

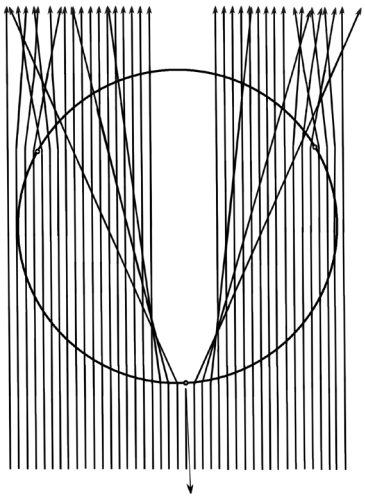

Figure 7. Detection of the proton inner structure via non-destructive scattering.

This conclusion immediately explains why none of these nucleon sub-components could ever be ejected from a nucleon while still retaining its fractional charge, because if they really originally were electrons and positrons, then of course, they will naturally adiabatically recover their normal mass and charge characteristics as soon as they escape the electromagnetic stresses they are subjected to while being part of the stabilized stationary action nucleon structures [24].

The trispatial geometry indeed made it possible to calculate precise mean rest masses for these elementary positive and negative subcomponents of protons and neutrons corresponding to a sequence of stable axial resonance states that can be related to a sequence of integers, which locates these masses within the experimentally estimated possible mass ranges in both cases (see **Table 1**), that is, a sequence of three related masses that can be obtained from one of the possible equations that allows this calculation, such as the following equation established in reference [22], and analyzed in a more general perspective in reference [24], that is, a resonance sequence for the masses of stable elementary particles similar to the resonance sequence of the electronic orbitals of the hydrogen atom that Louis de Broglie was the first to notice at the beginning of the 20th century [4] [49]:

$$m_{i[d,u,e]} = \frac{k}{a_0}\left(\frac{3e}{n\alpha c}\right)^2 \quad (n = 1,2,3) \tag{35}$$

where "e" is the unit charge, "α" is the fine structure constant, "c" is the speed of light, "a_0" is the Bohr radius, *i.e.* the mean axial distance between the fundamental electronic orbital of the hydrogen atom and the proton, and "k" is the Coulomb constant:

$$k = \frac{1}{4\pi\varepsilon_0} = 8.987551788\text{E}9 \tag{36}$$

Effectively, the masses obtained from Equation (35) fall right into the ranges experimentally established within which their true rest mass has to lie, that is, between 1 and 5 MeV/c^2 for the positive subcomponent, and between 3 and

Table 1. Sequence of masses in axial resonance state of elementary particles obtained using Equation (35).

	Rest mass	Energy	Charge	Reference
Free moving electron or positron	9.10938188E−31 kg	0.511 MeV	±1 = 1.602176462E−19 C	[21]
Electromagnetically stressed positron 1 in the neutron 2 in the proton	2.049610923E−30 kg	1.1497473 MeV	+2/3 = 1.068117641E−19 C	[22]
Electromagnetically stressed electron 2 in the neutron 1 in the proton	8.198443693E−30 kg	4.59899 MeV	−1/3 = 5.340588207E−20 C	[22]

10 MeV/c^2 for the negative subcomponent [41]. These precise rest masses were established with respect to the distances separating the electromagnetically stressed electrons and positrons from the coplanar axis about which each stabilized triad is in *rotation*/*resonance* within electrostatic *Y*-space (**Figure 3**) as analyzed in reference [22].

The expression "*rotation*/*resonance*" is used here to clearly put in perspective that the same amount of energy is adiabatically induced by the Coulomb interaction in the rest masses of the electromagnetically stressed electrons and positrons, whether they are actually rotating on circular orbits about the coplanar axis and/or translation about the normal axis, or simply are in a state of "*stationary axial resonance*" at these distances from these two *rotation*/*translation*/*resonance* mutually perpendicular axes.

Let us note, by the way, that at the time of the Breidenbach experiments [10], a mathematical theory developed separately by Murray Gell-Mann and George Zweig was considered confirmed by the Breidenbach experiments, which resulted in these electromagnetically stressed positrons and electrons captive of the nucleons' internal structures being named "*up quark*" and "*down quark*" respectively at a time when the conclusion had not yet been drawn that these nucleons' subcomponents could be simple positrons and electrons whose mass and charge characteristics were altered by the intensity of the electromagnetic interactions at such short distances within these structures.

Since the Gell-Mann and Zweig theory also predicted the existence other virtual particles also named "*quarks*", but that never were detected by non-destructive collisions within nucleons, unlike the two that were named "*up*" and "*down*", the outcome was an enormous and persistent confusion in the community fuelled by multiple references to the Gell-Mann and Zweig theory, and the almost total absence of references to the experimental data gathered and analyzed by Breidenbach *et al*., which left the impression during the following decades that even the sub-components actually detected by Breidenbach *et al*. were only theoretical and that their physical existence had never been confirmed.

The most edifying demonstration of this confusion is that in a major work on quantum field theory (QFT) published in 1993, that is, 25 years later, by a renowned physicist in the community, we find the following mention in section 1.2 of his book [50], that shows that he had never heard about the Breidenbach *et al*. experiments that were carried 25 years before, otherwise it seems obvious that he would have taken them into account:

"*Ironically, one problem of the quark model was that it was too successful. The theory was able to make qualitative* (*and often quantitative*) *predictions far beyond the range of its applicability. Yet the fractionally charged quarks themselves were never discovered in any scattering experiment*".

However, in order to maintain continuity with the literature that was historically produced naming the electromagnetically constrained positrons and electrons as "*up quarks*" and "*down quarks*", including the other articles of this series, we will keep the symbols "*u*" (for "*up*") and "d" (for "*down*"), that histori-

cally symbolized them when referring to the fractionally charged scatterable subcomponents of nucleons detected by Breidenbach, *i.e.* "uud" for the proton and "udd" for the neutron.

$$m_U = \frac{E_U}{c^2} = \frac{V_m}{c^2}\left\{S_U\left[\frac{\varepsilon_0 \boldsymbol{E}^2}{2}\right]_Y + \left(2 - S_U\right)\left[2\left(\frac{\varepsilon_0 \boldsymbol{\nu}^2}{4}\right)_X \cos^2(\omega t) + \left(\frac{B^2}{2\mu_0}\right)_Z \sin^2(\omega t)\right]\right\} \quad (37)$$

$$m_D = \frac{E_D}{c^2} = \frac{V_m}{c^2}\left\{S_D\left[\frac{\varepsilon_0 \boldsymbol{E}^2}{2}\right]_Y + \left(2 - S_D\right)\left[2\left(\frac{\varepsilon_0 \boldsymbol{\nu}^2}{4}\right)_X \cos^2(\omega t) + \left(\frac{B^2}{2\mu_0}\right)_Z \sin^2(\omega t)\right]\right\} \quad (38)$$

The trispatial LC equations for the electromagnetically stressed positrons (initially named "*up quarks*") and electromagnetically stressed electrons (initially named "*down quarks*") constituting the non-destructively scatterable nucleon structure are slightly different from Equations (30) and (31) that describe free moving electrons and positrons that are not being subjected to these electromagnetic stresses, because the transverse drift of the energy that defines the intensity of their fractional charges towards a more intense magnetic state, which is imposed on them by the very short gyroradius of their stationary action states [51], does not allow an equal density of their electrical and magnetic states, unlike the default equal electric vs magnetic density state of the electromagnetic energy of electrons and positrons moving on straight line trajectories.

The expressions "S_U" and "S_D" are the *magnetic drift constants* of the energy of the stabilized rest masses of the electromagnetically stressed positrons and electrons, respectively equal to "2/3" and "1/3" and which are analyzed and explained in references [22] and [4].

It is important to be aware that the sum of the stabilized rest masses of electromagnetically stressed electrons and positrons (**Table 1**) making up the scatterable structure of the proton (uud) constitutes only about 2% of its total measured mass, and that this sum for the neutron (udd) constitutes only about 2.4% of its total measured mass. The difference can only be due, of course, to the energy of their respective carrier-photons [22], whose intensity depends directly on the inverse of the distance between charged elementary particles and the translation axis of normal *X*-space (**Figure 3**) with respect to which each triad is in *translation*/*resonance*, an axis that is perpendicular to the coplanar *rotation*/*resonance* axis with respect to which the rest masses and fractional charges of the electromagnetically stressed electrons and positrons are determined.

As in the case of the expression "*rotation*/*resonance*" previously mentioned in relation with the *Y*-space coplanar axis, the expression "*translation*/*resonance*" is used here to clearly put in perspective that the same amount of energy is adiabatically induced by the Coulomb interaction in each electromagnetically stressed electron and positron carrier-photon, whether they are in actual translation in

circular orbit around the normal X-space axis or simply are in a state of stationary axial resonance with respect to this mean distance from this translation/resonance axis, that is, a resonance motion oriented perpendicularly with respect to such a circular orbit.

24. The Conceptual "Translation/Resonance" Transposition

The same "*translation/resonance*" relationship also applies to the electron's rest orbital in the hydrogen atom for the same reason. In fact, it was Louis de Broglie who first understood in 1923 that the electron could only be in a state of axial resonance when stabilized at a mean distance of the proton in the hydrogen atom corresponding to the Bohr radius, even if it could also be theoretically perceived as being in translation on a closed orbit around the proton.

This conclusion of major importance was published in a note in which he proposed this first preliminary interpretation of the conditions that could explain the stability of the electron within atomic structures [4], since it was in harmony with the stability condition determined by Bohr and Sommerfeld for a trajectory traveled by a mass at constant velocity [49]. Here is a quote of his major conclusion:

"*L'onde de fréquence ν et de vitesse c/β doit être en résonance sur la longueur de la trajectoire. Ceci conduit à la condition*":

Translation

"*The wave of frequency ν and velocity c/β must be in resonance over the length of the trajectory. This leads to the condition*":

$$\frac{m_o\beta^2c^2}{\sqrt{1-\beta^2}}T_r = nh \quad (\text{"}n\text{" being an integer}) \tag{39}$$

It is this conclusion that gave Schrödinger the idea of representing the resonance volume visited by the electron in the rest orbital of the hydrogen atom by a wave function [7], as put in perspective at reference [4]. When de Broglie made his discovery, however, it was not yet clear that the very substance of the electron was truly electromagnetic in nature [21], and also that of its carrier-photon, that he intuitively identified as a "*pilot wave*" meant to propel the electron, but whose electromagnetic nature could not be identified at the time [4].

As mentioned earlier, it was not until the early 1930s that it was experimentally confirmed that the very substance of the invariant mass of the electron was nothing more than the "*electromagnetic energy substance*" of an electromagnetic photon of minimum energy 1.022 MeV decoupling into a pair of massive particles of equal masses, namely an electron and a positron [12]. Before this event, no one had had the opportunity to associate electromagnetic energy with the very substance of the mass of elementary particles, so none of the theories developed before this observation could take into account this new discovery in their elaboration, which of course includes Einstein's two theories of Special Relativity and General Relativity, as well as Quantum Mechanics in its traditional form.

De Broglie related the energy of the electron momentum at the Bohr orbit with Planck's constant and classical mechanics, but like the entire scientific community at that time, he did not relate it with the Coulomb interaction as represented with Equation (16) emerging from Maxwell's first equation and therefore he did not have at his disposal the conclusion that the half-quantum energy of the electron's momentum that would theoretically support the electron's motion longitudinally on its theoretical orbit around the proton is the same that also supports its axial resonance motion oriented perpendicularly to this orbit, as well as the associated half-quantum of its electromagnetic energy oriented transversely to this momentum energy, and that the unidirectional energy of its momentum can only be structurally oriented towards the proton.

In fact, the structural axial orientation of the momentum energy of the electron towards the proton does not exclude the possibility that the electron may move transversely on a closed orbit about the proton, in addition to oscillating simultaneously in axial resonance mode as de Broglie concluded, but at such a short distance between the electron and the proton and at such an intense level of induced energy, it can be expected that the axial resonance mode clearly dominates.

It is a fact that the Planck constant associates the emission of electromagnetic energy strictly with the time factor. But this association of the induction of energy with the time factor is due to the fact that this constant was established by the analysis of the energy frequencies emitted during the de-excitation of electrons, that had previously been momentarily excited towards metastable orbitals further away from atomic nuclei, when they return to their rest orbitals of stationary action, which all are resonance states directly related to the frequency of the mean energy induced at the electron's rest orbital in the hydrogen atom, taken as fundamental, as analyzed and described in reference [24], and that the energy of Planck's quantum of action corresponds to the energy of a single cycle of this ultimate reference frequency, as subsequently determined by de Broglie:

$$h = m_0 v_B \lambda_B = 6.62606876\text{E}{-}34 \text{ j}\cdot\text{s} \tag{40}$$

where "m_0" is the rest mass of the electron, "v_B" is the conventional reference classical velocity of the Bohr orbit (2,187,691.253 m/s) and "λ_B" is the length of the Bohr orbit (3.32491846E−10 m), whose radius is the fundamental constant ($a_0 = r_0$ = 5.291772083E−11 m), that is, the mean distance from the fundamental resonance orbital of the hydrogen atom to its nucleus, which defines the energy induced at this distance from the proton, or "E_B = 4.359743808E−18 j" (27.21138346 eV) as easily calculated with the Coulomb equation [24]. Its frequency is therefore "f_B = 6.579683921E15 Hz".

A simple calculation shows that at velocity "v_B", the duration of a single cycle of this frequency corresponds exactly to the length of the Bohr orbit "λ_B", which is why multiplying the length of this absolute reference orbit by the Planck constant makes it possible to obtain the energy induced at the Bohr orbit as precisely as with the Coulomb equation.

This is also why the energy corresponding to this reference frequency seems to correspond to the number of orbits that must be run in one second to supposedly "accumulate" all of the energy induced at the Bohr orbit, which has long created the perception that this induced energy "seems" to be distributed over all these cycles and that it takes one second for all the energy of the quantum to be accumulated:

$$E_B = h \cdot f_B = \frac{e^2}{4\pi\varepsilon_0 r_B} = 4.359743808\text{E}{-18 \text{ j}} \tag{41}$$

in which "r_B" is the Bohr radius, *i.e.* "5.291772083E−11 m" (see Equation (7)).

Just as Marmet's Equation (M-7) can be generalized to use *the longitudinal electromagnetic wavelength* of any amount of electromagnetic energy, the same generalization was also made for the Coulomb equation in reference [20], as analyzed and described in detail at reference [4]:

$$E = h\nu = \frac{e^2}{2\varepsilon_0 \alpha \lambda} \tag{42}$$

where "α" is the fine structure constant (7.297352533E−3). The longitudinal wavelength of an amount of electromagnetic energy is also obtained using the following well-known equation, so the longitudinal electromagnetic wavelength of the energy "E_B" obtained with Equation (41) is:

$$\lambda = \frac{hc}{E_B} = 4.556335252\text{E}{-8 \text{ m}} \tag{43}$$

which allows re-obtaining the same amount of energy with generalized Equation (42) already obtained with standard Equation (41):

$$E = h\nu_B = \frac{e^2}{2\varepsilon_0 \alpha \lambda} = 4.359743808\text{E}{-18 \text{ j}} \tag{44}$$

It is in fact the relationship established with Equation (42) between the standard equation used to calculate electromagnetic photons energy and the generalized Coulomb equation that makes it possible to carry out the conceptual "*translation*/*resonance*" transposition required to be able to alternate between the analysis of the stable quantized energy states corresponding to all electronic and nucleonic stationary action orbitals in atoms, that relates Planck's constant with the number of theoretical cycles that the electron must theoretically run on the Bohr orbit; and that also allows the analysis of the infinitesimally progressive adiabatic induction of energy, which is a constantly active function of the inverse of the distance separating the charged elementary particles constituting all atoms, and which is induced "perpendicularly" by structure to any orbital motion, whether theoretical or effective.

This transposition in no way diminishes the usefulness of the Planck constant for calculations involving the study of the stable and metastable stationary action states of the various orbitals and the quantized emission of Bremmsstrahlung photons, when de-exciting electrons move from a metastable orbital to a stable resonance orbital, whose emission mechanics we will analyze later, but it makes

it possible to add to the body of mathematical tools the constants required to adequately deal with the infinitely progressive variations in the amount of energy adiabatically induced in electrons' carrier-photons by the Coulomb interaction during the axial resonance motion sequences into which they are captive when stabilized in the various stationary action orbitals in atoms, as analyzed in reference [4], as well as when they are in free least action motion, *i.e.* in process of moving towards these stabilized axial stationary action states, as analyzed at reference [33].

25. Electromagnetic Energy Adiabatic Induction Constants

25.1. The Electromagnetic Intensity Constant

As analyzed and described in reference [20], since the speed of light is constant in vacuum, it can therefore be stated that the amount of energy of which an electromagnetic photon is made is inversely proportional to the distance it must travel in vacuum for one cycle of its wavelength to be completed, which can be represented by "$E = 1/\lambda$". This means that by isolating product "$E{\cdot}\lambda$" on the left side of this relation, the value obtained will be constant.

A quick analysis of Equation (44) reveals that this constant can alternatively be defined from the familiar set of electromagnetic constants that also defines the generalized Coulomb equation and the *longitudinal electromagnetic wavelength* of any amount of electromagnetic energy (λ):

$$H = E\lambda = \frac{e^2}{2\varepsilon_0 \alpha} = 1.98644544\text{E}{-}25 \text{ j}\cdot\text{m} \tag{45}$$

That is, the quantum of action in joules-meter (j·m), which is the counterpart dissociated from the time factor of the Planck quantum of action defined in joules-seconds (j·s), and that was named "*the electromagnetic intensity constant*" in reference [20]. Dividing now constant "H" by the speed of light "c", we observe that the Planck constant is obtained, which reveals that "$H = hc$" directly links Planck's constant to electromagnetism, whereas it is historically considered a measured constant not derived from electromagnetic equations:

$$h = \frac{H}{c} = 6.62606876\text{E}{-}34 \text{ j}\cdot\text{s} \tag{46}$$

The unexpected result of this relation is that the Planck time based quantum of action can now be obtained from the same set of electromagnetic constants that defines constant "H", by combining Equations (45) and (46), which makes available to the community this newly established definition of the Planck constant, established strictly from known fundamental constants and derived from experimentally confirmed equations, which is currently absent from both the "*CRC Handbook of Chemistry & Physics*" [41] and from the list of constants of the "*National Institute of Standards and Technology*" (NIST) [40]:

$$h = \frac{e^2}{2\varepsilon_0 \alpha c} = 6.62606876\text{E}{-}34 \text{ j}\cdot\text{s} \tag{47}$$

25.2. The Electrostatic Energy Induction Constant

Metaphorically speaking, Planck's constant allows an "horizontal" (that is, "translational") exploration of the stable orbital states of the hydrogen atom, so to speak, but the Coulomb Equation (41), which provides the same energy, was used to define *an electrostatic energy induction constant* that allows a "vertical" (that is, "axial") exploration of the hydrogen atom and of its nucleus.

The required *electrostatic energy induction constant*, which was named "K" in reference [22] and could be considered as an "*induction quantum*", was established in two different ways. The first method emerged from the analysis of the decoupling mechanics of a photon of energy 1.022 MeV into an electron-positron pair in the trispatial geometry, as established in reference [21], and the second method simply consists in multiplying Equation (41) by "r_B" squared:

$$K = E_B \cdot r_B^2 = \frac{e^2 \cdot r_B}{4\pi\varepsilon_0} = 1.220852596\text{E}{-}38 \text{ j}\cdot\text{m}^2 \tag{48}$$

It is with this constant that it became possible to enter the hydrogen nucleus "vertically", or "axially" so to speak, by varying distance "r" between two charged particles in equation "$E = K/r^2$", and thus establish the exact amounts of adiabatic energy induced in each of the internal components of the proton and neutron (see **Table 1**), thus allowing to finally establish coherent trispatial LC equations for the electromagnetically stressed electrons and positrons (see Equations (37) and (38) previously mentioned) and their carrier photons that determine their effective masses and volumes, as analyzed at reference [22].

26. Gravitation

In fact, such a "vertical" exploration, so to speak, of atomic and nuclear structures induces an acute awareness of the adiabatic nature of the energy induced in all of the charged particles making up their structures [24] [33], that is, an adiabatic energy that can only vary in an infinitesimally gradual manner with any variation in the distances separating them; an energy that moreover does not depend in any way on the velocity of particles, but that manifests its existence under the form of this velocity each time that local electromagnetic circumstances allow and that remains fully induced even if this velocity cannot be expressed due to local electromagnetic equilibrium states.

As analyzed in references [4] and [16], when this velocity cannot be expressed, the momentum energy of each charged particle remains induced all the same and can then only exert a "*pressure*" in the vectorial direction imposed on it by the local electromagnetic equilibrium.

In atomic structures, this vectorial direction can only be towards the center of each atom due to the very nature of the Coulomb interaction. In accumulations of atoms making up larger masses, the tendency seems to be that this "*pressure*" tends to apply towards the centre of mass of these masses, which becomes obvious with masses such as that of the Earth, for example, on the surface of which all objects seem to be "*attracted*" to its centre of mass. But this supposed "*attrac-*

tion" can only be the "*pressure*" exerted by the total sum of the individual momentum energies of each charged particle constituting each object being applied against the surface of Earth, because their vectorial direction of application can only be by structure towards the Earth's centre of mass [4] [16].

In summary, the "*weight*" of an object as measured at the Earth's surface can only be a measure of this "*pressure*" exerted by the sum of the individual momentum energies vectorially oriented towards its centre of mass, belonging to the whole set of separate charged particles that constitute the measurable mass of this object. If this object is elevated above the ground and then left free to move, the velocity allowed by this sum of momentum energies can again be expressed until its motion becomes hindered again as the object meets again the surface of the Earth, at which point it will again exert a pressure equivalent to the amount of momentum energy induced by Coulomb interaction at this distance between each charged particle of this object and each charged particle of the Earth's mass [33].

At the astronomical level, the celestial bodies of the solar system seem to be captive of stable stationary action resonance states at mean distances from the Sun similar to that which de Broglie assumed to apply to the electron in the hydrogen atom [49], *i.e.* a state of axial resonance limited by very precise minimum and maximum stable distances from the central star, that is, their perihelion and aphelion. These two boundary distances combined with the mean radius of the elliptical orbit of each celestial body constitute three stable references that allow clearly defining the volumes of space visited over time by each celestial body about the central star.

On the other hand, unlike the case of the hydrogen atom, as analyzed in reference [4], for which the intensity of the momentum energy level induced in the electron at the mean distance from Bohr radius distance clearly favors a localized high frequency axial oscillation motion, rather than a translational motion along the theoretical Bohr ground orbit, the level of adiabatic energy induced in each charged particle of the Earth's mass at the average distance from the Earth's orbit being insufficient to generate such a high frequency axial oscillation, given the inertia of the macroscopic mass of which each charged particles is captive, rather favors the stabilization of celestial bodies in the observed states of stationary action orbital motion.

The volume of space visited over time by each celestial body about a central star can evolve into fairly complex shapes for celestial bodies that have satellites, which induces beats frequencies that modify the otherwise regular volumes visited by bodies that do not have a satellite. In fact, all bodies stabilized in such axial resonance systems mutually influence each other's trajectories and the shape of the resonance volumes they visit. It is this type of interaction, combined with the occultation process of the central star as these bodies pass between this star and our position in space that allowed the identification of the many planets orbiting nearby stars that have recently been discovered.

A similar electromagnetic dynamics defined by Quantum Mechanics (QM) is

also applicable at the subatomic level to the elementary particles making up every atom of which all macroscopic masses are made, including our own bodies. In their cases, however, high-frequency axial stabilization, rather than orbital motion, is clearly favored due to the intensity of the adiabatic energy induced in each charged elementary particle at such short distances between the particles compared to their inertia.

An analysis initiated in references [35] and [52], completed in reference [16], of the sequence in decreasing order of intensities of the various stationary action states of electromagnetic equilibrium in which elementary particles can stabilize, shows that all possible cases of force application traditionally distributed among 4 fundamental forces: 1) *Strong interaction*, 2) *Weak interaction*, 3) *Electromagnetic force*, and finally 4) *Gravitational force*; can only be four quantized levels of Coulomb interaction intensity corresponding to the various energy levels of these stationary action equilibrium states.

Just like it seemed sensible to keep the terms "*up*" and "*down*" to designate positrons and electrons electromagnetically constrained within nucleon structures to maintain consistency with the bulk of previously published literature, it also seems sensible for the same reason to keep the easy to relate to concept of "*attraction*" to identify individual occurrences of Coulomb interaction between any pair of oppositely signed electrically charged particles. So, to facilitate the establishment of a mental image of the various orders of magnitude of electrostatic interaction application between any pair of such particles, the term "*attractor*" was defined in reference [35], embodying the idea that an "*individual-inverse-square-of-distance-attractor*" would be in action between each pair of these elementary particles in the universe. So, for simplicity's sake, any occurrence of the mentally easy to visualized concept of an electrostatic attraction between a pair of oppositely signed charged particles in the universe is referred to as an "*attractor*" in **Table 2**.

It now becomes possible to separate the Coulomb interaction gradient into four ranges of intensities, the boundaries of which correspond to the various ranges of stationary action resonance intensities that can be identified in nature (**Table 2**). As put into perspective in reference [35], the most intense level is determined by the resonance states characterizing the interacting electromagnetically constrained electrons and positrons forming the internal scatterable structure of nucleons, corresponding to the traditional "*strong interaction*". The second level applies to the stabilization states of nucleons within atomic nuclei, corresponding to the traditional "*weak interaction*". The third level applies to electronic resonance states within atoms and molecules, as well as between atoms and molecules in direct contact with each other in any accumulation of matter, corresponding to the traditional "*electromagnetic force*". And finally, a fourth and final level of intensity applies to any atom, molecule and larger mass in a state of least action free fall, and those captive in stationary action orbits at the astronomical level, and corresponds to the traditional "*gravitational force*".

Table 2. Coulomb interaction quantized intensity ranges (see Reference [35]).

Table of electrostatic attractors		
Name	Range	Related Traditional force
Primary Attractor	Between electromagnetically stressed electrons and positrons inside a proton or neutron	Strong
Secondary Attractor	Between electromagnetically stressed electrons and positrons belonging to different protons and neutrons in a nucleus	Weak
Tertiary Attractor	Between an orbiting electron and each electromagnetically stressed positron of an atomic nucleus and between each electron and each electromagnetically stressed positrons of other nuclei in all close by atoms	Electromagnetic
Temporary Local Attractor	Between half-photons inside a photon	Electromagnetic
Temporary Far Attractor	Between any half-photon and every other heterostatic particle in the universe	Electromagnetic
Quaternary Attractor	Between each charged particle in an atom and each heterostatic particle in relative free fall in the universe	Gravity

These various levels of adiabatic carrier energy induction intensity by the Coulomb interaction, one of the major components of which is their transverse electromagnetic energy increment, corresponding to a variable increment of permanently induced adiabatic mass, provided for each charged particle in existence, can then be directly related with the 4 forces of the Standard Model as put into perspective in reference [35]; four forces that ultimately turn out to be simple alternative representations of the various levels of intensity of application of a single "*force*", namely the underlying adiabatic energy induction Coulomb interaction, as analyzed at reference [16].

27. Nucleon Expansion/Compression as a Function of the Gravitational Gradient Intensity

The fact that the momentum half-quantum of adiabatic energy which is permanently induced by the Coulomb interaction in each electron is oriented axially towards the center of each atom taken separately, and that this energy can only be expressed as a pressure oriented towards the center of the atom when it cannot be expressed as a velocity, as analyzed and described in reference [4], also has the consequence that when atoms accumulate to form larger masses, the vectorial resultant of all interactions between electrons and nuclei accumulated in close proximity will tend to orient the direction of application of these momentum half-quanta towards the centre of such masses, resulting in an addition of their individual pressures towards the centre of these masses.

When these accumulations of atoms become sufficient to form macroscopic masses, the resulting increase in pressure by addition as the depth increases in these bodies can only result in a forced contraction of the outer electronic orbitals of their atoms towards each their nuclei, as put into perspective in reference [35] and analyzed in depth in reference [33].

It is well verified that heat increases with depth in the Earth's mass [53]. However, it is also very well understood that heat in macroscopic masses is nothing more than an increase in the energy of the electrons of atoms, an increase which, when exceeding certain levels specific to each atom, forces the electrons of the outer layers of these atoms to jump to a metastable orbital further away from each nucleus involved. Since these levels are extremely unstable, these electrons return almost instantaneously to their stable stationary action orbital by then emitting a Bremmsstrahlung photon that evacuates the energy (*i.e.* heat) accumulated as an electromagnetic photon, whose emission mechanics will be analyzed in the next section.

In the case of such heat increase with depth in planetary masses such as that of the Earth, it is well established that this increase is adiabatic in nature [53], and can only coincide with an adiabatic increase in energy by compression of the electronic orbitals towards their central atomic nuclei, because it is the resulting greater proximity between electrons and nuclei that causes the Coulomb interaction to induce this increased energy as a function of the inverse of the distance separating the electrons from the nuclei.

However, given that the atoms are in direct contact with each other in these masses and that this pressure is constant, this excess adiabatic energy cannot be evacuated by the emission of electromagnetic photons and simply increases with depth in the mass as the captive electrons of the outer electronic layers of the atoms approach the nuclei more and more as the depth increases, until an estimated temperature of about 5100 degrees Kelvin is reached at the centre of the Earth [53], as analyzed in reference [33].

Consequently, at the centre of proto-stellar masses in formation, following a sufficient accumulation of interstellar hydrogen, this compression of the electron orbitals makes the hydrogen atoms electrons eventually reaches the distance to the proton that coincides with the induction of a carrier-energy in each electron reaching the critical decoupling threshold of 1.022 MeV for those at the very center of the proto-stellar mass, at which point decoupling into electron-positron pairs is forced by the immediate proximity of the high-frequency resonating charges of the proton, resulting in the formation of neutrons with enormous bremmsstrahlung energy emission that trigger and will subsequently maintain the nuclear fusion chain reaction in stars as analyzed in reference [35].

A side effect of the contraction of electronic orbitals towards nuclei in macroscopic masses such as planetary masses is that these atomic nuclei approach each other more and more as the depth increases in the mass, which reduces the distances between these nuclei, intensifying the Coulomb interaction between the nuclei of these atoms.

The result is an increase in the outward "pull" involving the Coulomb interaction on all the charges of each nucleon of the various nuclei, which forces an increase in the *translation*/*resonance* distances of each triad relative to their central axis of *translation*/*resonance* in X-space, decreasing the amount of variable adiabatic energy induced in their carrier-photons, thus decreasing the effective mass of all nucleons at this depth of the macroscopic masses, as analyzed in references [22] [35]. The overall effect is that atomic nuclei become less and less massive as depth increases in macroscopic masses.

On the other hand, when small masses are taken away above the Earth's surface, the opposite effect can only occur by structure, because the energy of the electromagnetically constrained electrons' and positrons' carrier-photons of the nuclei of the atoms making up such small masses can only increase as a result of the increase in distances between them and all of the elementary charged particles making up the Earth's mass, which results in a contraction of the *translation*/*resonance* distances within each triad of the small mass with respect to the normal x-axis as a result of the weakening of the Coulomb interaction between the charges of these small masses and those of the Earth.

This contraction of the nucleonic orbitals within the nucleons of atomic nuclei making up such small masses moving away from the Earth, can only result in a proportional contraction of the electronic layers of these atoms, the measurable consequence of which is the increase in adiabatic energy induced at these shorter distances between the captive electrons and the nuclei, and therefore, in an increase in the electromagnetic frequency of the Bremmsstrahlung photons emitted by electrons momentarily excited moving to a metastable orbital further away from the nucleus, as they de-excite almost instantaneously when returning to their stationary action orbitals.

It is this mass increase of atomic nuclei with increasing altitude above the Earth's surface that really explains the increase in the frequency of Bremmsstrahlung photons used in an atomic clock during the Hefele and Keating experiment [45] mentioned previously to measure time flow, supposedly demonstrating an alleged acceleration in the rate of "time" flow with altitude, then considered as "evidence" of the validity of SR [35]; which is a conclusion that was drawn before the adiabatic nature of the momentum energy and of the transverse magnetic field energy permanently induced in each charged elementary particle was put in perspective.

In reality, such atomic clocks, whose accuracy depends on the frequency of Bremmsstrahlung photons emitted by electrons being de-energized, remain accurate as long as they are not moved from where they were calibrated. Any axial displacement in the gravitational gradient or change in its state of motion, such as when used in an orbiting satellite for example, requires recalibration that takes into account the local electromagnetic equilibrium.

Finally, the systematic "anomalies" observed about the trajectories of all space probes, extensively publicized in the case of the Pioneer 10 and 11 space probes about their escape trajectories from the solar system, that all behave systemati-

cally in deep space as if they were slightly more massive than measured on the ground before launch, also find a logical explanation in the previously analyzed fact that the rest masses of nucleons and macroscopic masses can only vary as a function of any axial displacement in the gravitational gradient.

There is then no doubt that the "anomalies" of the elliptical trajectories of Uranus, Neptune and Pluto, as well as those of comets Halley, Encke, Giacobini-Zinner, Borelli and others, that undergo systematic deviations of unknown origin as mentioned by R.W. Kühne [44], and in fact, all of the elliptical trajectories of the planets of the solar system, would benefit from being reconsidered with regard to this variability of their rest masses as a function of their axial oscillation in the Sun's gravitational gradient, and the variation of their transverse magnetic field as a function of their variable velocity on their elliptical trajectories.

28. The Bremmsstrahlung Photon Emission Mechanics

Now that the main conclusions that were drawn in the past about elementary particles, originating from already accumulated trustable experimental data, have been put in perspective in light of Maxwell's initial interpretation, the de Broglie hypothesis and Marmet's derivation within the broader framework of the trispatial geometry, let us now look at the Bremmsstrahlung photon emission mechanics that this geometry allows establishing, that is, an emission mechanics that de Broglie and Schrödinger were looking forward to establishing in the 1920s, but that elicited little interest in the community at the time, for lack of a potential avenue of resolution to be explored at this time [4].

For this purpose, we will analyze the specific case of an electron in process of being captured by a proton to form a hydrogen atom, whose final stable least action equilibrium state, more precisely describable as state of "*stationary*" action, was analyzed in reference [4]. Before proceeding to the description of the actual emission mechanics, let us put some numerical figures in perspective with regard to the inertia of the various amounts of energy involved.

Immediately prior to its capture and stabilization at mean rest orbital distance from the proton (a_0 = 5.291772083E−11 m), the electron will have reached the relativistic velocity of 2,187,647.561 m/s, driven by the precise amount of "ΔK" momentum energy that its carrier-photon will have accumulated at this distance as it accelerated towards the proton [33]:

$$E_K = \Delta K = m_0 c^2 \left(\gamma - 1\right) = 2.179784832\text{E}{-}18 \text{ j} \tag{49}$$

This velocity generates the "*forward inertia*" of the amount of momentum energy (13.6 eV) that will cause its own evacuation as an electromagnetic Bremmsstrahlung photon as the forward motion of the electron is suddenly brought to a dead stop as a first step in the establishment of its stable axial stationary action orbital state. In addition to the forward inertia provided by this momentum energy, the total inertia of the incoming electron will also involve the inertia of the total amount of energy making up its carrier-photon transverse

half-quantum and that of its invariant rest mass ($E = m_0c^2$ = 8.18710414E−14 j), both of which will not be evacuated during the stabilization process:

$$E_e = \Delta K + \Delta m_m c^2 + m_0 c^2 = 8.187540114\text{E}{-}14 \text{ j} \quad (50)$$

On the other hand, the "*stationary inertia*" of the proton towards which the electron is accelerating depends on a much larger amount of energy:

$$E_p = m_p c^2 = 1.503277307\text{E}{-}10 \text{ j} \quad (51)$$

So the well known ratio of the inertias of both interacting components will of course be:

$$\frac{E_e}{E_p} = \frac{1}{1836.054891} \quad (52)$$

We can observe that the forward inertia of the incoming electron is 4 orders of magnitude less than the stationary inertia of the proton, whose magnetic fields are its component that will stop the motion of the electron, by interacting in counter-pressure with respect to those of the incoming electron due to repulsive mutual parallel magnetic spin alignment imposed by structure, as clearly put in perspective in reference [4]. But the factual disproportion between the forward inertia of the electron momentum energy and the stationary inertia of the proton is immensely larger:

$$\frac{E_K}{E_p} = \frac{1}{68694481.49} \quad (53)$$

This ratio reveals that whereas the forward inertia of the incoming electron will be countered by the stationary inertia close to 2000 times its own inertia, the forward inertia of the momentum energy of the incoming electron, that will be evacuated from the electron-proton system during the stoppage process, will be countered by a stationary inertia close to 69 million times its own forward inertia as the electron is coming in at a sizable fraction of the speed of light. This ratio puts in very clear perspective how instantaneously the forward motion of this momentum energy towards the proton will find itself countered during the stopping process.

However, contrary to the momentum energy of a moving object hitting a wall at our macroscopic level, for example, that we know experimentally will be communicated to the wall as the object hits it, we also know experimentally that the momentum energy of the incoming electron is not communicated to the proton, but will be ejected right out of the electron-proton system as a detectable and measurable outgoing electromagnetic photon of energy "2.179784832E−18 j", wavelength "9.113034513E−8 m" and frequency "3.289710552E15 Hz", moving at the speed of light.

The issue of how the separation and ejection of this bremmsstrahlung photon mechanically proceeds has been pending ever since Louis de Broglie and Erwin Schrödinger began studying this process in the 1920's [4], but it was not really possible to resolve it before the expanded Maxwell compliant trispatial geometry

previously described was elaborated and presented in 2000 at the event Congress-2000 [18].

This new space geometry now allows understanding that although the electron and its carrier-photon are suddenly stopped in their forward motion towards the proton while being abruptly captured at mean ground state orbital distance from the proton in a hydrogen atom, the forward motion of its "ΔK" momentum energy component calculated with Equation (49) is not stopped in its forward motion "*within*" the internal trispatial structure of the electron carrier-photon (**Figure 3(a)** and **Figure 3(b)**), whose three separate spaces of its trispatial inner configuration act as communicating vessels [3], a forward inertia of moving electromagnetic photons that was confirmed by the Einstein's photoelectric proof.

The key to understanding why the motion of the "ΔK" momentum energy half-quantum of the electron carrier-photon is not stopped inside the carrier-photon as the latter is itself stopped in its forward motion, relates to step (c) of its trispatial electromagnetic cycle, as represented with **Figure 4**, which is the step, during its transverse oscillating cycle, during which all of its transverse energy reaches its maximum volume within magnetostatic Z-space (**Figure 3**).

The manner in which the forward moving momentum energy "ΔK" of the electron being captured by the proton first crosses over to Z-space, as it own forward inertia forces it across the central point-like junction area interconnecting the three spaces through which the particle's energy freely transits within its own trispatial complex; and is then ejected backwards as a magnetic pulse during the electric phase of the carrier-photon's transverse oscillation cycle (**Figure 4(e)**), as the two separated charges behave in Y-space, during the electron stopping process, as a fixed-length dipole antenna [54], can be summarized in a four steps sequence illustrated with **Figure 8**.

Figure 8(a) represents the electron accompanied by its carrier-photon internally reaching step 4-c (**Figure 4(c)**) of its transverse oscillating cycle, as both of their magnetic fields begin colliding with the relatively huge magnetic field of the proton, as they repel each other by momentarily all being in parallel magnetic spin alignment, as analyzed in reference [4].

Figure 8(b) represents the second step of the ejection process, and illustrates the actual stopping sequence, as the complete complement of the "ΔK = 2.179784832E−18 J" momentum energy has just been forced into Z-space by its own forward inertia, which actually momentarily doubles the amount of energy

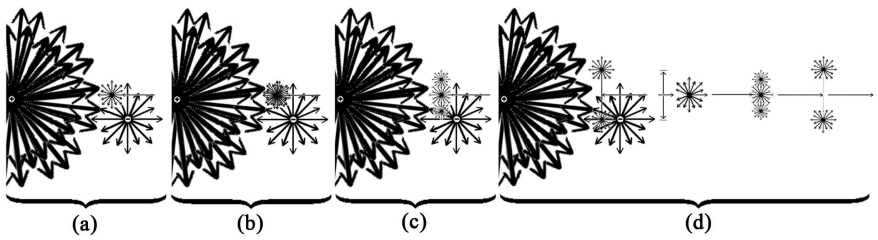

Figure 8. Representation of a Bremmsstrahlung emission mechanics.

making up the magnetic field of the incoming carrier-photon, a doubling which is graphically represented by an increased visual density of the carrier-photon magnetic sphere:

$$2\cdot\Delta\boldsymbol{B}=\frac{\mu_0\pi ec}{\alpha^3\lambda^2}=470103.4692\text{ T} \tag{54}$$

where "λ = 4.556335256E−8 m", which is the wavelength of the electron carrier-photon at the very beginning of the stopping process caused by the mutual magnetic repulsion of their magnetic fields.

As it stands, this momentary doubling of the electron carrier-photon magnetic field as the electron begins to be captured in the hydrogen atom ground state should be detectable as a recordable magnetic intensity peak coinciding with the Bremmsstrahlung photon emission, which would directly confirm the present photon emission mechanics.

Something else might already have drawn the reader's attention in **Figure 8(b)**. Although the momentum energy initially belonging to *X*-space, and represented by the left-pointing arrow leading to the carrier-photon magnetic sphere in **Figure 8(a)**, was just mentioned as having been forced into *Z*-space by its own forward inertia to add up with the already residing magnetic energy as calculated with Equation (54), an identical arrow still is present in **Figure 8(b)**. This requires an additional explanation, because this is no misrepresentation, because given that both the electron and the proton are electrically charged in opposition, the Coulomb interaction does not allow by structure that no momentum energy be induced in the electron carrier-photon at this distance from the proton, as put in perspective in reference [33].

Moreover, reference [42] clearly puts in perspective that a clear distinction must be made between an "*uncompensated mechanically induced rotation or translation motion*" and a "*permanently compensated electrostatically or gravitationally induced rotation or translation*". Such uncompensated motion characterizes the state of a satellite launched into a metastable inertial orbit about the earth for example, or any object artificially rotated at our macroscopic level by means of a single initial impulse. The orbit of such an artificial satellite always degrades causing the satellite to crash, and the rotation of such an artificially rotated object always stops, unlike the natural permanently compensated orbit of the Earth for example, and its natural permanently compensated rotation. Considering the clear correlation previously established between translational, rotational motions and the states of stationary action resonance, the capture and stabilization of an electron in the stationary action resonance orbital of a hydrogen atom clearly belongs to the "*permanently compensated*" category, as put into perspective in reference [33].

Since the amount of "ΔK" momentum energy induced by the Coulomb interaction at this distance from the proton can in no way be different from 13.6 eV, it can be concluded that as the initial amount of forward moving "ΔK" momentum energy is evacuated from *X*-space, a replacement 13.6 eV amount of "ΔK"

momentum kinetic energy has to synchronously be adiabatically induced by the permanently acting Coulomb interaction, an energy whose vectorial direction of application will now be expressed as a "*stationary pressure*" exerted towards the proton, increasing, so to speak, the permanent counter-pressure established between the parallel-aligned magnetic fields involved [4]. This means that momentarily, the carrier-photon will involve 40.8 eV, including now the momentary double intensity magnetic field, until the 13.6 eV temporarily transferred to *Z*-space is subsequently evacuated as a separate out-going electromagnetic photon.

Figure 8(c) represents the setting up of the metaphorical dipole antenna that will emit the excess 13.6 eV energy as an electromagnetic photon. As the carrier-photon magnetic field reached maximum "*presence*" in *Z*-space as represented in **Figure 8(b)**, the related dipole electric field was down to zero "*presence*" in *Y*-space, which corresponds to the two rods of a fixed length dipole antenna being neutral when no alternating current is provided to the antenna [54].

As the magnetic energy represented in **Figure 8(c)** starts moving back into electrostatic *Y*-space, the energy builds up in *Y*-space as two opposite charges moving in opposite directions on the *Y*-*y*/*Y*-*z* plane [3] [24], causing the two opposite charges to eventually peak at their maximum allowed value, which cannot exceed the maximum transverse ***E***-field energy authorized mean value of "2.179784832E−18 J (13.6 eV)" at this distance between the positively charged proton and the negatively charged electron, which combined with the newly induced equal authorized momentum energy value which is now "*stationarily pressuring*" the electron against the magnetic field of the proton, and is adiabatically maintained by the Coulomb interaction at this mean distance.

It is this maximum ***E***-field energy limit enforced by the Coulomb interaction that causes the sudden maximizing of the distance between both charges in *Y*-space causing it to act similarly the two fixed length dipole antenna rods, which allows the extra energy that was forced into *Z*-space, initially coming from *X*-space, to now moves on into *Y*-space and overload the now fixed maximized length of the *Y*-space dipole, causing it to emit the excess 13.6 eV energy as a magnetic pulse in magnetostatic *Z*-space, in the same manner as electromagnetic energy pulses are emitted from a very normal dipole antenna at our macroscopic level, which is represented with **Figure 8(d)**.

The question comes up here as to why does the electron not simply fly away from the proton since it is universally known to do so when precisely this amount of "ΔK = 2.179784832E−18 j" energy that it now already possesses is provided to it from an incoming electromagnetic photon, which is the case that will be addressed in the next and last section of this paper. The answer is really simple in this specific case, and is provided by simply becoming aware that the whole practically instantaneous sequence represented by **Figure 8** occurs while the "*forward inertia*" of the total amount of energy making up the electron invariant rest mass and its carrier-photon is applying its maximum pressure against the magnetic field of the proton, momentarily defeating any possibility for the

electron to be ejected at this precise moment, and also defeating any possibility for the distance between the electron and the proton to vary during this so brief stopping sequence process.

Right after having been chased into Z-space by the Y-space electric dipole, the first thing that will happen to the freed energy will be the transfer from Z-space to X-space of half its energy to build the momentum energy half-quantum that will then start propelling it at the speed of light away from the proton, in the first step of the re-establishment of its natural trispatial electromagnetic equilibrium. Once both energy half-quanta have reached their default equal longitudinal and transverse energy levels as could be determined according to de Broglie's hypothesis and from Marmet's derivation, the energy of its transverse magnetic $\boldsymbol{B}$-field will naturally start transversely oscillating by crossing over to Y-space to induce the corresponding $\boldsymbol{E}$-field, thus initiating the stable transverse electromagnetic oscillation of the new Bremmsstrahlung photon, now moving freely at the speed of light, as represented with **Figure 8(d)** [3].

Note that although the complete process took a noticeable amount of time to describe, the actual sequence of events causing the electron to come to a momentary dead stop as it is being captured by a proton, has to be practically instantaneous, due to the velocity of the incoming electron, combined with the fact that the whole sequence definitely has to be completed during the fleeting half-cycle of the carrier-photon transverse electromagnetic oscillation, beginning with its parallel magnetic spin alignment (**Figure 4(c)**) with respect to the spin orientation of the magnetic field of the proton and ending with the maximum $\boldsymbol{E}$-field charges separation (**Figure 4(e)**) as represented at the beginning of **Figure 8(d)**; the whole sequence occurring, as previously mentioned, while the inertia of the total amount of energy making up the electron invariant rest mass and the momentarily invariant mass of its carrier-photon are applying maximum pressure against the magnetic field of the proton [4].

29. The Electromagnetic Photon Absorption Mechanics

As soon as the bremmsstrahlung photon has been emitted, the "*forward inertia*" of the electron invariant mass/electromagnetic-fields and of its carrier-photon variable mass/electromagnetic-fields half-quantum, due to their incoming velocity, will be replaced by their default "*stationary inertia*", to which must be added the "*adiabatically variable forward pressure*" provided by the newly induced ΔK carrier-photon momentum energy half-quantum, which is permanently oriented towards the proton, that jointly interact in counter-pressure with respect to the "*oscillating*", but nevertheless "*stationary inertia*" of the much larger mass/electromagnetic-fields of the proton, which interaction establishes and maintains the electron on its axial least action resonance trajectory within the stationary action volume of space that Schrödinger meant to describe with the wave equation [7], as described in reference [4].

Now that only the permanent "*forward pressure*" of the recently and adiabat-

ically induced "ΔK" momentum is preventing the electron from escaping, and that the "*momentary pressure*" that was initially exerted towards the proton due to the "*forward inertia*" of the electromagnetic fields of the electron and carrier-photon, which initially prevented the electron carrier-photon transverse $\boldsymbol{E}$ field energy from exceeding its incoming initial value of "2.179784832E−18 j", is no more in action, but which is what caused the bremmsstrahlung photon to be emitted, as described in the previous section; any energy coming from outside the electron-proton system will be captured by the Y-space electric dipole of the carrier-photon, presumably still acting as a dipole antenna, but whose length can now vary, and will be equally distributed between both carrier-photon half-quanta, to the extent that the electron's magnetic gyroradius in the hydrogen atom will allow [51].

The resulting increase in the axial resonance volume that the electron will visit as a result, will cause the electron to eventually jump to an authorized metastable orbital further from the proton before returning almost immediately to the rest orbital, emitting in the process a Bremmsstrahlung photon that will evacuate the corresponding excess energy, or to escape completely from the proton if the energy supplied from outside the electron-proton system reaches the escape level of "ΔK = 2.179784832E−18 j", either by progressive accumulation or by collision with an incident photon of energy 2.179784832E−18 j.

All possible cases of energy emission and absorption must of course be explained and documented in the context of trispatial geometry, but since this document is intended only to put in perspective the underlying electromagnetic context that allows a general description of the mechanics of electromagnetic photon emission and absorption by electrons in the trispatial geometry, as a complement to the establishment of the electron stabilization mechanics in the hydrogen atom previously described in reference [4], their development is beyond the scope of the present paper.

30. Conclusions

This analysis highlights the point that it is no more difficult to conceive that electromagnetic energy can consist of localized photons at the subatomic level than it is to conceive that water consists of localized molecules at the submicroscopic level, even if at our macroscopic level we treat electromagnetic energy as if it was made of continuous wave impulses and water as if it was a fluid without internal structure.

The main conclusion of this paper, however, is that when Maxwell's initial interpretation is correlated with the de Broglie hypothesis about the double-particle photon and Marmet derivation in context of the trispatial geometry, electromagnetism can finally be completely harmonized with Quantum Mechanics, as analyzed in reference [4]; a harmonization that now allows a first mechanical explanation to the processes of electromagnetic photon emission and absorption by electrons, as previously described.

It must also be clearly put in perspective that Maxwell's initial interpretation is

a conclusion firmly grounded on the study and analysis of experimental data collected earlier during easily reproducible experiments that were performed by many experimentalists, as well as on the conclusions and equations that they drew from this data. The electromagnetic equations generally referred to as "*Maxwell equations*" are in fact a set of mutually complementary equations that have been established mainly by Coulomb, Gauss, Ampère and Faraday and whose mutual coherence was established by Maxwell. Lorentz, Biot, Savart and a few others then completed the current set of mutually complementary electromagnetic equations from the analysis of more data obtained from other experiments equally easy to reproduce.

Intrigued at not finding any evidence of an experiment confirming the point-like magnetic behavior of spherical magnetic fields whose two poles coincide geometrically, which must be the *de facto* magnetic structure of electrons, given their systematic point-like behavior during all scattering experiments, this author designed and carried out in 1998 an easily reproducible experiment with magnets magnetized accordingly, whose data and subsequent analysis were published in 2013, for the experiment to become available in the education community [39]. One year later, S. Kotler *et al.* published an article describing an experiment performed with electrons that directly confirmed the prediction of the 1998 experiment [55].

The education community now has at its disposal a complete set of demonstration experiments easily reproducible during hands-on laboratory teaching sessions, ranging from the first Coulomb electric experiment to the 1998 magnetic experiment to help teaching and confirming every aspect of electromagnetic energy behavior.

Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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