Journal of Modern Physics, 2023, 14, 876-932
https://www.scirp.org/journal/jmp
ISSN Online: 2153-120X
ISSN Print: 2153-1196

Introduction to Synchronized Kinematic and Electromagnetic Mechanics

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How to cite this paper: Michaud, A. (2023) Introduction to Synchronized Kinematic and Electromagnetic Mechanics. *Journal of Modern Physics*, **14**, 876-932.
https://doi.org/10.4236/jmp.2023.146051

Received: April 7, 2023
Accepted: May 28, 2023
Published: May 31, 2023

Abstract

Introduction to fundamental physics according to the parallel harmonization of kinematic and electromagnetic mechanics, in accordance with Wilhelm Wien's project, which involved the integration in kinematic mechanics of the mass increase of the electron as a function of its velocity, as measured by Walter Kaufmann with his bubble-chamber experiments, and analyzed and confirmed by H. A. Lorentz and all the leading edge physicists who then re-analyzed this data.

Keywords

Kinematic Mechanics, Electromagnetic Mechanics, Electrostatic Recall Constant, Restoration Force, Gravitation

1. Introduction

In the first decade of the 1900s, the debate was ongoing as to whether the mass of bodies was mechanical in nature in the sense established in classical mechanics from experiments carried out with macroscopic masses, or electromagnetic in nature, according to recent discoveries made from the data collected about the electromagnetic behavior of electrons in Walter Kaufmann's bubble chamber [1] [2] [3] [4], by means of electron beams accelerated and guided on curved trajectories at relativistic velocities by a combination of finely tuned electric and magnetic ***E***- and ***B***-fields, according to the method developed in the previous decade by H. A. Lorentz [5].

Coinciding with the beginning of Kaufmann's experiments but in an unrelated research project, Wilhelm Wien, the famous experimentalist who first experimentally confirmed the quantized nature of light with his black-body experiments [6], published in 1901 an article analyzing the possibility of harmonizing kinematic mechanics with electromagnetic mechanics from a common basis, which is an issue that had been under discussion in the physics community ever since Maxwell formulated his electromagnetic theory 40 years earlier [7]:

"*Es ist zweifellos eine der wichtigsten Aufgaben der theoretischen Physik, die beiden zunächst vollständig isolierten Gebiete der mechanischen und elektromagnetischen Erscheinungen miteinander zu verknüpfen und die für jedes geltenden Differentialgleichungen aus einer gemeinsamen Grundlage abzuleiten.*" Wilhelm Wien (1901) [7].

"*It is undoubtedly one of the most important tasks of theoretical physics to link the two domains of mechanical and electromagnetic phenomena, which are currently completely separated, and to derive differential equations that would be applicable to each from a common basis.*"

According to his analysis, the dominant trend in the last quarter of the nineteenth century, supported by Maxwell, Thompson, Boltzmann, and Hertz, was to give priority to kinematic mechanics as a common foundation, because Maxwell had succeeded in establishing his electromagnetic equations by adapting the classical wave equation to account for the propagation of light in a vacuum, which allowed him to predict the existence of the entire spectrum of non-visible electromagnetic frequencies, which was later confirmed by Hertz. According to the arguments presented in his paper, Wien was rather of the opinion that electromagnetic mechanics would be a more appropriate common basis for this harmonization:

"*Diese Untersuchungen haben zweifellos das Größe Verdienst, nachgewiesen zu haben, dass beiden Gebieten etwas Gemeinschaftliches zu Grunde liegen muss, und dass die gegenwärtige Trennung nicht in der Natur der Sache begründet ist. Andererseits aber scheint mir aus diesen Betrachtungen mit Sicherheit hervorzugehen, dass das System unserer bisherigen Mechanik zur Darstellung der elektromagnetischen Vorgänge ungeeignet ist.*" Wilhelm Wien (1901) [7].

"*These investigations have undoubtedly the great merit of having demonstrated that both domains must be grounded on something common and that the present separation is not rooted in their nature. On the other hand, however, it seems to me with certainty that from these considerations the system of our kinematic mechanics up to now is unsuitable for the representation of electromagnetic processes.*"

His most important argument was that the calculations made by Searle [8] using the electromagnetic force equations developed by Heaviside [9] revealed that the energy and mass of localized charged particles in motion should increase with velocity, whereas the calculations made using the equations of kinematic mechanics did not allow such an increase.

In the years following the publication of Wien's analysis, Kaufmann carried out numerous experiments involving electrons accelerated to relativistic velocities on curved trajectories, that allowed measuring separately their longitudinal and transverse inertia [1] [2] [3] [4]. Extensive analysis of the Kaufmann data successively carried out by Abraham, Lorentz, Planck, Poincaré, Bucherer, Neumann and Einstein [10]-[15] confirmed in conformity with Searle's calculations [8], that the inertia of electrons moving at relativistic velocities on curved trajectories, indeed increases with velocity, both longitudinally and transversely, as particularly well analyzed and explained by Lorentz in his 1904 article [10], even discounting the longitudinally oriented momentum energy of the electrons, which brought solid support to Wien's conclusion that both mechanics should be grounded on electromagnetism.

However, disregarding the momentum energy of macroscopic masses, due to the too low velocities that can be achieved with such masses, which forever relegates any possible measurement of any velocity related increase in macroscopic mass far below any detectable level, as analyzed in [16] [17], no longitudinal or transverse mass increase was ever measured in experiments with macroscopic masses, which entertained doubts as to the possibility that macroscopic masses could also be subject to the observed and confirmed mass increase of moving electrons.

In the same 1904 article in which Lorentz analyzed in depth the electromagnetic behavior of electrons in Kaufmann's bubble chamber, he also defined, on a completely separate issue, the set of transformations that immediately drew the attention of the whole community, by establishing a neat foundation to the Special Relativity Theory (SRT) proposed by Einstein in his third 1905 article [18]. That is, a solution to the then *apparent* impossibility at the time of identifying *a stable absolute reference* in the universe with respect to which the motion of ponderable masses could be defined and calculated, a conclusion drawn as an outcome of the failure of the Michelson experiments to reveal such a reference.

The interest of the Lorentz transformations lay in their ability to allow mathematically describing and calculating the motion of macroscopic masses in relation to each other from the point of view of kinematic mechanics, but this unfortunately conceptually excluded the very possibility that absolute motion could be possible in the universe, possibly from an unexpected reference that was yet to be discovered, a question that was eventually resolved from the point of view of electromagnetic mechanics, as we will see further on.

Interestingly, the Lorentz force equation $F = q(\boldsymbol{E} + v \times \boldsymbol{B})$ whose validity for calculating the motion of free moving electrons propelled and guided by electric and magnetic fields—confirmed in the same 1904 article [10] from the analysis of the data collected by Kaufmann—has been used ever since to guide free moving electrons with the highest degree of precision in cathode ray tubes (CRT), and other free moving charged particles in high energy accelerators, on the utterly precise trajectories that can be established only by taking into account their velocity related transverse increase in inertia as observed in Kaufmann's bubble chamber:

"*Hence, in phenomena in which there is an acceleration in the direction of motion, the electron behaves as if it had a mass* m_1, *those in which the accelera-*

tion is normal to the path, as if the mass were m_2. These quantities m_1 and m_2 may therefore properly be called the 'longitudinal' and 'transverse' electromagnetic masses of the electron. I shall suppose that there is no other, no 'true' or 'material' mass." H. A. Lorentz (1904) [10].

On his side, Poincaré made this comment:

"*Abraham's calculations and Kaufmann's experiments have shown that mechanical mass itself is zero and that the mass of electrons, or at least of negative electrons, is exclusively of electrodynamic origin. This forces us to change the definition of mass; we can no longer distinguish mechanical mass from electrodynamic mass, because then the former would disappear; there is no other mass than electrodynamic inertia; but in this case the mass can no longer be constant, it increases with the velocity; and even, it depends on the direction, and a body animated by a notable velocity will not oppose the same inertia to the forces which tend to deviate it from its course, and to those which tend to accelerate or to delay its forward motion.*" Henri Poincaré (1905) [11].

But despite Searle's calculations [8], Wien's conclusion [7] and the confirmation brought by Kaufmann's data as analyzed by Lorentz, Poincaré, Bucherer, Neumann, Planck and Einstein [12] [13] [14] [15], the confirmed electromagnetic behavior of electrons was deemed not to apply to macroscopic masses for which no such variation was ever measured, which ended up causing these characteristics to be ignored in the establishment of the Special Relativity Theory (SRT), according to a decision taken in 1907 by the leading researchers in the community, in agreement with Einstein's opinion, that it should not be taken account of when dealing with macroscopic masses:

"*Herr Kaufmann has determined the relation between* [*electric and magnetic deflection*] *of β-rays with admirable care… Using an independent method, Herr Planck obtained results which fully agree with Kaufmann… It is further to be noted that the theories of Abraham and Bucherer yield curves which fit the observed curve considerably better than the curve obtained from relativity theory. However, in my opinion, these theories should be ascribed a rather small probability because their basic postulates concerning the mass of the moving electron are not made plausible by theoretical systems which encompass wider complexes and phenomena.*" Albert Einstein (1907) ([15], p. 159).

With these remarks, the kinematic mechanics approach was thus chosen as the common basis from which differential equations applicable to both the kinematic and electromagnetic domains should emerge. Abraham Pais' 1982 conclusion regarding these remarks of Einstein and the agreement of the community clearly hints at the problems that this decision failed to resolve with respect to the electromagnetic properties of the electron:

"*Special Relativity killed the classical dream of using the energy-momentum-velocity relations of a particle as a means of probing the dynamic origin of its mass. The relations are purely kinematic. The classical picture of a particle as a finite little sphere is also gone for good. Quantum field theory has taught us that particles nevertheless have structure, arising from quantum fluctuations. Re-*

cently, unified field theories have taught us that the mass of the electron is certainly not purely electromagnetic in nature. But we still do not know what causes the electron to weigh." Abraham Pais (1982) ([15], p. 159).

In reality, the level of knowledge about the electromagnetic nature of the charged and massive electron and other stable elementary electromagnetic particles of which the atoms constituting all macroscopic masses are made was not sufficiently advanced at the beginning of the 1900s for better conclusions to be drawn.

When speaking of *quantum fluctuations* in his comment written in 1982, Pais was of course referring to the *Quantum Field Theory* (QFT) developed by Paul Dirac, grounded on the *Lorenz gauge*, that postulated a stable conservative zero-point energy level in all of vacuum, about which neutral level would spontaneously and stochastically expand and retract pairs of oppositely charged elementary particles, such as electron-positron pairs, that could then interact to constitute all matter in the universe.

Let us note at this point that QFT was conceived before it was discovered by direct observation in bubble chambers in the early 1930's that such electron-positron pairs actually can come into being only by means of the destabilization of electromagnetic photons that possess sufficient energy to completely account for the energy of which the invariant rest masses of both particles are made, that is, electromagnetic photons exceeding ever so slightly the threshold energy of 1.022 MeV, which is twice the 0.522 MeV energy known to constitute each of their invariant rest masses, when such photons' trajectories run close enough to charged and massive particles, such as atomic nuclei, for them to destabilize and convert to such pairs [19] [20], and even when coming close enough to other photons at a single point in space, as experimentally confirmed at the Stanford Linear Accelerator (SLAC) in 1997 [21].

The difference between QFT, defined before these discoveries, and the trispatial model of electromagnetic mechanics (EMM), that takes into account these experimentally confirmed processes of generation of charged and massive electron-positron pairs, made of the electromagnetic energy of localized photons interacting with charged and massive particles or with other photons is analyzed in [22].

Of course, the classical and naive image of elementary particles as small, clearly defined spheres has definitely disappeared, as mentioned by Pais. But in light of the more extensive knowledge now available, it is the conclusion that the relations between masses could be purely kinematic that proves to have been quite illusory, given the discovery made later that the energy of which the masses of all charged elementary particles are made, constituting the atoms whose local accumulations establish all macroscopic masses, is purely electromagnetic in nature.

The same electromagnetic nature also characterizes their carrying energy, which is permanently and adiabatically induced for each of them by the Coulomb restoring force as a function of the inverse square of the distances separating them, and which is constituted by the unidirectional energy of their ΔK momentum, that ensures their motion or alternatively the pressure that they exert on other particles, and by the transversely oscillating energy of the simultaneously induced local $\Delta \boldsymbol{E}$ and $\Delta \boldsymbol{B}$ fields that guide them locally in straight line when no external influence interferes.

It is the electromagnetic properties of this energy, of which the invariant mass of all elementary particles is made, as well as their *carrying energy*, which we will analyze in this article, and then put in perspective how the electromagnetic mechanics that emerges from these properties harmonizes with traditional kinematic mechanics.

2. The Establishment of the Special Relativity Theory

Before proceeding to this analysis, let us proceed to a historical review of the events that surrounded the choice of the kinematic perspective as a common foundation for the two domains and the consequences of this choice.

As revealed by Einstein's previously quoted remarks, the kinematic approach was favored in 1907, which led to the adoption of the theory of Special Relativity (SR) without taking into account the increase in the transverse mass of electrons with velocity observed from Kaufmann's data, and that formalized the basis of mechanics strictly on the relative motion of bodies with respect to each other according to the Lorentz transformations [10]. Even the simple possibility that light could move in the universe at the absolute invariant speed of light, independently of the speed of the source and of that of the absorbing destination, quickly became inconceivable to many, even though the speed of compression sound waves in a homogeneous medium, for example, is well understood to be absolutely independent of the speed of the source and of that of the receiver.

To compensate for the absence of the electromagnetic increase in mass with velocity observed with Kaufmann's data, the Special Relativity theory varied the time dimension and the length of bodies according to velocity as a function of the γ-factor, with the length of masses contracting and time slowing down with increasing velocity and with increasing intensity of the gravitational gradient, while maintaining the conservative concept of potential energy converting to momentum kinetic energy during velocity increases, and reconversion to potential energy during decelerations, which does not imply a continuous *physical* existence of this kinetic energy.

Contrariwise, the electromagnetic mass increase of the electron, according to Kaufmann's data, implies that the energy that constitutes the kinematic mass increment of the electron $\Delta m_m c^2$, corresponding to the local oscillating $\Delta \boldsymbol{E}$ and $\Delta \boldsymbol{B}$ fields of its carrying energy, as well as the associated ΔK momentum energy, physically exists and varies adiabatically with any change in velocity or proximity to other charged particles, without involving any variation in time or length of masses; conformity with the γ-factor being intrinsically accounted for both for the momentum energy and for the related oscillating fields energy due to their continuous physical existence [23].

As observed by Einstein, the difference between longitudinal mass m_1 and transverse mass m_2 of the moving electron—as identified by Lorentz in his 1904 article—was not observable for masses at our macroscopic level, and this condition seemed to him and to his colleagues not relevant in their search for the cause of gravitation, that they assumed to apply only to macroscopic masses.

In reality, given that all macroscopic masses consist of subatomic charged electromagnetic particles stabilized in various stationary action resonance states, including electrons, it therefore turns out that it can only be the sum of their interactions at the subatomic level that can establish the observable behavior of larger accumulations of such particles at our macroscopic level. Indeed, given the low velocities possible for such large local accumulations of particles at our macroscopic level, all experimental evidence seems to show that all processes involving such masses can be successfully treated using classical Newtonian kinematic mechanics.

For processes involving very small masses interacting with very large masses, however, relativistic mechanics comes into play due to the great influence of even small changes in the intensity of the gravitational gradient on the internal distances between the stabilized charged particles that constitute these small masses, as for example atomic clocks moving away from the Earth, or the motion of Mercury on its elliptical orbit very close to the huge mass of the Sun compared to its relatively insignificant mass, or the very small masses of the Pioneer 10 and 11 spacecrafts moving away from the large mass of the Sun on their trajectories leading out of the solar system, as analyzed in [23].

This summarizes about all that we can directly measure of the sum of the interactions between all charged particles occurring at the subatomic level that all macroscopic masses are made of.

As already mentioned, the fact that the energy of which the rest mass of the electron is made really is electromagnetic in nature was discovered only later, in the early 1930s, when it was observed that photons of energy greater than 1.022 MeV could easily be converted into massive electron-positron pairs [19] [20] [24]. However, this discovery was obviously insufficient to lead to reconsideration, because much later, in the 1980s, the opinion of Pais quoted above still was that their relations could only be purely kinematic. But more and more discoveries have accumulated since then to finally confirm beyond any doubt that the common basis of physics should be electromagnetic.

The complete historical background of the evolution of electromagnetic theory since James Clerk Maxwell [25] and Ludwig Lorenz [26] 160 years ago, and the evolution of the kinematic theory from its historical regrounding on relative motion in 1907 is analyzed in [23]. Since Maxwell and Lorenz established their apparently conflicting approaches, the community has focused strictly on the *Lorenz gauge* approach involving *a single electromagnetic field*. This approach is obviously correct for dealing with electromagnetic energy at our macroscopic scale, the proof being the whole set of successful engineering developments that we benefit from grounded on the idea of such a *single electromagnetic field*, in which the vectorial differences between the ***E***-field and the ***B***-field have no role to play.

Metaphorically speaking, just like dealing with water as a fluid at our macroscopic level allows successfully dealing with all aspects of its use that does not require involving the individual characteristic of the *quantized water molecules* of which it is really made, it is well understood that it would be illusory to try establishing the characteristics of the *localized quantized water molecules* and of their subatomic components by means of the macroscopic water fluidity perspective.

It turns out that the same problematic dichotomy between the fluidity perspective of the macroscopic level of magnitude and the quantized perspective of the subatomic level also applies to electromagnetic energy. It is at this point that Maxwell's interpretation brings in concepts that are absent from the Lorenz gauge approach and that resolve this problem at the quantized level of localized photons and other charged and massive elementary particles, namely the different *spatial orientation* of the oscillation of the ***E***-field energy with respect to the *temporal orientation* of the ***B***-field energy oscillation, the *displacement current* related to the ***E***-field oscillation, and the *implicit mutual LC-induction* of the ***E***- and ***B***-fields that Maxwell contributed with his theory.

In summary, the two possible representations of *continuous electromagnetic waves* established by Maxwell and Lorenz are illustrated with **Figure 1** and **Figure 2** as an oscillating electromagnetic pulse of intimately related ***E***- and ***B***-fields, the two fields being *spacewise* offset by 90˚, oscillating transversely on longitudinal planes according to the classical concept of a wave propagating by transverse oscillation in an elastic medium.

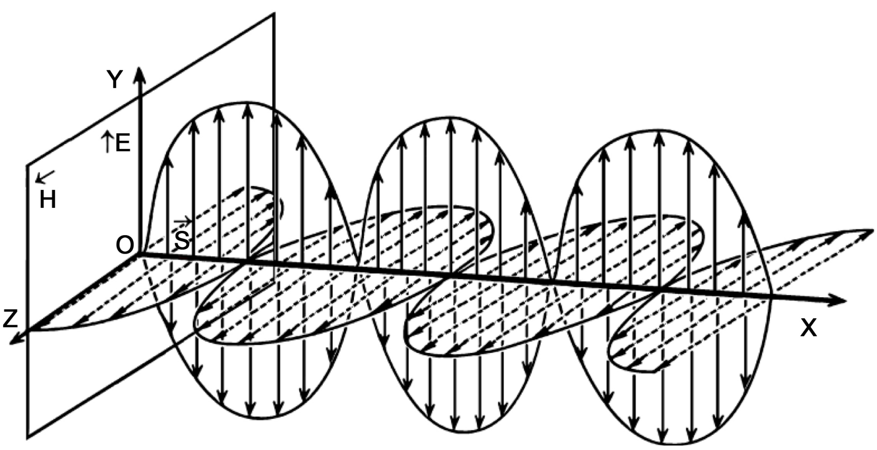

Figure 1. *Spacewise* orthogonal ***E***- and ***B***-fields transverse oscillation representation of an electromagnetic pulse propagating in an underlying elastic medium—defined as the *aether*—*timewise* dephased by 180˚ and mutually inducing each other, involving the assumed existence of a *displacement current* as conceived by Maxwell.

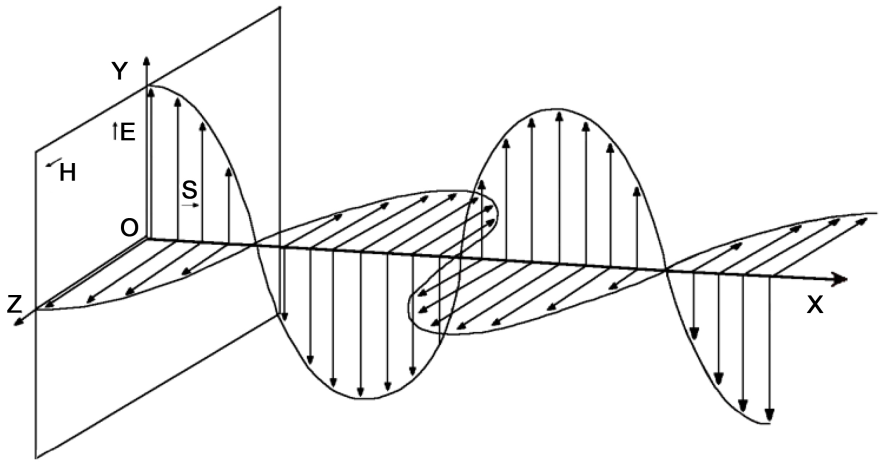

Figure 2. Standard *spacewise* orthogonal ***E*** and ***B*** fields transverse oscillation representation of an electromagnetic pulse propagating in an underlying elastic medium—defined as the *aether*—simultaneously peaking *timewise* in phase to maximum intensity, corresponding to the *Lorenz gauge* interpretation.

But whereas Lorenz represents them as *timewise* reaching *simultaneously* their maximum intensity (**Figure 2**), Maxwell initially conceived them as *timewise* alternately reaching their maximum intensity while being 180˚ out of phase (**Figure 1**), by introducing the concept of *displacement current* linked to the ***E***-field as the *mechanical cause* of the induction of the ***B***-field, which, when reaching its maximum intensity, reduces the ***E***-field to zero, as in the well-known LC relation, at which moment the ***B***-field, being symmetrically out of balance, will re-induce the ***E***-field while in turn falling to zero, thus establishing the complete loop of one cycle of the frequency corresponding to the energy of the pulse in propagation.

Maxwell's concepts of a *displacement current* and separate ***E***- and ***B***-fields, treated as separate entities inducing each other by means of *LC oscillation*, proved to be superfluous and even brought an unnecessary level of complexity to the treatment of electromagnetic energy as a continuous wave, and this is what contributed to the *Lorenz gauge* approach being initially preferred. But these additional features of Maxwell's theory now prove to be the elements required to allow the establishment of the uninterrupted sequence of energy conversion processes that mechanically establish the known sequence of quantized resonance states, progressing in intensity from the freely moving photon to the more intense states of the nucleons forming atomic nuclei, which are listed in **Section 7**.

Let us mention at this stage of the analysis that Maxwell's initial interpretation, more adapted to the treatment of quantized states of electromagnetic energy at the subatomic level, does not disqualify in any way the *Lorenz gauge* perspective, that proved to be totally appropriate to the treatment of electromagnetic energy as *a single continuous electromagnetic field* at our macroscopic level of magnitude, in the same way that treating water molecules as quantized at the molecular level does not disqualify the treatment of water as a fluid at our macroscopic level.

Maxwell conceived the motion of light in vacuum as involving a *transverse oscillation* of the ***E***- and ***B***-fields of light energy *on two longitudinal planes*, spatially offset by 90˚ from each other to explain the velocity of light in the longitudinal direction in vacuum (**Figure 1** and **Figure 2**) by means of an adaptation of the classical mechanics wave equation, by similarity with a wave propagating along an elastic cord, as analyzed in [27].

$\frac{\partial^2 y}{\partial x^2}=\frac{m_L}{F}\frac{\partial^2 y}{\partial t^2}$ that becomes once the m_L/F constant is resolved

$$\frac{\partial^2 y}{\partial x^2}=\frac{1}{v^2}\frac{\partial^2 y}{\partial t^2} \tag{1}$$

This equation establishes that energy pulses propagate longitudinally by *oscillating transversely on the longitudinal plane* of the motion of the wave—*i.e.*, when matched to the electromagnetic ***E***- and ***B***-fields mutually perpendicular vectors, the electromagnetic pulse is represented as propagating on two mutually perpendicular planes that remain parallel to the direction of motion of the wave (**Figure 1** and **Figure 2**).

$$\frac{\partial^2 \boldsymbol{B}}{\partial x^2}=\mu_0\varepsilon_0\frac{\partial^2 \boldsymbol{B}}{\partial t^2} \quad \text{and} \quad \frac{\partial^2 \boldsymbol{E}}{\partial x^2}=\mu_0\varepsilon_0\frac{\partial^2 \boldsymbol{E}}{\partial t^2} \tag{2}$$

with constant $\varepsilon_0\mu_0$ resolving of course to $1/c^2$ by similarity with classical reference Equations (1), thus establishing the related velocity as the *absolute invariant speed of light* in vacuum.

The almost immediate adoption by the community of the Lorenz gauge approach (**Figure 2**), since it was easier to use for mathematical generalization purposes, led to the Lorenz gauge eventually becoming the foundation for all subsequent electromagnetic developments to this day, such as QFT from which Quantum Electrodynamics (QED) emerged; which also led, in the absence of continued reference to Maxwell's alternative possibility, to the disappearance from the collective awareness that Maxwell's original conclusions involved a *displacement current* and that the ***E***- and ***B***-fields had separate and equally important functions in his theory, and to the assumption by most in the community that the Lorenz gauge approach was in agreement with Maxwell's own conclusions.

3. The Evolution from the 3D + 1 Vectorial Space Geometry to the 3 × 3D + 1 Vectorial Space Geometry

The very simple and easily confirmed Biot-Savart law, used by Paul Marmet to derive Equation (30) cited further on, to reveal for the first time the simultaneous increase with velocity of the magnetic field and of the mass of electrons moving in a wire [28], is the perfect example to explain the triple ontological orthogonality of electromagnetic energy, corresponding to the well-established vector cross-product of the ***E***- and ***B***-fields vectors, resulting in a third velocity vector perpendicular to the first two (Figure 3(a)).

When electrons are set in motion in a wire by applying voltage to it, a macroscopic magnetic ***B***-field instantly develops about the wire that can easily be directly detected with a very ordinary magnetic compass, whose energy direction of motion about the wire is oriented very precisely perpendicular to the direction of motion of the flow of electrons in the wire. It is well established that the flow of electrons moving from the negative end of the wire towards the positive end occurs at the surface of the wire, each moving negative electron remaining strongly attracted all along its progression along the outside surface of the wire to the closest positive atomic nucleus that it happens to pass by in the wire; that is, a direction of interaction between the electrons and the atomic nuclei that establishes the electric ***E***-field as being oriented perpendicular to both the direction of motion of the electrons flow at the surface of the wire on one hand, and to the direction of motion of the energy of the ***B*** field about the wire as revealed by the compass on the other. This triple orthogonality can now be easily visualized as corresponding to Figure 3(a).

In the early 1930's, about 30 years after Einstein published his first paper of 1905 on the question of the possible permanent maintenance of the localization of electromagnetic energy after emission, Anderson [19] observed experimentally that localized photons of energy equal to or greater than 1.022 MeV, easily converted into *charged* and *massive* electron-positron pairs, the two particles being eventually measured as identical in all respects, except for the signs of their *equal and invariant charges*, to which a negative sign for the electron and a positive sign for the positron were attributed by convention.

This drew attention to the need for a consistent mechanical explanation of this confirmed process of conversion of the energy of a localized electromagnetic photon in free motion, then assumed to be *electrically neutral* and *massless*, into a pair of *massive* and *charged* electron and positron, that stabilize in stable stationary resonance states—each with an invariant rest mass of 9.10938188E−31 kg, an invariant unit charge of 1.602176462E−19 Coulombs, and whose invariant energy content oscillates at the stable invariant frequency of 1.235589976E20 Hz, corresponding to the electron Compton wavelength (λ_c = 2.426310215E−12 m).

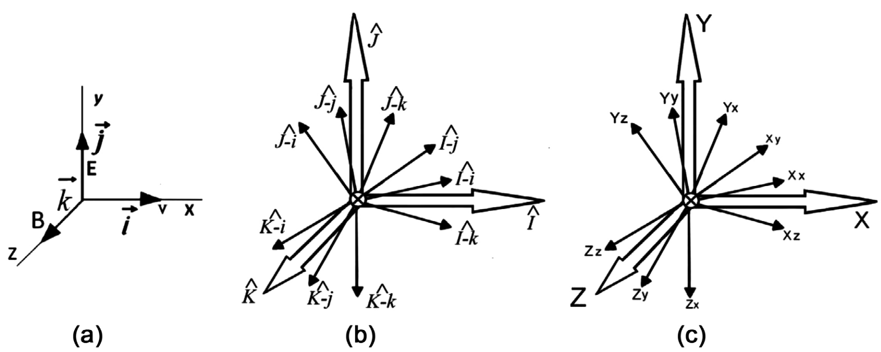

Figure 3. Major and minor unit vector sets applicable to the trispatial geometry.

3.1. Calculation of the Recall Constant and of the Restoration Force of Electrons and Positrons

We will now examine with **Figure 4** the manner in which the energy of a 1.022 MeV photon is known to convert to a pair of charged and massive electron and positron, first observed by Anderson in the 1930's [19] and analyzed in Reference [29].

To establish the mechanics of this conversion, **Figure 4** does not represent the magnetic field energy $\Delta \boldsymbol{B}$, since this energy will be considered at the moment when it has completely converted to the twin oscillating charges of the photon, represented at their maximum value in Y-space.

Figure 4(a) depicts a 1.022 MeV photon before destabilization, half of whose energy is its momentum energy ΔK, and the other half is depicted as the instantaneous moment when its two electrical components reach their maximum distance $\alpha\lambda_C/2\pi$ apart from each other, while its magnetic aspect reaches zero presence, and where λ_C is the electron's Compton wavelength, that represents half of the energy of this 1.022 MeV photon.

As unexpected as this may appear, it turns out that the classical spring equation of Hooke's law also applies to the electromagnetic oscillating motion of the elastic energy substance of which photons and electrons are made, as established in Section XXIII of Reference [30].

$$F = -kx \tag{3}$$

In relation with which the following classical *work/energy* equation was established for the case of an element subjected to elastic stretching:

$$E = -\frac{kA^2}{2} \tag{4}$$

Considering that **Figure 4(a)** reveals that, in the case of the 1.022 MeV photon, two elements are subjected to elastic stretching, Equation (4) will be multiplied by 2 to account for this double relation:

$$E = 2\left(-\frac{kA^2}{2}\right) = -kA^2 \tag{5}$$

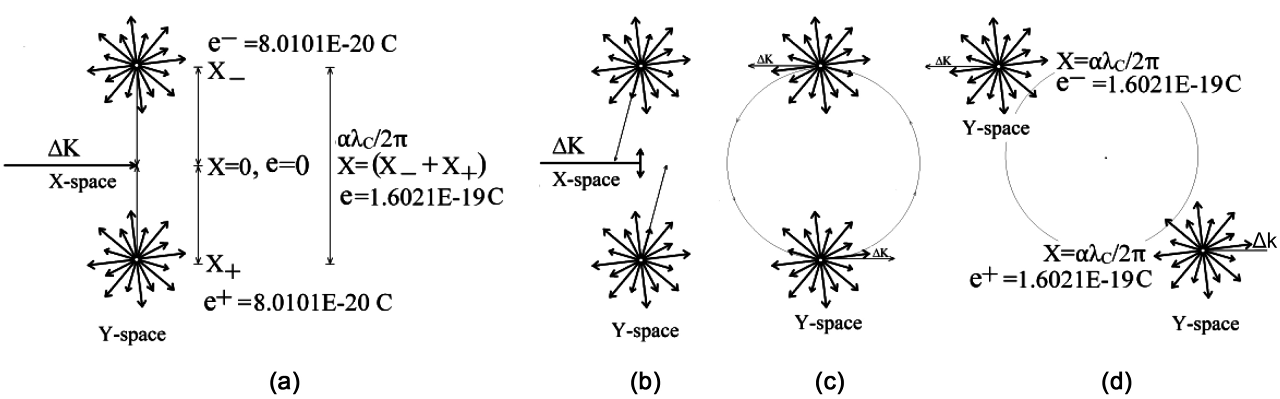

Figure 4. A 1.022 MeV photon decoupling into an electron-positron pair.

It was established in [31] that even though the energy of localized photons is established with traditional equation $E = hc/\lambda$, λ being the distance that a photon travels while one of its transverse electromagnetic cycles is completed, the transverse amplitude A of this oscillation on the transverse plane will be, with reference to **Figure 4(a)**:

$$x = A = \frac{\alpha\lambda}{2\pi} \tag{6}$$

And that the energy E of any related electromagnetic quantum can be resolved by any of the following relations, the last relation of which having been also established in [31], then the energy related to the electron Compton wavelength λ_C will be:

$$E_C = h\nu_C = \frac{hc}{\lambda_C} = \frac{e^2}{2\varepsilon_0\alpha\lambda_C} = 8.187104139\text{E}-14\ \text{j} \tag{7}$$

This is what allowed establishing the *electrostatic elastic recall constant k* for this photon from Equation (5) in the following manner via a method different from that used in 2013 [30], using the definition of the amplitude A obtained from Equation (6) and the rest mass energy of the electron obtained with Equation (7):

$$k = -\frac{E_C}{A_C^2} = -\frac{8.187104139\text{E}-14}{\left(\alpha\lambda_C/2\pi\right)^2} = -1.031019177\text{E}16\ \text{j/m}^2 \tag{8}$$

Thus, as illustrated in **Figure 4(a)**, as the oscillating half of the photon's energy begins to move away from the neutral $x = 0$ position to reach its maximum amplitude $x = A = \alpha\lambda/2\pi$, a force named *the restoring force* in Hooke's law, because it is exerted in the direction opposite to the displacement—hence the minus sign in Equation (8) and in the following Equation (9)—begins to apply and reaches its maximum intensity at the maximum amplitude of the transverse oscillation, that is, a *restoring force* that will inevitably tend to bring the two charged components back toward the neutral electric amplitude $x = 0$ in Y-space, and whose energy will have momentarily completely evacuated Y-space while simultaneously reaching its maximum magnetic *presence* in Z-space:

$$F = -kx = -k\cdot\frac{\alpha\lambda_C}{2\pi} = -29.05350473\ \text{Newtons} \tag{9}$$

How can we now verify that this figure is correct? Since force F is proportional to kx in Equation (9), and that it was calculated with an amplitude $A = \alpha\lambda_C/2\pi$ which is very precisely 137.0359998 times shorter than the amplitude related to the electron's Compton wavelength $\lambda_C/2\pi$, if we multiply Equation (9) by α once, we will get the force applicable to the longer amplitude distance related to the electron's Compton wavelength λ_C:

$$F\cdot\alpha = -k\cdot\alpha^2\lambda_C/2\pi = -0.212013666\ \text{Newtons} \tag{10}$$

Now, the numerical figure obtained with Equation (10) is not really familiar and does not really provide so obvious a confirmation that the figure obtained with Equation (9) is valid. But we know that all frequencies related the stable states in atoms are quantized in an increasing scale of precise resonance frequencies, so it could be expected, assuming at this point that α might precisely be the required frequency multiplier involved, that repeating the multiplication process should eventually hit upon a force value which is familiar, which would then really confirm the validity of the starting Equation (9).

About this increasing sequence of resonance frequencies/wavelengths, we know also that the energy induced at the Bohr atom rest orbit is equal to the electron rest mass energy multiplied by α^2. Since force is proportional to energy, we can further find the force associated with the oscillation amplitude of the energy of a photon of same energy as that induced at the Bohr rest orbit by further multiplying by α^2:

$$F \cdot \alpha \cdot \alpha^2 = -k \cdot \alpha^4 \lambda_C / 2\pi = -1.12900148\text{E}-5 \text{ Newtons} \tag{11}$$

But this photon is obviously moving at velocity *c*. We know also that force is proportional to velocity, and we know further that the theoretical velocity at the mean Bohr rest orbit is equal to *c* multiplied by *α*. Consequently, a final multiplication by α should provide the well known force associated to the distance at which the electron stabilizes from the proton when captured in the hydrogen atom ground state orbital, whose mean distance from the proton is precisely the Bohr radius:

$$F \cdot \alpha \cdot \alpha^2 \cdot \alpha = -k \cdot \alpha^5 \lambda_C / 2\pi = -8.238721808\text{E}-8 \text{ Newtons} \tag{12}$$

Which tentatively confirms, as initially calculated in [30], that *electrostatic recall constant k* = −1.031019177E16 j/m² calculated with Equation (8) would apply to all charges in existence, be they the pair of varying intensity charges oscillating within localized photons or separated stabilized pairs of charges such as the electron, the positron, the stabilized fractionary charges of the inner scatterable subcomponents of protons and neutrons, or the charge of the electron and the composite charge of the proton within a hydrogen atom, and even the pairs of varying intensity neutrinic charges oscillating within stabilized electron and positron masses.

3.2. The Origin of the Coulomb Force

Ever since the Coulomb force was discovered in relation with the discovery of electrostatic attraction between opposite signs charges and repulsion between same sign charges, the question remained open as to the ontological cause of the Coulomb force.

As analyzed in [32] the repulsion between same sign charges can be neglected at the macroscopic level between elementary particles, since the energy induced in these particles decreases to such an extent as they move away from each other that the effect of such repulsion becomes infinitesimal and imperceptible at the macroscopic level between any pair of such particles. Therefore, only the energy growing with decreasing distances between opposite charges provided by the

Coulomb restoring force established in the previous section will be considered for the rest of our analysis. As an example of how negligible at our macroscopic level electrostatic repulsion between same sign charged particles really is, we only need to touch our thumb with our index finger to become aware that this *touching contact* involves the mutually repelling electrons of the outer layers of the atoms of which both fingers are made.

If one considers that even at our macroscopic level, when stretching an elastic cord, for example, the *restoration force* begins to exist only when the elastic cord begins to be stretched, even slightly, from its unstretched resting state, and that such a moment of zero tension also exists during the constant oscillating motion of the photon energy, one can also consider that the *Coulomb restoring force* involved may also not exist during that fleeting moment in which the transverse amplitude x is momentarily equal to zero in Y-space, as illustrated in **Figure 4(a)**, while the oscillating energy is simultaneously momentarily immobilized in maximum presence in magnetostatic Z-space.

This opens the door to considering the possibility that the *Coulomb force* could not even exist without the prior existence of the *fundamental electromagnetic energy substance*, and that its cause could be related to the intrinsic properties of this energy *substance*. The 4 properties identified in [33] and [34] that this *fundamental substance* must have to allow a mechanical explanation of the behavior of localized photons, turn out to be essential for the existence of the *Coulomb force* to even be possible. They are a property of *elasticity*, that allows the substance to stretch and contract due to a property of *fluidity*, without its volume varying, due to a property of *incompressibility*, and a property of *tending-to-always-remain-in-motion* that renders it physically unable to remain immobile.

As analyzed in depth in [35] [36] [37], the first step for a pulse of magnetic energy ejected from a fixed length dipole antenna to set itself in motion, can only be for half of this energy to self-orient transversely to the other half—a *half-half* partitioning, for symmetry considerations—in order to provide the required *ds* fulcrum for the other half to press against and propel the transverse half in vacuum, which only an intrinsic property of the *energy substance* such as a *tendency-to-always-remain-in-motion* can logically trigger. As confirmed mathematically in [36] [37] [38], this symmetric half-and-half division between a longitudinally oriented *propulsive* energy component ΔK and a transversely oriented *propelled* energy component already establishes *the absolute invariance of the speed of light in vacuum*—see Equation (14) below.

As the magnetic pulse began to self-distribute in two equal parts by causing some of its substance to move in a transverse direction, the motion of this transversely oriented energy could proceed only by self-distributing as two quantities moving in opposite directions—again due to symmetry considerations, thus initiating the elastic stretching represented in vectorial Y-space illustrated with **Figure 4(a)**.

This distribution as *two quantities elastically moving away from each other* immediately triggers the coming into being of a *restoring force* related to an *increasing elastic return intensity* that will reach the constancy of the *k* level when the maximum amplitude of the oscillation is reached, an intensity that universally stabilizes at the maximum level of exactly e = 1.602176462E−19 Coulomb for a separating pair, which is the maximum charge intensity attained for all electrons and positrons in the universe as each pair decouples, physically separating into equal parts the entire 1.022 + MeV energy of the photon from which they originated, and which then remains at this maximum return intensity for all electrons and positrons in the universe, as illustrated in **Figure 4(d)**. It could even be considered that the unit charge of electrons and positrons is nothing other than *the fundamental elastic recall constant intensity of the universe*.

As they reached maximum transverse separation, due to the *incompressibility* property of its substance, and the requirement for motion now having been satisfied for the ΔK momentum energy half, and given that longitudinal motion is now forbidden for the two energy components now in motion of the transverse energy half, the only avenue for it to continue obeying its *tendency-to-always-remain-in-motion* turns out to start symmetrically moving backwards towards the common center-of-presence that they share with the now fully extended momentum energy component, and the only mechanical way that the *incompressible* volume of the returning energy substance will allow it to continue moving will be for it to start moving symmetrically in a third direction by expanding omnidirectionally as an energy sphere in what is represented by the vectorial Z-space of **Figure 3(c)**.

Having then completely evacuated Y-space as its amplitude reaches zero in this space and its volume reaches maximum in Z-space, to continue moving, the energy will then start moving back to Y-space as the two separate elements moving away from each other illustrated with **Figure 4(a)**, initiating the second cycle of the now established LC oscillation of the electromagnetic energy quantum, moving at speed c in the vacuum of normal X-space, whose *set of centers-of-presence* of all existing photons establishes a *level* 0 trispatial vector field weakly interacting with each other, and moving at the speed of light in all directions in the universe.

Any trispatial photon of level 0 reaching the threshold intensity of 1.022 MeV is then likely to decouple into an electron-positron pair as represented in **Figure 4**, whose *set of* 1.602176462E−19 *Coulomb intensity level centers-of-presence* would establish *two opposite trispatial vector fields*, *one on either side of the zero level field*, each element of which constantly seeks to join any 1.602176462E−19 Coulomb-level element of the opposite level 1 field with the recall intensity established with Equation (8), thus defining *a trispatial gravitational field of level* 1 *trispatial vector complexes*, each element of which being accompanied by a *level* 0 photon induced by the Coulomb interaction that allows it to move or apply pressure depending on the energy level of this photon and of the local electromagnetic equilibrium. The *level* 2 *trispatial vector complexes* of the stable trispatial gravitational field will be described later.

It could thus be tentatively concluded that the very existence of the Coulomb restoring force could be due to the ontological existence of this property of the fundamental *energy substance* of *always-tending-to-remain-in-motion*.

3.3. The Decoupling of 1.022 MeV Photons

Figure 4(b) illustrates the beginning of the destabilization process of the return motion of the two charged elements towards each other that prevents them from directly returning toward each other as illustrated in **Figure 4(a)**, to initiate the usual transfer process to Z-space. This deflection of their return trajectories initiates an orbital motion around the *center-of-presence* of the photon that will inexorably drive them to reach a circular escape orbit, as analyzed in [29], *i.e.*, a motion sustained by the momentum energy ΔK of the photon that gradually transfers into Y-space to provide the increased energy needed to establish this circular orbit, which will be established when both elements simultaneously reach the speed of light in that orbit, as shown in **Figure 4(c)**, at which point they will separate to move separately into X-space, sharing the remaining energy of the initial photon, as shown in **Figure 4(d)**. The complete mechanical decoupling cycle of the initial photon is analyzed in depth in [29].

This confirmed conversion of freely moving electromagnetic photons into massive charged elementary particles, first observed by Anderson in 1933 [19], is what confirmed the electromagnetic nature of the energy of which their mass is made, a confirmation that directly invalidated the conclusion reached by the community in 1907, according to which the electron was only a mass in the kinematic sense of the term as defined in classical mechanics, and brought to light the fact that this invariant rest mass energy was then also likely to be represented as a half corresponding to an invariant $\boldsymbol{E}$-field, given the invariance of its unit charge, while the other half could only correspond to an oscillating $\boldsymbol{B}$-field—oscillating, given that no other portion of the total amount of energy of the invariant rest mass of the electron remains available to explain the oscillation frequency related to the known Compton electron wavelength (λ_c)—*i.e.*, a magnetic $\boldsymbol{B}$-field as discovered by Marmet in 2003 [28] and whose oscillation was experimentally confirmed by similarity with the experiment published in 2013 [38], and directly confirmed with interacting electrons with the experiment by Kotler *et al.* of 2014 [39].

A first telltale as to which direction should be investigated to allow establishing this mechanical conversion illustrated by **Figure 4** was provided by Louis de Broglie when he concluded in 1937 that 3D/4D space geometry was too restrictive to allow exactly describing and explaining the existence of elementary particles:

"…*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.*" Louis de Broglie 1937 ([40], p. 273).

"…*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.*"

It so happens that the conditions established by de Broglie in the 1930's for all symmetry requirements to be respected and for Maxwell's equations to be complied with, can be satisfied for localized electromagnetic quanta if the self-sustaining oscillation occurs on *a plane perpendicular to the direction of motion of the energy in space*, a plane already hinted at by the traditional plane wave treatment of energy (**Figure 5(a)**), and that did not require an elastic medium in which to propagate, if related to an amount of momentum energy that would provide for the propagation of the transversely oriented energy quantum that would be oscillating in standing mode.

Let us recall that plane wave treatment in the traditional spherical expanding

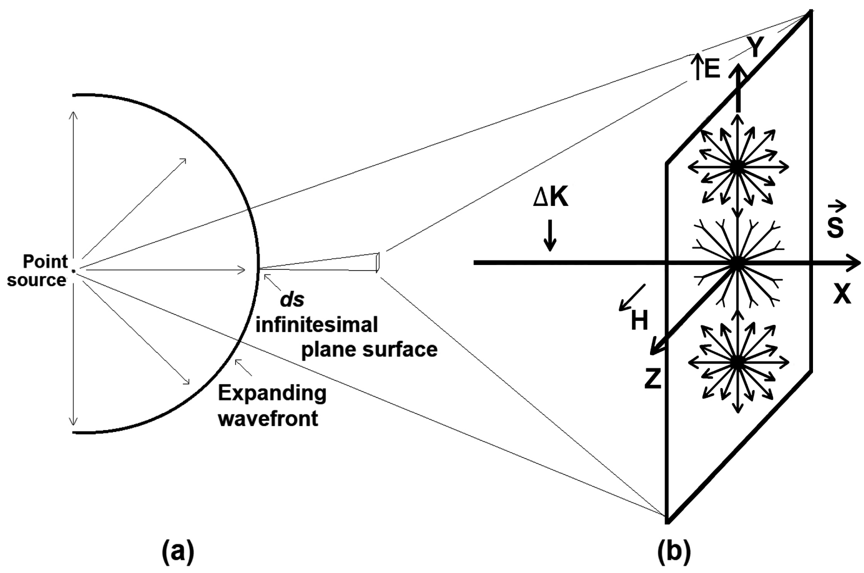

Figure 5. Comparison between traditional plane wave treatment of the energy of an electromagnetic energy pulse that would be spherically expanding in an underlying medium (the aether) from its point of emission (**Figure 5(a)**), and treatment of the same energy pulse remaining localized as it propagates without spherically expanding, requiring no underlying medium according to Einstein's conclusion [41] and de Broglie's conditions [40] (**Figure 5(b)**).

wave perspective involves treating an infinitesimally small *ds* surface section of the wavefront, assumed flat due to the infinitesimal curvature of such a small portion of the surface of a sphere, to calculate the same amount of energy emitted at the point-like source of the wave (**Figure 5(a)**), as if it was not spherically distributed. This method mathematically provides the same amount of energy emitted at the source and measured at its point of absorption as if the emitted energy quantum had remained localized all the way to its point of absorption (**Figure 5(b)**).

"*Es scheint mir nun in der Tat, daß die Beobachtungen über die* '*schwarze Strahlung*', *Photolumineszenz, die Erzeugung von Kathodenstrahlen durch ultraviolettes Licht und andere die Erzeugung bez. Verwandlung des Lichtes betreffende Erscheinungsgruppen besser verständlich erscheinen unter der Annahme, daß die Energie des Lichtes diskontinuierlich im Raume verteilt sei. Nach der hier ins Auge zu fassenden Annahme ist bei Ausbreitung eines von einem Punkte ausgehenden Lichtstrahles die Energie nicht kontinuierlich auf größer und größer werdende Räume verteilt, sondern es besteht dieselbe aus einer endlichen Zahl von in Raumpunkten lokalisierten Energiequanten, welche sich bewegen, ohne sich zu teilen und nur als Ganze absorbiert und erzeugt werden können.*" Albert Einstein, 1905 ([41], p. 133).

"*In fact, it seems to me that the observations on* '*black-body radiation*', *photoluminescence, the production of cathode rays by ultraviolet light and other phenomena involving the emission or conversion of light can be better understood on the assumption that the energy of light is distributed discontinuously in space. According to the assumption considered here, when a light ray starting from a point is propagated, the energy is not continuously distributed over an ever increasing volume, but it consists of a finite number of energy quanta, localized in space, which move without being divided and which can be absorbed or emitted only as a whole.*"

In **Figure 5(b)**, the vector representation is a freeze of the motion of the oscillating energy at step **d** of **Figure 6** halfway crossed over into Y-space coming from Z-space. In this case the condition $\nabla \cdot \boldsymbol{B} = 0$ always applies by structure since

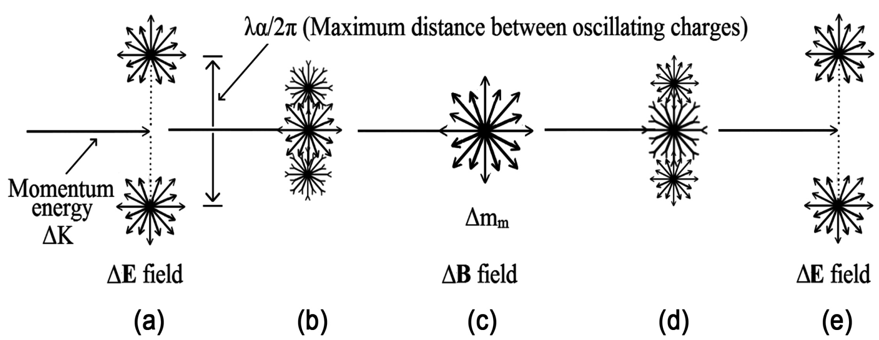

Figure 6. Representation of the stationary transverse oscillation cycle of the oscillating electromagnetic half-quantum of a free moving photon or of the carrier-photon of an electron.

all of the photon energy remains contained within its local oscillating volume, its source always remaining local to the position of the photon all along its trajectory.

This solution emerged from the long established invariant triple vectorial orthogonality of the vector cross product of the ***E*** and ***B*** vectors which is so fundamental in electromagnetism (**Figure 3(a)**). When the ***j*** and ***k*** minor unit vectors of *normal space* representing the ***E*** and ***B*** fields are *expanded* into becoming *fully developed major* 3*D vectorial spaces* represented by ***J*** and ***K*** *major unit vectors*, each possessing its own internal ***ijk*** *minor unit vectors set*, a *fully developed major* 3*D vectorial normal space*, represented by a *major unit vector* ***I*** emerges by vectorial cross product of the major vectors ***J*** and ***K***, that also maintains its usual *internal set of minor* ***ijk*** *unit vectors* (**Figure 3(b)** and **Figure 3(c)**).

Thus comes into being for visualization purposes the 3 × 3D + 1 expanded vector space that underlies the trispatial model, the +1 element representing of course the time dimension. Suffices then to open the 3-ribs umbrellas one at a time to visualize in sequence the motion of the energy substance as it circulates within each 3D vectorial spaces of the set.

The common punctual origin of the three orthogonal vector spaces then becomes an infinitesimal dV volume through which the energy of the quantum, now perceived as a physically existing local amount of *substance*, can now transit between the three spaces as if they were communicating vessels, to establish the equilibrium state required by symmetry, and whose infinitesimal ds cross section serves as a fulcrum against which the momentum energy of the quantum can apply its *pressure* to cause motion of the transversely oscillating half when the local electromagnetic environment allows it.

This entirely new vectorial space geometry effectively allowed logically representing not only free moving photons, but also to mechanically explain how such photons of sufficient energy can decouple into pairs of electron-positron as illustrated with **Figure 4** [29], and also to mechanically explain how triads of sufficiently thermal electrons and positrons can accelerate to stabilize as the most energetic triads of elementary electromagnetic particles configurations that can exist in the universe, that is, protons and neutrons [42], represented as *level* 2 vectorial complexes in the universal trispatial vector field in **Section 8**.

The development of the trispatial vector complex is what allowed the development in [33] [34], of the first LC equation of internal electromagnetic mechanics of the photon (13) in conformity with the conditions identified by Louis de Broglie as being required for localized photons to satisfy both the Bose-Einstein statistic and Planck's law, and perfectly explain the photoelectric effect while respecting Maxwell's equations and remaining consistent with the properties of Dirac's theory of complementary corpuscle symmetry ([40], p. 277):

$$E\vec{I}\,\vec{i} = \left(\frac{hc}{2\lambda}\right)_X \vec{I}\,\vec{i} + \left[2\left(\frac{e^2}{4C}\right)_Y \left(\vec{J}\,\vec{j}, \vec{J}\,\vec{j}\right)\cos^2(\omega t) + \left(\frac{Li^2}{2}\right)_Z \vec{K}\sin^2(\omega t)\right] \quad (13)$$

4. The Establishment of the Electromagnetic Mechanics of Elementary Particles

The first step in preparation for the harmonization of kinematic and electromagnetic mechanics according to Wien's project [7] consisted of course in reversing the consequences of the 1907 decision that led to the adoption of the incomplete theory of Special Relativity, and in finally taking into account the electromagnetic behavior of the electron observed and measured during Kaufmann's experiments.

The particularity of this observed electromagnetic behavior of the electron, compared to its previously accepted kinematic behavior, is that its transversely measurable mass increases with velocity, an increase that becomes measurable only when velocities reach more than 2000 km/s, velocities that were largely exceeded in the Kaufmann bubble chamber.

What allowed reversing this long established perspective was the publication, shortly after the trispatial geometry was presented at Congress-2000 [43], of Paul Marmet's article in 2003 [28] in which he derived an equation from the Biot-Savart equation, that confirmed that the energy of the magnetic field of an accelerating electron, known to increase with velocity, was in fact the same energy that was measured as the increasing electron mass as measured from the data collected by Kaufmann [1] [2] [3] [4].

This discovery allowed separating for the first time the velocity related $\Delta\boldsymbol{B}$ magnetic field increment of the accelerating electron from the invariant $\boldsymbol{B}_e$ field of its invariant rest mass in an article published in 2007 [31] and observing that the electron carrying energy had the very same electromagnetic structure as Equation (13) for free moving photons. The only difference being that in the case of the electron carrying energy, its momentum component was *propelling* the inert rest mass of the electron in addition to also propel its own $\Delta\boldsymbol{B}$ field related Δm_m complement inert mass, which is what forever prevents the electron from reaching the speed of light, because the energy ratio $\Delta K/(\Delta m_m c^2 + m_0 c^2)$ can never reach unity as in the case of Equation (13), in which the energy ratio $\Delta K/\Delta m_m c^2$ is invariably equal to 1/1, which is what sets the velocity of light as an asymptotic velocity limit for all massive elementary particles, as established with Equation (14) defined in [37]:

$$v = c\frac{\sqrt{4ax + x^2}}{2a + x} = c\frac{\sqrt{0 + x^2}}{0 + x} = c\frac{\sqrt{x^2}}{x} = c\frac{x}{x} = c \quad (14)$$

In which a represents the energy in joules of the electron's rest mass ($E = m_0 c^2 = 8.18710414\text{E}{-}14$ j) and x represents the energy in joules of its carrying energy. This equation provides the relativistic velocity of the electron on the full scale of relativistic velocities without any need to use Lorentz's γ factor, and in which, if the energy of the electron's rest mass a is set to zero, then it will provide the light-invariant velocity of its carrier-photon as if now moving freely as an isolated electromagnetic photon. The first step of the kinematic-electromagnetic harmonization thus involved the incorporation into the equations of kinematic mechanics of the energy that contributes to the transverse increase of the mass of the moving electron.

This first step was accomplished by incorporating this magnetic energy into Newton's kinetic energy equation $\Delta K = 1/2 m_0 v^2$ in order to account for the entire energy induced by the Coulomb interaction in Kaufmann's experiments in an article published in 2013 [37], *i.e.*, the electron momentum energy plus the transverse magnetic energy induced simultaneously.

Equation (14) was established precisely as an outcome of this conversion, that first involved converting Newton's kinetic energy equation to its electromagnetic version in [37], using as a confirming numerical example the well known wavelength of the energy induced at the Bohr radius of the hydrogen atom as a reference, that happens to provide the mean energy induced in the ground state electronic orbital of the hydrogen atom:

$$\Delta K = \frac{hc}{2\lambda_B} = \frac{mv^2}{2} = 2.179871902\text{E}-18 \text{ Joules} \tag{15}$$

The missing magnetic energy component induced in the electron at the Bohr radius distance from the proton was then added to the electromagnetic version of the kinetic energy equation:

$$\Delta E = \frac{mv^2}{2} + \Delta m_m c^2 = \frac{hc}{2\lambda} + \frac{L_\lambda i_\lambda^2}{2} \tag{16}$$

And finally, by combining LC Equation (13) for the photon developed in [30] with LC Equation (31)—shown further on—for the rest mass of the electron, developed in Reference [29], Equation (17) was obtained, providing both the trispatial kinematic energy momentum equation and its electromagnetic version:

$$E = \frac{mv^2}{2} + \Delta m_m c^2 + m_0 c^2 = \frac{hc}{2\lambda} + \frac{L_\lambda i_\lambda^2}{2} + \frac{hc}{2\lambda_C} + \frac{L_{\lambda_C} i_{\lambda_C}^2}{2} \tag{17}$$

The process of integrating the electromagnetic versions of all three kinematic components of Equation (17) into a single ratio of unidirectional energies over magnetic energies, to isolate a squared velocities ratio in line with Marmet's Equation (30) led to the following form in [37]:

$$\frac{(hc)^2 (4\lambda + \lambda_C)}{\lambda_C \lambda^2 \left(2L_C i_C^2 + L_\lambda i_\lambda^2\right)^2} = \frac{v^2}{c^2} \tag{18}$$

from which Equation (14) was derived, as well as Equation (19), from which the Lorentz γ-factor was derived for the first time in history in [37] from an electromagnetic equation, thus demonstrating that the gamma factor is naturally embedded in all electromagnetic equations, and is related to the non-rectilinear variation of the energy adiabatically induced in all elementary charged particles by the Coulomb interaction and has consequently no relation whatsoever with the time dilation and/or mass length contraction assumed as a premise in the SR theory.

$$\frac{4\lambda\lambda_C + \lambda_C^2}{\left(2\lambda + \lambda_C\right)^2} = \frac{v^2}{c^2} \tag{19}$$

These developments then allowed the establishment of the uninterrupted series of interaction sequences between elementary charged particles that provide an uninterrupted sequence of causality between the two sets of kinematic and electromagnetic equations for all mechanical energy conversion processes:

1) From the quantities of unidirectional kinetic energy that constitute the momentum of elementary charged and massive particles and their electromagnetic complement, both induced simultaneously and adiabatically in each charged particle by the Coulomb interaction, whose mechanics is analyzed in [16] and [17].

2) To the release as a free-moving electromagnetic photon of any quantity of this energy that becomes in excess of the precise amount allowed by some stable or metastable electromagnetic equilibrium state in atoms, for example, when an electron becomes captive of the resonance state of an atom's available orbital after having accelerated to reach this equilibrium state, whose emission and absorption trispatial mechanics are analyzed in [35] and [36].

3) To the creation of electron-positron pairs from the destabilization of free moving photons of energy 1.022 MeV or more, whose mechanics is analyzed in [29].

4) To the creation of protons and neutrons from the interaction of thermal triads of electrons and positrons in volumes of space sufficiently small and with insufficient energy to escape mutual capture, whose mechanics of stabilization is analyzed in [42].

5) To the final shedding in the form of neutrino energy of momentary metastable excess mass—different from velocity related momentary relativistic mass increment—as overexcited newly created massive elementary particles are forced by local electromagnetic equilibrium states into reaching their lowest possible and henceforth stable and invariant electron or positron rest mass, whose trispatial mechanics of emission is analyzed in [44].

5. Establishment of the Relation between the Energy of the Magnetic Field and the Energy of the Electron Mass

It was only after Paul Marmet established the relation between the variable magnetic field of the moving electron and its variable mass in 2003 that Maxwell's original interpretation was again brought to the fore as being required to mechanically explain this relation [28], because it implies by structure that the $\boldsymbol{E}$ and $\boldsymbol{B}$ fields must induce each other in alternance, since it is not physically possible for the $\Delta\boldsymbol{B}$ field, revealed by Marmet's derivation as being induced simultaneously with the $\Delta\boldsymbol{K}$ momentum energy, not to be accompanied by a $\Delta\boldsymbol{E}$ field with which it would alternate, to account for the oscillating frequency of this carrier energy, a process which must involve by structure the *displacement current* that Maxwell conceived of as being involved on the $\boldsymbol{E}$ side of the relationship, that would induce the magnetic field $\boldsymbol{B}$ increasing to its maximum intensity while the $\boldsymbol{E}$ field reduces to zero, followed by the re-establishment of the *displacement current* of the $\boldsymbol{E}$ field as the $\boldsymbol{B}$ field reduces to zero in turn, thus initiating the individual LC electromagnetic cycle of the corresponding frequency.

This means, since the Coulomb interaction—linked to the first Maxwell equation by the relation $e\boldsymbol{E}$—which is known to induce in each charged particle twice the energy of its momentum, that:

$$\Delta E = d \cdot F = d \cdot q\boldsymbol{E} = d \cdot q_1 \frac{q_2}{4\pi\varepsilon_0 d^2} = d \cdot \frac{q_1 q_2}{4\pi\varepsilon_0 d^2} = \frac{q_1 q_2}{4\pi\varepsilon_0 d} = \frac{e^2}{2\varepsilon_0 \alpha\lambda} \tag{20}$$

in which $d = x = A = \alpha\lambda/2\pi$ (ref: Equation (6)).

That is, the ΔK momentum energy provided for by the traditional relativistic equation for calculating momentum energy:

$$\Delta K = m_0 c^2 (\gamma - 1) \tag{21}$$

plus the $\Delta m_m c^2$ magnetic mass increment revealed by Marmet's derivation, which is also equal by structure to the same relation:

$$\Delta m_m c^2 = m_0 c^2 (\gamma - 1) \tag{22}$$

Which means, as observed in [37], that in line with Equation (20), the total energy induced in an electron at any velocity will be equal to:

$$\Delta E = \Delta K + \Delta m_m c^2 = 2 m_0 c^2 (\gamma - 1) \tag{23}$$

This involves that half of the energy induced in each elementary charged particle by the Coulomb interaction self-transposes by structure transversely to the direction of application of its momentum energy, a transversely oriented half that will then start oscillating on its own between an electric state $\Delta\boldsymbol{E}$ and a magnetic state $\Delta\boldsymbol{B}$ that provide the relativistic mass increment—*i.e.* the sum of the instantaneous energies represented by $\Delta\boldsymbol{E} + \Delta\boldsymbol{B}$, or the energy of $\Delta\boldsymbol{E}$ or $\Delta\boldsymbol{B}$ at maximum intensity, that is, a mass increment Δm_m—which is added to the rest mass m_0 of the particle, a sum that turns out to be the total mass propelled at a given relativistic velocity determined by the simultaneously induced relativistic momentum energy ΔK.

Marmet's discovery that the $\boldsymbol{B}$-field of the electron's rest mass energy is only half of the energy of its rest mass then led to further derivations that allowed understanding that the $\boldsymbol{B}$-field of the second term of the Lorentz force equation is the sum of the invariant $\boldsymbol{B}_e$-field of the electron's rest mass energy, plus the variable $\Delta\boldsymbol{B}$ field of its carrying energy, that oscillates in alternating motion with the associated $\Delta\boldsymbol{E}$ field on planes transverse to the direction of motion of the electron, this associated $\Delta\boldsymbol{E}$ field itself being in vector cross product relation with the invariant $\boldsymbol{E}_e$ field of the electron's rest mass energy, which means that the Lorentz force equation:

$$F = q(\boldsymbol{E} + \boldsymbol{v} \times \boldsymbol{B}) \tag{24}$$

can be amended to the following form to describe a straight line motion of particle q:

$$F = q\left[\left(\boldsymbol{E}_e \times \Delta\boldsymbol{E}\right) + \boldsymbol{v} \times \left(\boldsymbol{B}_e + \Delta\boldsymbol{B}\right)\right] \tag{25}$$

Let us note at this point, that it is the equal density by structure of the $\Delta\boldsymbol{E}$ and the $\Delta\boldsymbol{B}$ carrying-energy components—since it is the same amount of energy that oscillates between the two states—as they reach in alternance their maximum intensity—that causes the default straight line motion of charged particles. What causes curved trajectories of elementary particle beams that can be calculated with the Lorentz force equation is the addition of external $\boldsymbol{B}$ fields established in the environment of the moving charged particle beams, that add their energy to the $\Delta\boldsymbol{B}$ field component of the carrier-photon of the particle induced by the Coulomb interaction, thus causing the default 1/1 equal $\Delta\boldsymbol{E}/\Delta\boldsymbol{B}$ energy density ratio to drift in favor of the density ratio $\Delta\boldsymbol{E}/(\Delta\boldsymbol{B} + \boldsymbol{B}_{\text{external}})$ that applies a transverse force favoring the magnetic force at the expense of the force exerted by the electric force, which is what causes these curved trajectories.

Let us also note that the $\boldsymbol{E}_e$ and $\boldsymbol{B}_e$ fields accounting for both halves of the invariant rest mass of the electron that are also part of the Lorentz force Equation (25), for calculation requirement, play no role in guiding the electron, since they represent the omnidirectionally inert transverse energy of the invariant rest mass of the electron.

This led to the establishment and publication in 2007 [31] of the first level equations of these two separate magnetic fields from the specific wavelengths of the separate energy quanta involved:

$$\boldsymbol{B}_e = \frac{\mu_0 \pi e c}{\alpha^3 \lambda_C^2}, \quad \Delta\boldsymbol{B} = \frac{\mu_0 \pi e c}{\alpha^3 \lambda^2} \tag{26}$$

whose sum provides the first level composite $\boldsymbol{B}$-field usable in the Lorentz force Equation (24) to guide electrons on straight line trajectories (The establishment of the composite $\boldsymbol{B}$ field defining curved trajectories will be addressed in **Section 9**):

$$\boldsymbol{B} = \boldsymbol{B}_e + \Delta\boldsymbol{B} = \frac{\pi \mu_0 e c\left(\lambda^2 + \lambda_C^2\right)}{\alpha^3 \lambda^2 \lambda_C^2} \tag{27}$$

Similarly, the corresponding first level invariant $\boldsymbol{E}_e$ field of the other half of the rest mass energy of the electron and the variable $\Delta\boldsymbol{E}$ field of its carrying energy could be separated in [31]:

$$\boldsymbol{E}_e = \frac{\pi e}{\varepsilon_0 \alpha^3 \lambda_C^2}, \quad \Delta\boldsymbol{E} = \frac{\pi e}{\varepsilon_0 \alpha^3 \lambda^2} \tag{28}$$

whose vectorial cross product—given that their energies are oriented perpendicular to each other within electrostatic Y-space, the $\boldsymbol{E}_e$-field energy being oriented in the Y-x direction and the $\Delta\boldsymbol{E}$-field energy being oriented in the Y-y direction—provides the first level composite $\boldsymbol{E}$-field component used in the Lorentz force Equation (24) in relation with the same density $\boldsymbol{B}$-field to guide electrons on straight line trajectories:

$$\boldsymbol{E} = \boldsymbol{E}_e \times \Delta\boldsymbol{E} = \frac{\pi e}{\varepsilon_0 \alpha^3} \frac{\left(\lambda^2 + \lambda_C^2\right)\sqrt{\lambda_C\left(4\lambda + \lambda_C\right)}}{\lambda^2 \lambda_C^2 \left(2\lambda + \lambda_C\right)} \tag{29}$$

Then, from the electromagnetic definition of the invariant magnetic rest mass M_0 of the electron, amounting to exactly half the invariant m_0 mass of the electron, that emerged from Marmet's so critically important Equation (30), numbered "Equation 23" in his article [28]:

$$M = \frac{\mu_0 e^2 v^2}{8\pi r_e c^2} = \frac{m_e}{2}\frac{v^2}{c^2} \quad \text{leading to} \quad M_0 = \frac{\mu_0 e^2}{8\pi r_e} = \frac{m_e}{2} \tag{30}$$

an LC equation could be derived in [29] to describe both the invariant electric energy corresponding to the electric charge localized in Y-space and the invariant energy transversely oscillating between spaces X and Z corresponding to the magnetic field of the invariant rest mass of the electron:

$$E = m_e c^2 = \left(\frac{hc}{2\lambda_C}\right)_Y + \left[2\left(\frac{(e')^2}{4C_{\lambda_C}}\right)_X \cos^2(\omega t) + \left(\frac{L_{\lambda_C} i_{\lambda_C}^2}{2}\right)_Z \sin^2(\omega t)\right] \tag{31}$$

And for its carrying energy, an LC equation identical to Equation (13) previously derived for free moving photons could also be derived, representing its momentum energy residing in X-space while its magnetic energy oscillates between spaces Y and Z:

$$E = \left(\frac{hc}{2\lambda}\right)_X + \left[2\left(\frac{e^2}{4C}\right)_Y \cos^2(\omega t) + \left(\frac{Li^2}{2}\right)_Z \sin^2(\omega t)\right] \tag{32}$$

This is what allowed understanding that the varying carrying-energy of the electron in motion had the exact same electromagnetic structure as localized free moving photons, whose internal electromagnetic structure was hypothesized by Louis de Broglie in the 1930's in [40], hence the name of *carrier-photon* given afterwards to the carrying energy of the electron in numerous other articles of the electromagnetic mechanics project.

As previously mentioned, this development in turn allowed logically converting Newton's non-relativistic momentum kinetic energy equation:

$$\Delta K = \frac{1}{2} m_0 v^2, \quad v = \sqrt{\frac{2 \cdot \Delta K}{m_0}} \tag{33}$$

to its electromagnetic equivalent by integrating the missing magnetic energy component revealed by Marmet's revolutionary Equation (30) in the establishment of LC equations (13) and (31):

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

From which, two equations were derived in [37] that provide the full range of relativistic electron velocities from the theoretical zero m/s velocity to near the asymptotic limit for massive particles of the speed of light, either from the wavelengths of the energy of the rest mass of the particle and of its carrier-photon, or directly from the corresponding energy quanta in joules:

$$v = c\frac{\sqrt{\lambda_C\left(4\lambda + \lambda_C\right)}}{2\lambda + \lambda_C}, \quad v = c\frac{\sqrt{4EK + K^2}}{2E + K} \tag{35}$$

In the same reference, was established the fact that the magnetic $\Delta\boldsymbol{B}$-field energy increment that accounts for the velocity related mass increment Δm_m observed in Kaufmann's data, is always equal in quantity to its ΔK accompanying relativistic momentum energy amount, that can be calculated with the traditional relativistic kinetic energy Equation (21), which means that the instantaneous relativistic mass of the moving electron can easily be calculated without using the γ-factor, simply by dividing by 2 the $\Delta\boldsymbol{E}$ amount of carrying energy calculated with Equation (20), or setting it as equal to ΔK or calculating it with Equation (21) by direct identity with the energy calculated for ΔK:

$$m = m_0 + \Delta m_m = m_0 + \frac{\Delta E}{2c^2} \tag{36}$$

and that the corrected energy-momentum equation that accounts for both the relativistic momentum energy and the related relativistic mass increment to be added to the rest mass of the electron can be represented by the following equation, by simply adding the total amount of energy ΔE induced in the electron calculated with Equation (23) to the invariant rest mass energy m_0c^2 of the electron, to establish the simplified trispatial energy-momentum equation:

$$E_e = \Delta E + m_0c^2 = \Delta K + \Delta m_m c^2 + m_0c^2 \tag{37}$$

6. The Relationship between Planck's Constant and the Resonance Frequencies of Electronic Orbitals

At the beginning of the 20th century, Planck discovered a major relationship between the different frequencies of the blackbody radiation that Wien had recently discovered to be quantized. He observed that their energy was systematically obtained by the product of their frequency by an action constant that he had calculated to have the very precise value of 6.62606876E−34 joules·second:

$$E = hv \quad \text{and since} \quad v = \frac{c}{\lambda} \quad \text{then} \quad E = \frac{hc}{\lambda} \tag{38}$$

In his 1924 doctoral thesis, Louis de Broglie succeeded by a brilliant deduction to relate Planck's constant, symbolized by the letter h, to the entire range of frequencies of photons emitted by the hydrogen atom and to bring to light the fact that they all were integer multiples of Planck's constant. The fundamental reference that he established involved the length of the Bohr orbit—$\lambda = 2\pi R$, R being the Bohr radius—and the classical momentum equation $p = mv$ applied to the electron rest mass m_0 on the idealized circular Bohr orbit:

$$h = \lambda m_0 v = \lambda p \tag{39}$$

and rearranging:

$$p = \frac{h}{\lambda} \tag{40}$$

Substituting p of Equation (40) for h/λ in Equation (38), the well known momentum energy equation $E = pc$ applicable to localized photons was obtained:

$$E = \frac{h}{\lambda} c = pc \tag{41}$$

These well known equations are generally mentioned in popular textbooks, such as [45] and [46], without explaining how de Broglie related Planck's constant to the resonance frequencies of the electron in the hydrogen atom orbitals in his doctoral thesis, published in 1924 by the French *Académie des sciences*. Due to its radical ideas, the peer-reviewers Jean Perrin, Paul Langevin, Elie Cartan and Charles Maugin sought Einstein's advice during the review process to obtain his opinion, which resulted in Einstein bringing it to Schrödinger's attention:

"*The examining board, perplexed by apparently radical ideas of de Broglie, asked Albert Einstein* (1879-1955) *whether the thesis deserved a doctoral degree. Einstein responded quickly by saying that the thesis deserved a Nobel Prize rather than a doctoral degree. Einstein recommended the thesis to Schrödinger, which resulted in celebrated Schrödinger equation.*" Nishimura, H. (2021) ([47], p. iii).

His thesis was finally translated to English only in 2021 by the *Minkowski Institute* [47]. It may seem surprising that such an important historical document remained available only in French for almost one century, but it was not unusual in the first half of the 20th century for scientific articles published in Europe not to be translated to a common language, given that most European scientists were generally multilingual. Many important papers of this era from Planck and Einstein, among others, have now been made available again in the common language as put in perspective in the Introduction to [48].

This could not be better illustrated than by a *thank you note* found in the introduction page of a 1900 major *Dutch archive of exact and natural sciences* publication, to the authors who had accepted to write their contribution either in French, in German "or" in English ([49], p. 10), which suggest that most researchers and potential readers of the archives of this era were expected to be familiar with at least these three languages.

When English became the standard formal publication language in the mid 20th century, Quantum Mechanics was already a well established science that now drew more attention to the complementary statistical developments of Heisenberg and the recent addition of Feynman's path integral rather than to Schrödinger's wave equation and its underlying de Broglie hypothesis, both having by now become part of history, and which were no longer attracting sufficient attention to be translated for further study. Such historical scientific documents are now progressively being translated to English by institutions such as the *Minkowski Institute* to become available to the international scientific community.

Let us now examine this equation from de Broglie that so revolutionized fundamental physics [47] [50]. Here is how he introduced his equation:

"*Dans le cas particulier des trajectoires circulaires dans l'atome de Bohr, on obtient*":

"*In the particular case of circular trajectories in the Bohr atom, we obtain*:"

$$m_0 \oint v \cdot \mathrm{d}l = 2\pi R m_0 v = nh \tag{42}$$

Before analyzing Equation (42) in detail, let us review how he conceived of this relation, also explained in introduction to [51] [52]. Here is de Broglie's description in his own words of the observation that he published in 1923 that led him to this major conclusion:

"*L'apparition, dans les lois du mouvement quantifié des électrons dans les atomes, de nombres entiers, me semblait indiquer l'existence pour ces mouvements d'interférences analogues à celles que l'on rencontre dans toutes les branches de la théorie des ondes et où interviennent tout naturellement des nombres entiers.*" De Broglie, L. ([53], p. 461).

"*The occurrence of integers, in the laws of quantified motion of electrons in atoms seemed to me indicative of the existence for these motions of interferences analogous to those met in all branches of wave theory, where integers naturally occur.*"

Shortly after, he published another note in *Les Comptes rendus de l'Académie des Sciences* in which he was proposing a preliminary interpretation of the conditions that might explain the stability of the electron within atomic structures [54].

"*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*:"

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

$$\frac{m_0 \beta^2 c^2}{\sqrt{1-\beta^2}} T_r = nh \text{, } n \text{ being an integer} \tag{43}$$

which is the stability condition determined by Bohr and Sommerfeld for a trajectory being run at constant velocity [54].

The following year, de Broglie published two more notes [55] [56], to which he refers in ([53], p. 462), in one of which he mentioned that from this viewpoint, Bohr's famous *frequency condition law* could be interpreted as involving some sort of *beat* or *pulsation* (*un battement* in the original French text), that is, a resonance state associating the frequency of the emitted wave to the initial electron stationary state and to its final stationary state. And then he submitted his doctoral thesis to the examination board.

We observe that the electron momentum energy $p = m_0 v$ is part of the resolved integral in Equation (42). It was already understood at the time that when an electron is captured by a proton to form a hydrogen atom, its momentum kinetic energy is liberated in the environment just as when a macroscopic masses is suddenly stopped in its motion. In the case of the electron, this sudden capture causes it to stabilize in the ground state of the hydrogen atom at the Bohr radius mean distance from the proton, well established to be R_1 = 5.291772083E−11 m, corresponding to integer value $n = 1$ in Equation (42).

The related emitted bremsstrahlung photon is well established to have an amount of energy equal to 13.60569162 eV, which when converted to joules gives:

$$\Delta K = 13.60569162 \times 1.602176462\text{E}-19 = 2.179871902\text{E}-18\ \text{j} \tag{44}$$

The classical velocity of the electron on the theoretical Bohr orbit at the Bohr radius distance can then be established with Equation (33):

$$v = \sqrt{\frac{2 \cdot \Delta K}{m_0}} = \sqrt{\frac{2 \cdot 2.179871902\text{E}-18}{9.10938188\text{E}-31}} = 2187691.252\ \text{m} \tag{45}$$

The length of the Bohr orbit is then:

$$\lambda_{R_1} = 2\pi R_1 = 2\pi \cdot 5.291772083\text{E}-11 = 3.32491846\text{E}-10\ \text{m} \tag{46}$$

Having now on hand the numerical values of every element of the resolved integral of Equation (42) for the first orbital, we can only imagine the surprise that de Broglie must have felt in obtaining Planck's constant by numerically resolving his equation, as also explained in [57] [58]:

$$h = \lambda_{R_1} m_0 v = 6.626068757\text{E}-34\ \text{j}\cdot\text{s} \tag{47}$$

That is, an equation which is at the origin of the introduction by Heisenberg of his uncertainty relation $\Delta x \cong h/m \cdot \Delta v_x$ in relation with de Broglie's previously proposed intuition in [54] that the electron had to be in resonance about its ground state trajectory in the hydrogen atom, and moreover, which provided confirmation that all allowed orbitals of the electron in the hydrogen atom had to be integer multiples of the ground state orbital constant, a condition that he had previously suspected as mentioned in [53], with the now added clarification that their energies could only be multiples of Planck's constant.

Is it surprising then that Einstein would have immediately told the Sorbonne board of reviewers upon having been consulted as to the value of de Broglie's discovery, that he deserved a Nobel Prize rather than a doctoral degree [47], for having resolved an issue that had mystified the community ever since Planck had related his constant to black-body radiation!

Indeed, nobody had succeeded before de Broglie in mathematically explaining how Planck's constant could be related to other known equations and established numerical values.

Planck's constant is then directly related to the length of one orbit that the electron would theoretically travel at Bohr radius distance from the proton in a hydrogen atom while moving at classical velocity 2187691.252 m/s, each orbit taking 1.59186E−16 second to be complete, and that add up to a number of orbits traveled per second exactly equal to the frequency of the energy induced in the electron at Bohr radius distance from the proton of:

$$\nu_{R_1} = \frac{v}{\lambda_{R_1}} = \frac{2187691.252}{3.32491846\text{E}-10} = 6.580495968\text{E}15 \text{ Hz} \quad (48)$$

When multiplied by Planck's constant, this frequency provides the exact amount of energy induced by the Coulomb interaction at Bohr ground state R_1 distance from the proton in the hydrogen atom:

$$E_B = h\nu_{R_1} = 4.3602818768\text{E}-18 \text{ j} \quad (49)$$

Equation (49) is also directly confirmed by applying the Coulomb Equation (20) to this distance, both the electron and the proton having the unit charge e = 1.602176462E−19 Coulombs:

$$\Delta E = h\nu_{R_1} = \Delta K + \Delta m_m c^2 = \frac{e^2}{4\pi\varepsilon_0 R_1} = 4.359743805\text{E}-18 \text{ j} \quad (50)$$

Of course, when the true relativistic velocity 2187647.561 m/s related to the total amount of energy calculated with the Coulomb equation is used in calculating the frequency with Equation (48), the exact value of 4.359743805E−18 J is obtained with Equation (49), which when divided by 2 and converted to eV, confirms the whole sequence by recuperating the energy of the 13.6059162 eV bremsstrahlung photon that initiated the whole sequence of reasoning that de Broglie followed to ultimately establish Equation (42).

This is how de Broglie could relate the momentum of the electron on the Bohr orbit to Planck's constant and then to the frequency and wavelength of the electromagnetic energy that causes the electron to theoretically move at the rated velocity by adapting Equation (47), which is only a simplified form of his historical Equation (42), That is, in summary, the well-known Equations (38), (39), (40) and (41) cited at the beginning of this Section:

$$h = \lambda m_0 v \Rightarrow p = mv = \frac{h}{\lambda} = \frac{h\nu}{c} \Rightarrow E = pc = h\nu \quad (51)$$

This is how the 1924 equation allowed deriving $E = pc = h\nu = \Delta K + \Delta m_m c^2$ = 4.359743805E−18 j from the kinematic and electromagnetic parameters of the stabilized electron in the ground state of the hydrogen atom, thus proving that the pc term in Equation (41) really provides the total amount of energy induced adiabatically in the electron by the Coulomb interaction.

7. Grounding the Mass of the Electron on an Electromagnetic Foundation

A clear demonstration that a common basis can be established to eventually derive a set of differential equations applicable to both kinematic and electromagnetic mechanics as envisioned by Wien [7] is that the density of the electron invariant rest mass energy can be calculated with the standard T^{00} electromagnetic stress energy tensor equation, by means of using the electron Compton wavelength λ_c = 2.426310215E-12 m to establish the corresponding invariant $\boldsymbol{E}_e$ field and the oscillating $\boldsymbol{B}_e$ field at maximum intensity of its rest mass energy; and from this density, by means of the incompressible isotropic volume equation, derived in 2007 in [31] in the first wave of derivations from Marmet's discovery, from the theoretical total immobilization of the electron oscillating rest mass energy, calculate the well established invariant rest mass of the electron.

Historically, the T^{00} stress energy tensor was used in context of the Special Relativity theory to deal with the *assumed* absolute existence of invariant rest masses and the *assumed* relative existence of momentum energy that would reduce to zero in the reference frame of each moving mass.

As put in perspective in [23], Aram D'Abro's analysis ([59], p. 217), highlighted the fact that when momentum energy is induced in charged particles by externally controlled $\boldsymbol{E}$ and $\boldsymbol{B}$ fields, this momentum energy turns out to be physically induced in an adiabatic manner, and remains physically present in the reference frame of each charged particle, whether the particle is moving in space or whether its motion is hindered by the local electromagnetic equilibrium. For example, when electrons are prevented from crashing on atomic nuclei by their default mutually repelling magnetic energy due to their parallel spin orientation forced by structure [51] [52], despite the constant pressure applied by their momentum energy towards the atomic nuclei.

It is from these considerations that the T^{00} stress energy tensor equation will be now used, assuming the continued physical existence not only of the rest masses energy of bodies, but also of the physical existence of the carrying-energy of their constitutive charged and massive elementary particles at any given moment, that comprises both the $\boldsymbol{E}_e$ and $\boldsymbol{B}_e$ field energy of their invariant rest masses, their momentum energy and the transverse $\Delta\boldsymbol{E}$ and $\Delta\boldsymbol{B}$ fields energy that contributes their transversely measurable mass increment, as observed during the Kaufmann experiments. Let us first deal with the invariant rest mass energy of the electron by means of the standard T^{00} equation:

$$T^{00} = \frac{1}{c^2}\left(\frac{1}{2}\varepsilon_0 \boldsymbol{E}^2 + \frac{1}{2\mu_0}\boldsymbol{B}^2\right) \tag{52}$$

and the $\boldsymbol{E}_e$ and $\boldsymbol{B}_e$ fields of the electron rest mass energy calculated by means of previously mentioned Equations (26) and (28):

$$\boldsymbol{E}_e = \frac{\pi e}{\varepsilon_0 \alpha^3 \lambda_C^2} = 2.484979751\text{E}22\ \text{N/C}, \quad \boldsymbol{B}_e = \frac{\mu_0 \pi e c}{\alpha^3 \lambda_C^2} = 8.289000222\text{E}13\ \text{T} \tag{53}$$

The absolute density of the energy of which the electron rest mass is made can now be calculated:

$$T^{00}_{\text{Electron}} = \frac{1}{c^2}\left(\frac{1}{2}\varepsilon_0 \boldsymbol{E}_e^2 + \frac{1}{2\mu_0}\boldsymbol{B}_e^2\right) = 6.08349328\text{E}16\ \text{kg/m}^3 \tag{54}$$

Then, by means of the *incompressible isotropic energy volume equation* developed in [31]:

$$V_e = \frac{\alpha^5}{} \frac{\lambda_C^3}{2\pi^2} = 1.497393267\text{E}-47\ \text{m}^3 \tag{55}$$

the well known invariant rest mass of the electron calculated from the density of this theoretical *incompressible isotropic volume* of the energy can now be obtained:

$$m_e = \frac{1}{c^2}\left[\frac{\varepsilon_0 \boldsymbol{E}_e^2}{2} + \frac{\boldsymbol{B}_e^2}{2\mu_0}\right]V_e = 9.109381877\text{E}-31\,\text{kg} \tag{56}$$

Of course, the invariant rest mass of the positron is established in the very same manner with the very same T^{00} Equation (52) since it is identical to the electron in all respects except for the sign of its *unit charge*, which is the direct opposite of that of the electron, as illustrated in **Figure 4(d)**.

As analyzed in **Section 3**, In the trispatial geometry, *charge* turns out to be the intensity of the *elastic return tension* of the oscillating energy that causes the constant transverse oscillation of the two ***E***-field components of the photon in Equation (66) shown further on.

In the process of the energy of a 1.022 MeV photon decoupling into a pair of two separate massive and charged electron and positron, what happens, as put in perspective in **Section 3** and analyzed in depth in [29], is that the separation of both particles systematically occurs as this return tension reaches its maximum intensity of 1.602176462E−19 Coulombs, at the same moment as both particle symmetrically reach the escape velocity of light in opposite directions on the Y-y/Y-x plane; the negative charge of the electron corresponding the elastic return tension from the negative direction along the Y-y axis, and the positive charge of the positron corresponding to the same elastic return tension from the positive direction along the Y-y axis.

After separation, this recall tension can only be released if an electron-positron pair captures each other in a metastable positronium system spiralling toward their meeting point, in either a para- or an orthopositronium configuration, on an orbit that rapidly decays until they meet, at which point their energy is generally transposed into many electromagnetic photons that escape at the speed of light, or by colliding directly, converting into a single photon of 1.022+ MeV, as recorded in a photograph of the FERMILAB bubble chamber experiment E632, described in [42].

The question now comes up as to what other stable particles in the universe do we have to contend with in physical reality, other than the familiar electrons that we know provide electrical current by circulating in electric wires and that define the volumes of all atoms in the periodic table by surrounding atomic nuclei with as many electrons as the atomic nuclei contains protons at some distance from the latter.

Let us have a closer look at the protons and neutrons that make up all atomic nuclei. As soon as protons and then neutrons were identified in the 1920's and 30's, there was a suspicion that they may not be elementary, contrary to electrons. The first non-destructive high energy scattering experiments carried out with protons and neutrons in the 1940's and 50's by means of incident electron beams also seemed to confirm that they occupied very small volumes in space since the high velocity electron beams that were used to collide with protons all rebounded against them in a totally elastic manner and were sent flying in all directions in a manner that revealed the physical volumes that they occupied, contrary to electrons, that systematically behaved as if they were point-like during mutual collisions, even when subjected to the highest possible energy non-destructive collision experiments.

The first high-energy accelerators in use at the time were not powerful enough to cause the scattering bullets (high-energy electrons) to actually enter the target proton and neutron volumes. The community had to wait until 1966 for the Stanford Linear Accelerator (SLAC) to enter service for the required energy levels to become available.

Experiments carried out from 1966 to 1968 at the SLAC facility with high energy non-destructive scattering of electrons against protons and neutrons allowed identifying three elementary massive and charged particles inside the volumes that they occupied, whose masses were in the same range as that of the incident electrons, as revealed by the highly inelastic rebound characteristics of some electrons rebounding backward with very little remaining energy, which means that their high energy coming in had been absorbed by particles inside the volumes of protons and neutrons that had masses in the very same range as the incoming electrons. These experiments carried out by Breidenbach *et al.* are analyzed in the article that they produced in 1969 [60].

Deep analysis then allowed establishing that protons and neutrons were systems of particles involving for the proton, two positively charged elementary particles that were named Up quarks, having a charge equal to 2/3 of that of a positron, and one negatively charged elementary particle that was named Down quark, having a charge equal to 1/3 of that of an electron. Neutrons on the other hand revealed a structure made Up of one up quark and two Down quarks identical to those found in protons.

It was suspected early on that despite the fractional charges, they may somehow be very normal electrons and positrons whose characteristics of mass and charge could be warped into these observed states due to the high intensity of the electromagnetic environment that pervades the inner volumes of protons and neutrons. It was in 2013 [42] that deep analysis seemed to confirm that the Up quarks had to be positrons constrained into this observed hyper-stressed state, and that Down quarks had to be electrons constrained into this observed hyper-stressed state, whose hyper-stressed inner electromagnetic structures will be discussed in more details in **Section 8**.

The sequence of stable masses related to the resonance frequencies of these hyper-stressed electrons and positrons, of which the nucleons of all nuclei of all atoms in the universe are made, has been established by means of the following general equation of stable masses at rest defined in [42]:

$$m_{[d,u,e]} = \frac{k}{a_0}\left(\frac{3e}{n\alpha c}\right)^2 = \left(\frac{3}{n}\right)^2 \frac{e^2}{4\pi\varepsilon_0 r_e}\frac{1}{c^2} = \left(\frac{3}{n}\right)^2 \frac{e^2}{2\varepsilon_0 \alpha\lambda_C c^2} \quad (n = 1,2,3) \qquad (57)$$

In which $r_e = \alpha\lambda_c/2\pi$ = 2817940285E−15 m is the classical electron radius, *i.e.*, the amplitude of oscillation of the electron's rest mass energy in the plane transverse to its direction of motion (see **Figure 4**).

The wavelengths and invariant rest masses of the Up quark state as clarified in Section 23 of [35] [36], and of the Down quark state, were determined in [42] and shown in **Table 1**.

The normally unconstrained masses of electrons and positrons are constrained in this manner within proton (uud) and neutron (udd) structures due to the mutual proximity of the three charged particles, and the substantial drift of their energy from the electric state to the magnetic state, causing the decrease of their electric charges—*i.e.* of their *elastic recall tension*—which is determined by the very short gyroradii imposed on them by the ultimate intensity levels of their stabilized stationary resonance states, as explained in [61].

It is the drift of their energy from the $\boldsymbol{E}$ field state to the $\boldsymbol{B}$ field state due to their tight gyroradii that causes their *elastic recall tension* to diminish as they draw nearer to the closest trispatial junction of the triad located on the Y-z coplanar rotation axis of the triad that causes them to stabilize at 2/3 the distance from the junction on one side of the Y-z coplanar rotation axis on the Y-y/Y-x plane for the Up quark state (See **Section 8**), and at 1/3 this distance for the Down quark state on the opposite side of the Y-z coplanar rotation axis.

Since the default energy density of both the local $\boldsymbol{E}_e$ field and $\boldsymbol{B}_e$ field of the unstressed electron and positron are equal by structure, this issue is easily dealt with when calculating their energy density by means of T^{00} Equation (52), since removing one third the energy of the $\boldsymbol{E}_U$ field state and adding this one third energy amount to the $\boldsymbol{B}_U$ field state is the solution. So, in its Up quark state, the values of these fields for the hyper-stressed positron will be:

$$\boldsymbol{E}_U = \frac{2}{3}\frac{\pi e}{\varepsilon_0 \alpha^3 \lambda_U^2} = 8.386806653\text{E}22\ \text{N/C}\,,\quad \boldsymbol{B}_U = \frac{4}{3}\frac{\mu_0 \pi e c}{\alpha^3 \lambda_U^2} = 5.595075145\text{E}14\ \text{T} \tag{58}$$

Table 1. Wavelengths, rest masses and charges of the electron/positron, and of the Up and down quarks states.

	Rest mass energy wavelength	Rest mass	Charge (Elastic recall tension)
Electron or Positron	2.426310215E−12 m	9.10938188E−31 kg	− or + 1.602176462E−19 C
Up quark state—Constrained positron	1.078360096E−12 m	2.049610923E−30 kg	+2/3 1.068117641E−19 C
Down quark state—Constrained electron	2.69590021E−13 m	8.198443693E−30 kg	−1/3 5.340588207E−20 C

and the absolute density of the energy of the Up quark state rest mass can now be calculated:

$$T_U^{00} = \frac{1}{c^2}\left(\varepsilon_0 \boldsymbol{E}_U^2 + \frac{\boldsymbol{B}_U^2}{\mu_0}\right) = 1.559132787\text{E}18\ \text{kg/m}^3 \tag{59}$$

Its theoretical *incompressible isotropic energy volume* will then be:

$$V_U = \frac{\alpha^5}{} \frac{\lambda_U^3}{2\pi^2} = 1.314583939\text{E}-48\ \text{m}^3 \tag{60}$$

The rest mass of the Up quark state calculated from the density calculated with Equation (59) can now be obtained:

$$m_U = \frac{1}{c^2}\left[\varepsilon_0 \boldsymbol{E}_U^2 + \frac{\boldsymbol{B}_U^2}{\mu_0}\right] V_U = 2.049610921\text{E}-30\ \text{kg} \tag{61}$$

Which confirms the rest mass of the Up quark state obtained by different means in [42]—see **Table 2**.

Similarly for the Down quark state, the drift of the energy of the electron from its local $\boldsymbol{E}_e$ field state to its $\boldsymbol{B}_e$ field state causing it to draw closer to the closest trispatial junction of the Y-z coplanar rotation axis, will cause it to stabilize at 1/3 of the distance from the junction on the other side of the axis with respect to the Up quark states (see **Section 8**), which is dealt with by removing 2/3 of the energy of the $\boldsymbol{E}_D$ field state and adding it to the $\boldsymbol{B}_D$ field state as calculated from its λ_D = 2.69590021E−13 m wavelength:

$$\boldsymbol{E}_D = \frac{1}{3}\frac{\pi e}{\varepsilon_0 \alpha^3 \lambda_D^2} = 6.709445473\text{E}23\ \text{N/C}\,, \quad \boldsymbol{B}_D = \frac{5}{3}\frac{\mu_0 \pi e c}{\alpha^3 \lambda_D^2} = 1.119015054\text{E}16\ \text{T} \tag{62}$$

The density of the rest mass of the Down quark state of the electron will thus be:

$$T_D^{00} = \frac{1}{c^2}\left(\varepsilon_0 \boldsymbol{E}_D^2 + \frac{\boldsymbol{B}_D^2}{\mu_0}\right) = 3.991380112\text{E}20\ \text{kg/m}^3 \tag{63}$$

The other values for the rest mass of the Down quark state of the electron will then be V_D = 2.054037337E−50 m^3, and finally, m_D = 8.198443775E−30 kg, that also confirms the Down quark state rest mass calculated by other means in Reference [42]—see **Table 2**.

Table 2. Comparing the densities, theoretically immobilized isotropic volumes and masses of the stable massive elementary charged particles.

	Electron or positron	Up quark state	Down quark state
Density kg/m^3	6.08349328E16	1.559132787E18	3.991380112E20
Immobilized Isotropic volume in m^3	1.497393267E−47	1.314583939E−48	2.054037337E−50
Rest mass in kg	9.109381877E−31	2.049610921E−30	8.198443775E−30

Up to this point in our analysis, the standard T^{00} Equation (52) was used to calculate only the energy density of the rest masses of the set of individual massive elementary particles of which all elements of the periodic table are made, without taking into account the varying mass energy density $\Delta m_m c^2$ component of their carrying energy, nor the related ΔK momentum energy (See **Section 8**), nor the energy density measurable as the rest masses of protons and neutrons (See **Section 8**), whose stable stationary action resonance structures are established by triads of hyper-stressed electrons and positrons, whose constrained momentum energy is also directly measurable as being *massive*, contrary to the momentum energy of unstressed photons and electrons as analyzed in **Section 8**.

Before addressing this issue and adapting the T^{00} equation to account for the total measurable rest mass energy of protons and neutrons, there is need to address the issue of the energy density of free moving photons that we know to be identical to the carrier-photons of elementary massive particles, and consequently also of the hyper-constrained carrier-photons of protons' and neutrons' inner elementary components. This issue will be dealt with in the coming section. Only then will it become possible to adapt the T^{00} equation to account for the totality of the mass of protons and neutrons.

Referring back to LC Equation (31) that was initially developed to account for the internal stationary LC oscillating energy of the electron rest mass from the trispatial perspective in Reference [29], the corresponding $\boldsymbol{E}_e$ and $\boldsymbol{B}_e$ fields related version of Equation (31) was also developed in the same reference, by relating the density involved to the theoretically immobilized *incompressible isotropic volume* Equation (55), identifying for the first time in [29] the *neutrinic energy* of the electron, possible source of neutrinos in the first stage of the establishment of the invariant rest mass of the electron during isolated neutron decay, and a confirmed source of neutrinos during the $\boldsymbol{\mu}$ and $\boldsymbol{\tau}$ particles decay processes towards their ultimate stable electron rest mass state—first experimentally confirmed in the case of the $\boldsymbol{\mu}$ particle by the 1959 Raines and Cowan experiment at the Savannah River Plant [62], whose production is analyzed in [44]:

$$m_e c^2 \vec{\mathbf{0}} = \left[\frac{\varepsilon_0 \boldsymbol{E}_e^2}{2} V\right]_Y \vec{\boldsymbol{J}} \vec{\boldsymbol{i}} + \left[2\left(\frac{\varepsilon_0 \nu_e^2}{4}\right)_X \left(\vec{\boldsymbol{J}} \vec{\boldsymbol{j}}, \vec{\boldsymbol{J}} \overleftarrow{\boldsymbol{j}}\right) \cos^2(\omega t) + \left(\frac{B_e^2}{2\mu_0}\right)_Z \overleftrightarrow{K} \sin^2(\omega t)\right] V_e \tag{64}$$

in which

$$V_e = \frac{\alpha^5 \lambda_C^3}{2\pi^2}, \quad \boldsymbol{E}_e = \frac{\pi e}{\varepsilon_0 \alpha^3 \lambda_C^2}, \quad \boldsymbol{B}_e = \frac{\pi \mu_0 e c}{\alpha^3 \lambda_C^2} \quad \text{and} \quad \nu_e = \frac{\pi e}{\varepsilon_0 \alpha^3 \lambda_C^2} \tag{65}$$

Although not initially derived from the Standard T^{00} Equation (52), it can easily be understood that combining the standard trigonometric equation ($\sin^2\theta + \cos^2\theta = 1$) with the T^{00} Equation (52), the oscillating part of Equation (64) can be obtained, if the *neutrinic energy* $\boldsymbol{\nu}_e$—Greek letter *nu*—is assumed to behave in the same manner on the X-y/X-z plane within X-space as the $\boldsymbol{E}$ field energy behaves on the Y-y/Y-z plane in Y-space for free moving photons as represented in LC Equation (13), and as analyzed in [29], since that when the *sin²* component equals zero, then the *cos²* component equals 1, and the reverse. This allows easily representing Maxwell's initial interpretation of the oscillation at frequency ωt between the $\boldsymbol{E}$ and $\boldsymbol{B}$ field states as mutually inducing each other in alternance while being timewise dephased by 180˚ (**Figure 1**).

In the case of the electron rest mass energy, this oscillation represented in Equation (64) involves rather the $\boldsymbol{\nu}_e$ field and the $\boldsymbol{B}_e$ field while the $\boldsymbol{E}_e$ field remains constant as explained in Reference [29], which is in agreement with the fact that the *charge* of the electron, that is, its *elastic recall tension*, is known to remain invariant at all velocities and in all circumstances.

The reason why Equation (64) still provides the full invariant rest mass of the electron by means of adding its invariant $\boldsymbol{E}_e$ field energy and its oscillating $\boldsymbol{B}_e$ field energy when it reaches maximum energy, is that the sum of the reciprocatingly oscillating squared $\boldsymbol{\nu}_e$ field and of the squared $\boldsymbol{B}_e$ field energies at any given moment is always equal by structure to either the squared $\boldsymbol{\nu}_e$ field energy at maximum or of the squared $\boldsymbol{B}_e$ field energy at maximum.

8. The Oscillating Δ*E* and Δ*B* Field Energy of Free Moving Electromagnetic Photons and Carrier-Photons

After having been summarily described in [63] and [64], inspired by the Hilbert vector field so clearly described by Hans Van Leunen in direct conversations and in his published articles [65] [66], the trispatial vector field was more clearly explained in [22] and [23] by verbally describing the trispatial inner vector complex applicable to each localized elementary particle, the energy substance of each electromagnetic elementary particle self-structuring by symmetry within its own trispatial vector complex, and self-propelling at the velocity of light within X-space according to Equation (14) for free moving photons, or applying pressure within Y-space according to the orientation of its momentum energy within Y-space for charged electrons and positrons, as described in [29], each type of trispatial vector complexes required to represent the various aspects of elementary quantized electromagnetic oscillation in the trispatial vector geometry will now be visually described, as well as the first level clusters of these complexes that account for elementary particle mass and motion at the subatomic level.

A visual representation of levels 0 to 3 of these trispatial vector complexes will be provided, with level 4 simply consisting of assemblies of all possible level 3 trispatial vector complex representations related to the elements listed in the periodic table of elements, of which all masses in the universe are made.

Trispatial LC Equation (13) for the electromagnetic photon was established in [33]. This equation was converted to its $\boldsymbol{E}$- and $\boldsymbol{B}$-fields equivalent equation in the same article:

$$E\vec{I}\,\vec{i} = \left(\frac{hc}{2\lambda}\right)_X \vec{I}\,\vec{i} + \left[2\left(\frac{\varepsilon_0 \boldsymbol{E}_{2\lambda}^2}{4}\right)_Y \left(\vec{J}\,\vec{j},\vec{J}\,\vec{j}\right)\cos^2(\omega t) + \left(\frac{\boldsymbol{B}_{2\lambda}^2}{2\mu_0}\right)_Z \vec{K}\sin^2(\omega t)\right]V_{2\lambda} \quad (66)$$

The set of both Equations (13) and (66) for free moving photons are different on two separate counts from the similarly structured set of both Equations (31) and (64) established to describe the inner electromagnetic structure of the invariant rest mass of the electron.

The first count concerns the wavelength λ of localized photons, that can vary according to the complete range of all possible electromagnetic frequencies, thus allowing Equation (13) and (66) to represent all possible energy intensities of localized electromagnetic photons in the universe, from the longest radio wavelengths to the shortest gamma wavelengths, including the minimum photon threshold energy of 1.637420828E−13 joules – 1.021997805 MeV—starting at which photons are susceptible to be easily destabilized into converting to rest mass stabilized electron-positron pairs by grazing massive particles, such as atomic nuclei, as first observed in the 1930's by Anderson [19], first recorded as decoupling in a bubble chamber, or are simply interacting in close proximity with other photons as first observed during the McDonald *et al.* 1997 experiments with beams of photons tightly collimated towards a single point in space, one beam involving 1.022+ MeV photons [21], according to the mechanics analyzed in [29] and summarized previously in **Section 3** in relation with **Figure 4**.

The second count relates to the fact that while the oscillating half of the rest mass energy of the electron represented with Equations (31) and (64) with reference to **Figure 3**, oscillates between Z-space and the X-y/X-z plane of X-space, on which the oppositely moving pair of $\boldsymbol{\nu}$-field state components is likely to be polarized in any direction on the X-y/X-z plane, the oscillating half of a free moving photon or carrier-photon represented by Equations (13) and (66), oscillates rather between Z-space and the Y-y/Y-z plane of Y-space, on which the pair of oppositely moving $\boldsymbol{E}$-field state components is also likely to be polarized in any direction on the Y-y/Y-z plane, as analyzed in [29].

As part of the trispatial vector field described in [22] and [23], trispatial vector complexes corresponding to Equations (31) and (64) for the electron and positron are illustrated with **Figure 7**. With regard to the difficulty in representing 3D elements on a 2D sheet of paper or screen, the vectors of each complex are not represented to relative scale and to relative physical 90° offset as they must

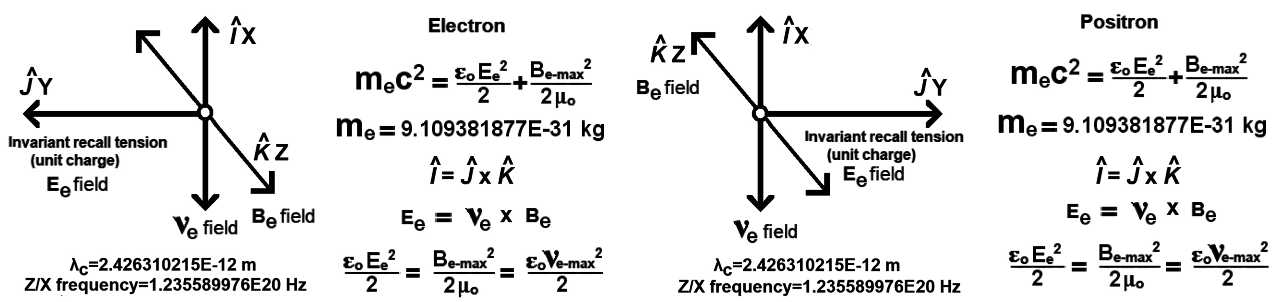

Figure 7. The trispatial vector complexes of the invariant rest masses of the electron and of the positron—level 1 trispatial vector complexes.

be mentally visualized. For correct orthogonal relationship to be understood, each axis of any given set of X-Y-Z axes must be mentally visualized as being exactly perpendicular to the other two as previously described in Figure 3.

The trispatial vector complex of a localized photon or carrier-photon described with Equations (13) and (66) is illustrated with Figure 8.

The vector complex of the electron in motion would then be represented with Figure 9. This figure is to be visualized as a more detailed description of Figure 7 and Figure 8 of [51] [52] in which only the varying ΔZ zitterbewegung distance between the electron center-of-presence of the electron energy and the center-of-presence of its carrier-photon energy was represented.

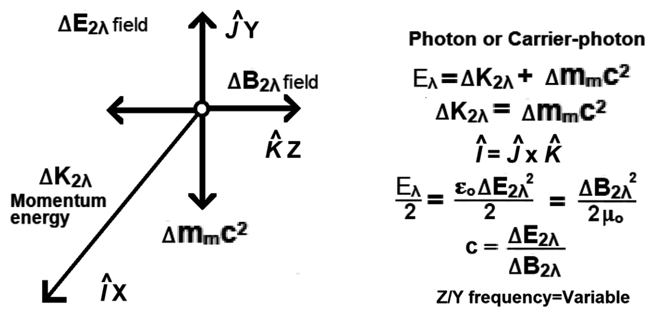

Figure 8. The trispatial vector complex of a photon or carrier-photon—level 0 trispatial vector complex.

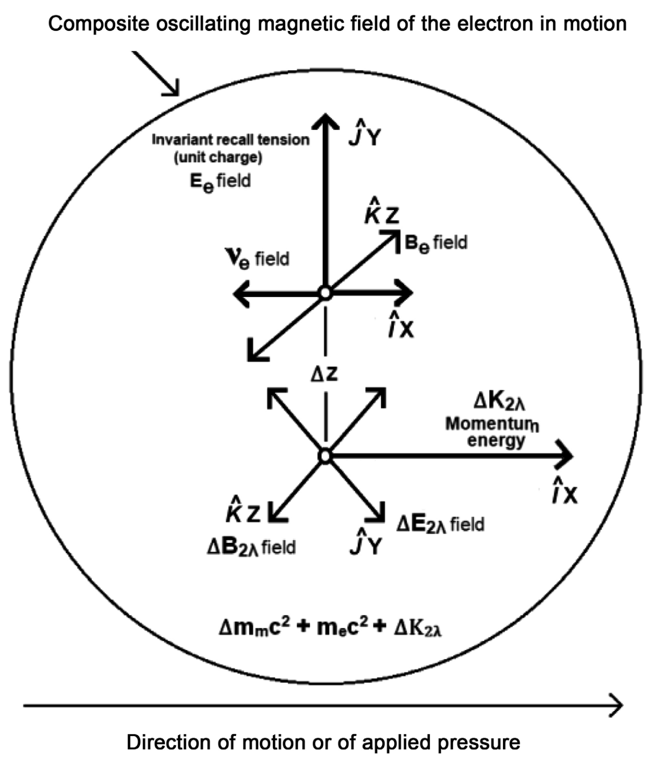

Figure 9. The trispatial vector complex of the relativistic mass of the electron in motion and of its momentum energy—level 2 trispatial vector complex.

It is to be noted also that the two *centers-of-presence* of the vector complexes of the electron and of its carrier-photon are moving side by side perpendicular-lyto the direction of motion of the system, while being propelled by the ΔK momentum energy of the carrier-photon.

The analysis of the reason for this invariant side by side relation is provided in Sections 10.8.11 and 10.8.12 in [67]. Briefly summarized, given that the amount of energy of the electron carrier-photon is determined exclusively by the distance between the electron *center-of-presence* and those of all other charged particles in the universe, any relative longitudinal acceleration or slowing down of the carrier-photon *center-of-presence* with respect to that of the electron ends up being physically impossible. Consequently, the only remaining direction of motion that remains available in the system for both *centers-of-presence* to move with respect to each other is thus transverse to the direction of motion of the system, which turns out to be the only possible cause of the transverse zitterbewegung oscillation ΔZ of the electron trajectory.

We now come to **Figure 10** that illustrates the trispatial vector complexes of the stabilized electrons and positrons in their hyper-stressed confined Up and Down quarks states that establish the structures of the proton and neutron, whose invariant rest masses were originally calculated in [42], and also in this article with Equations (61) and (63), as well as listed in **Table 2**.

Comparing them with the vector complexes of unstressed electrons and positrons illustrated with **Figure 7**, will reveal the relative reduction of their $\boldsymbol{E}$ field energy state to the benefit of their oscillating $\boldsymbol{B}$ and $\boldsymbol{v}$ fields energy states as a function of their reduced gyroradii within the nucleon structures as analyzed in [42].

Figure 11 illustrates the trispatial structure of the enormously stressed quark's carrier-photon's energy, whose ΔK momentum energy half remains stable while its oscillating half largely intensifies the $\Delta \boldsymbol{B}$ field state at the expense of the $\Delta \boldsymbol{E}$ field state, due to the same very tight gyroradius that causes the hyper-stressed electron and positron structures to be warped into the Up and Down quarks states illustrated with **Figure 10**, when they establish the proton and neutron

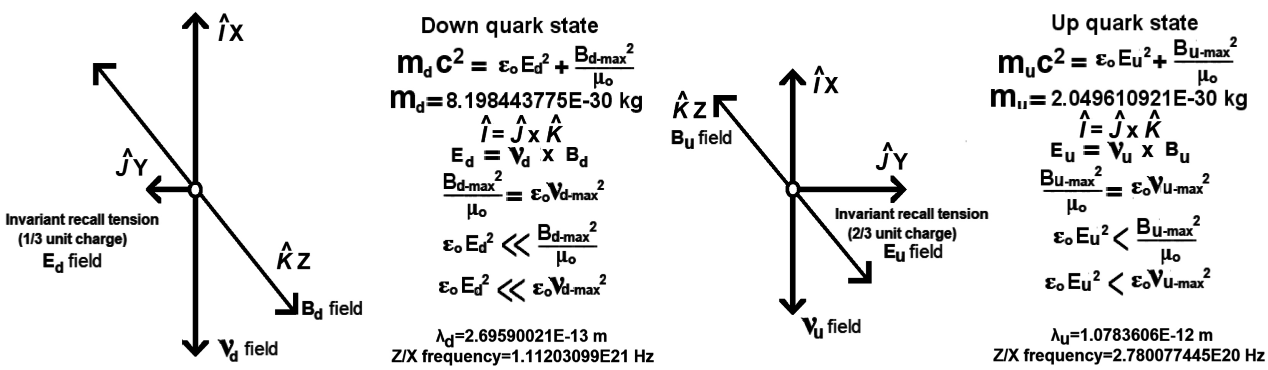

Figure 10. Trispatial vector structures of electrons and positrons in their confined hyper-stressed Up and Down quark states at rest—level 1 trispatial vector complexes.

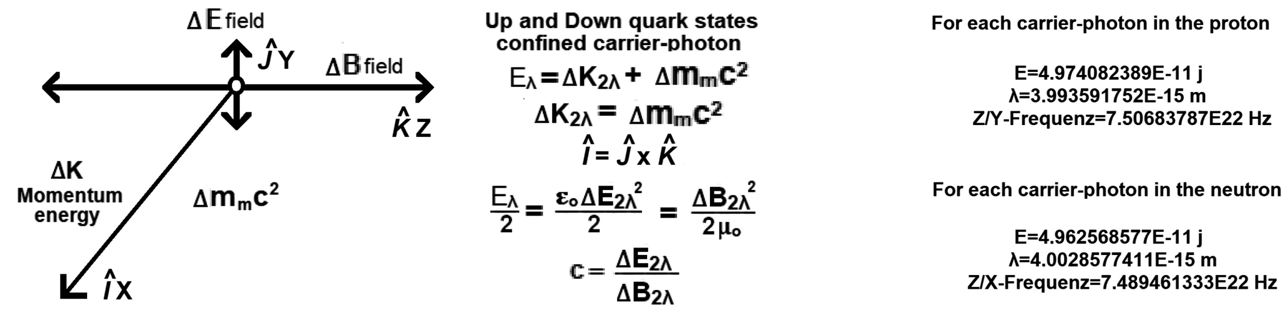

Figure 11. Confined hyper-stressed carrier-photon for Up and Down quarks—level 0 trispatial vector complex.

structures.

The analysis carried out in [42] revealed that within the stable stationary action states into which the local electromagnetic stationary resonance equilibrium confines the hyper-stressed electrons and positrons within nucleons, each uud and udd triad is forced to rotate/translate simultaneously about two mutually perpendicular axes, as illustrated with **Figure 12**—*in translation* about the normal X-space *X-x translation axis* and *in rotation of the triangular formation* about the electrostatic Y-space *Y-z coplanar rotation axis*.

To allow readers to more easily become aware of this unexpected state of motion, the illustrations used in [42]—reproduced here as **Figure 12**—represent the quarks states only by their *centers-of-presence*, without illustrating their trispatial vector complexes (**Figure 10**), and without representing at all their carrier-photons (**Figure 11**).

Figure 13 and **Figure 14** now introduce the Up and Down quarks' composite vector complexes and, more importantly, those of their constrained carrier-photons, to highlight an important consequence of the simultaneous orientations of the momentum energies of the three carrier-photons towards a single point located at the center of each nucleon; this consequence being that their combined energy becomes measurable omnidirectionally as mass, despite the fact that the momentum energy of each separate normal unconstrained photon (**Figure 8**) or carrier-photon (**Figure 9**) is known to be insensitive to transverse interaction, which causes their momentum energy to be measurable only when liberated in their direction of motion when captured as a kinetic energy increase of the absorbing particle in cases of free moving photons being absorbed, as an escaping bremsstrahlung photon when an electron is captured in some stable resonance orbital in an atom [35] [36], or when applying pressure in their direction of motion when such motion or evacuation is prevented from being expressed.

Indeed, the aforementioned insensitivity of the momentum energy to any transverse interaction would intuitively lead to conclude that only the oscillating half of the carrier-photons' energy of the hyper-constrained confined electrons and positrons in each nucleon would be omnidirectionally measurable as mass, *i.e.*, 155.2289185 MeV out of 310.457837 MeV for each carrier-photon in the

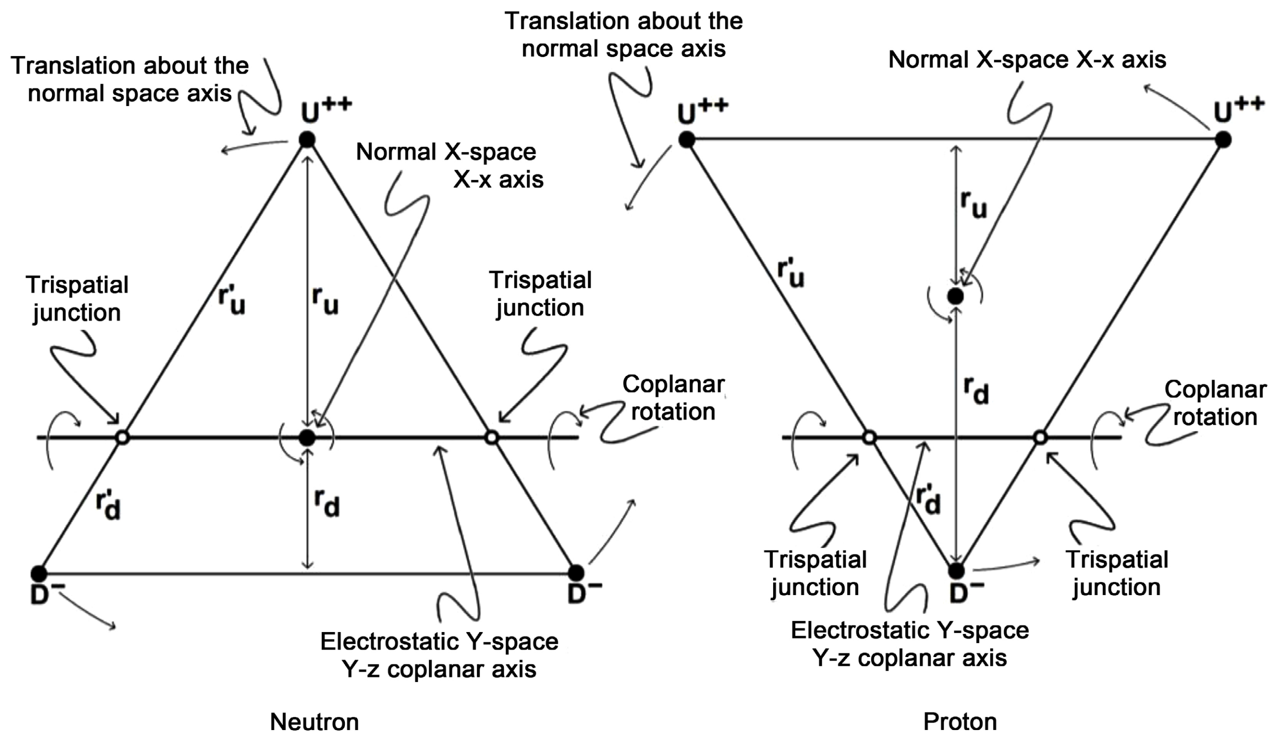

Figure 12. Rotation and translation axes of the proton and neutron triads – level 2 trispatial vector complexes.

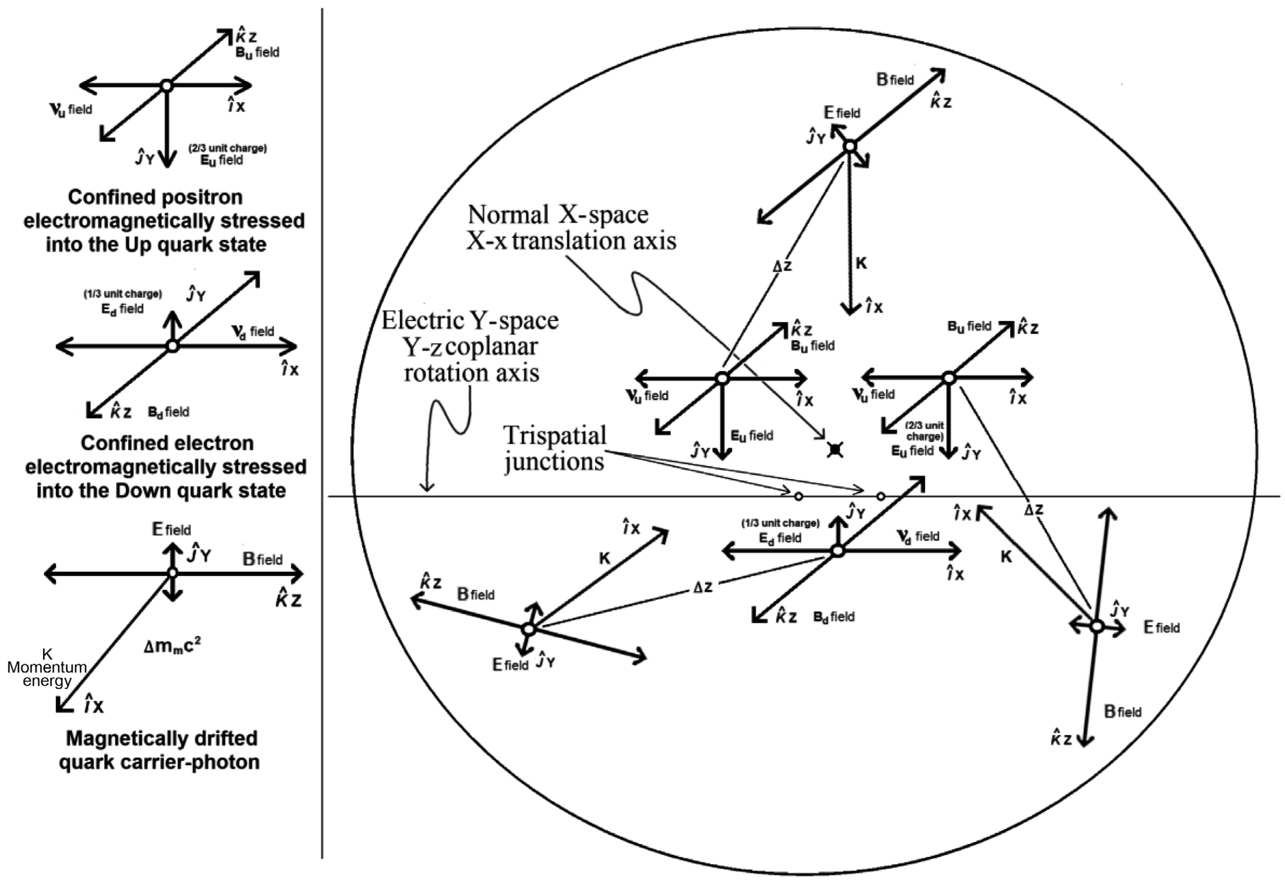

Figure 13. The proton at rest—level 2 trispatial vector complex.

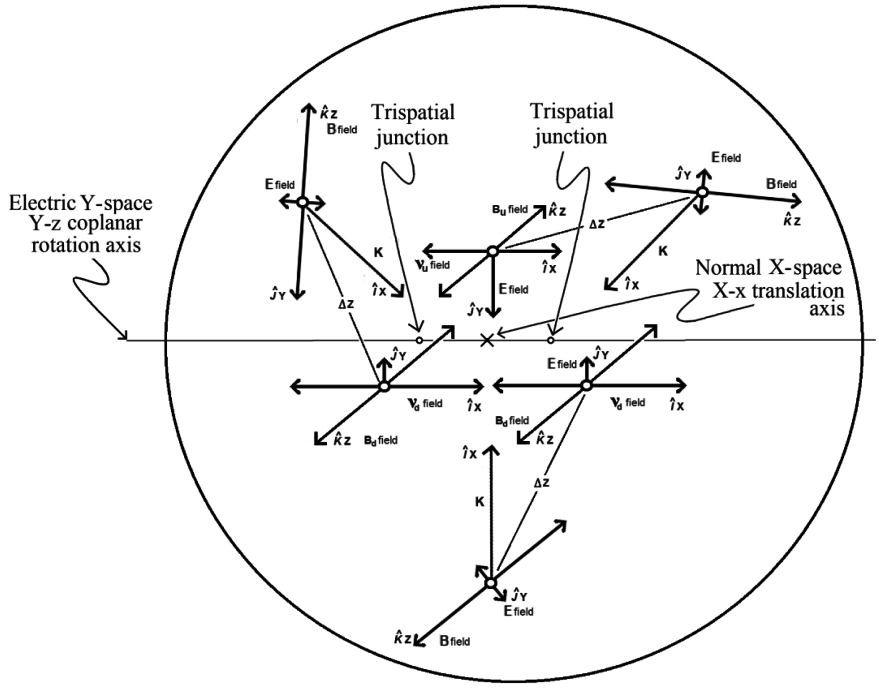

Figure 14. The neutron at rest—level 2 trispatial vector complex.

proton inner structure for a total of 465.6867555 MeV, and 154.8696007 MeV out of 309.7392013 MeV for each carrier-photon in the neutron inner structure for a total of 464.608802 MeV—see Table III in [42].

But given that the direction of application of the unidirectional pressure of the momentum energy of each of them is offset by 120˚ from the direction of application of that of the other two, all three of which are applied towards the center of the triad, whose triangular formation is in simultaneous high-speed rotation/translation about the coplanar Y-z axis of Y-space and about the perpendicular X-x axis of normal X-space (**Figure 12**), the pressure exerted by the momentum energy of each carrier-photon against the counter-pressure of the other two causes the assembly to omnidirectionally resist any change in their collective state of motion, in accordance with Newton's third law of motion, which explains why, in the case of protons and neutrons, the momentum energy of the constrained carrier-photons is also directly measurable as mass, so that no additional intrinsic momentum energy remains available for the nucleons to move on their own in space.

Consequently, the various energy amounts that must be considered to calculate the measurable mass of a proton or a neutron at rest are 1) the sum of the K momentum energies of their 3 constrained carrier-photons, omnidirectionally resisting any change in their state of motion, 2) the sum of the $\boldsymbol{B}$ field magnetic energies *at maximum* of the 3 constrained carrier-photons, 3) the sum of the constrained $\boldsymbol{E}$ field energies of the 3 constrained hyper-stressed electrons and positrons, and 4) the sum of the constrained $\boldsymbol{B}$ field energies *at maximum intensity* of their 3 constrained hyper-stressed electrons and positrons, as represented with **Figure 15**.

The electric $\boldsymbol{E}$ field energies of the confined carrier-photons (**Figure 11**) do not need to be taken account of in calculating the nucleons rest mass since that when the $\boldsymbol{B}$ field energies reach maximum intensity during the $\boldsymbol{E}/\boldsymbol{B}$ LC oscillation cycle between Y-space and Z-space, the $\boldsymbol{E}$-field energy has completely evacuated Y-space and the $\boldsymbol{E}$-field doesn't exist momentarily. The same consideration applies to the $\boldsymbol{\nu}$-field energies of the hyper-stressed electrons and positrons (**Figure 10**), since that when the $\boldsymbol{B}$-field energies reach maximum intensity during the $\boldsymbol{\nu}/\boldsymbol{B}$ LC oscillation cycle between X-space and Z-space, the $\boldsymbol{\nu}$-field energy has completely evacuated X-space and the $\boldsymbol{\nu}$-field doesn't exist momentarily. This is why only the $\boldsymbol{K}$ momentum energy and the $\boldsymbol{B}$-field energy of the confined carrier-photons, and the $\boldsymbol{E}$-field energy and the $\boldsymbol{B}$-field energy of the confined Up and Down quark states are required to calculate the rest mass of protons and neutrons.

However, attention should be drawn to the fact that the dimension of the propulsive energy K (joules) is not in itself related to the volume that it occupies in space, contrary to the squared $\boldsymbol{B}$ element in the $\boldsymbol{B}^2/2\mu_0$ term of the standard T^{00} mass density Equation (52) that must be used to establish this rest mass density. This problem is resolved by becoming aware of the invariance of the symmetric half-and-half equality between the propulsive momentum energy K of all free moving photons and carrier-photons and their transversely oscillating propelled energy $\boldsymbol{E}/\boldsymbol{B}$. This means that it suffices to mathematically double the energy of the $\boldsymbol{B}$-field at maximum intensity to take into account both the propulsive energy K and of its volume in order to correctly calculate the energy density of the nucleon rest mass.

So incorporating 6 occurrences of the $\boldsymbol{B}^2/2\mu_0$ term of the 3 confined carrier-photons instead of 3 will account for the total energy contributed by the confined carrier-photons to the rest mass of proton and neutron in the T^{00} equations that we will now establish. The initial version of the T^{00} Equation (52) that was used to establish the density of the electron rest mass energy can now be modified in the following manner to establish the density of the energy of the proton rest mass.

$$T^{00}_{\text{Proton}} = \frac{1}{c^2}\left[6\left(\frac{\boldsymbol{B}_{cP}^2}{2\mu_0}\right) + 2\left(\varepsilon_0 \boldsymbol{E}_U^2 + \frac{\boldsymbol{B}_U^2}{\mu_0}\right) + \left(\varepsilon_0 \boldsymbol{E}_D^2 + \frac{\boldsymbol{B}_D^2}{\mu_0}\right)\right] \tag{67}$$

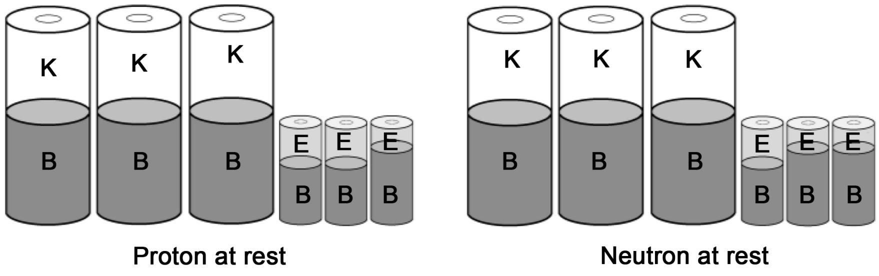

Figure 15. The energy which is part of the proton and neutron rest masses.

And for the neutron:

$$T^{00}_{\text{Neutron}} = \frac{1}{c^2}\left[6\left(\frac{\boldsymbol{B}_{cN}^2}{2\mu_0}\right) + \left(\varepsilon_0 \boldsymbol{E}_U^2 + \frac{\boldsymbol{B}_U^2}{\mu_0}\right) + 2\left(\varepsilon_0 \boldsymbol{E}_D^2 + \frac{\boldsymbol{B}_D^2}{\mu_0}\right)\right] \tag{68}$$

Knowing the energy of each of the confined carrier-photons of the inner components of the proton, established in Table III in [42] as 4.974082389E−11 joules, the wavelength required to calculate their individual $\boldsymbol{B}$-fields can now be obtained from the standard energy conversion equation:

$$\lambda_{cP} = \frac{hc}{E} = \frac{hc}{4.974082389\text{E}-11} = 3.99359175238\text{E}-15\ \text{m} \tag{69}$$

We can now calculate the related $\boldsymbol{B}$-field:

$$\boldsymbol{B}_{cP} = \frac{4}{3}\frac{\mu_0 \pi e c}{\alpha^3 \lambda_{cP}^2} = 4.07949314367\text{E}19\ \text{T} \tag{70}$$

This provides for a $\boldsymbol{B}$-field energy density of:

$$u_{cP} = \frac{\boldsymbol{B}_{cP}^2}{2\mu_0} = 6.62174657493\text{E}44\ \text{j/m}^3 \tag{71}$$

The *theoretically immobilized incompressible isotropic energy volume* of the confined carrier-photon's energy can then be calculated as if it was completely immobilized into the smallest possible spherical volume:

$$V_{cP} = \frac{\alpha^5}{}\frac{\lambda_{cP}^3}{2\pi^2} = 6.67710023966\text{E}-56\ \text{m}^3 \tag{72}$$

At this point of the analysis, it is useful to mention that all calculations in this article were carried out on a TI-89 Titanium hand calculator, whose number of significant digits for internal calculation is 14 digits. So the numerical energy result obtained in coming Equation (73) that will follow seems to be heavily impacted due to the 100 orders of magnitude difference between the 6E44 numerical value obtained with Equation (71) and the 6E−56 numerical value obtained with Equation (72), which is assumed to be the cause of the difference between the calculated value of following Equation (73) and the expected more precise value obtained by different means in Table III in [42], and that was meant to confirm the soundness of the density value obtained with Equation (71) by multiplying it by the theoretically immobilized isotropic energy volume established with Equation (72):

$$E_{cP} = \frac{\boldsymbol{B}_{cP}^2}{2\mu_0} V_{cP} \cong 4.42140656424\text{E}-11\ \text{j} \quad \text{instead of } (4.974082389\text{E}-11\ \text{j}) \tag{73}$$

It is expected that a processor able to deal with the 100 orders of magnitude difference between the values calculated with Equations (71) and (72) should recuperate the correct initial energy value of 4.974082389E−11 joules from Equation (73). Consequently, the values calculated with the remaining coming equations are at best approximate and need to be confirmed with more capable computer equipment. Resolving Equation (67) for the energy density of the proton, we obtain:

$$T^{00}_{\text{Proton}} = \frac{1}{c^2}\left[6\left(\frac{\boldsymbol{B}^2_{cP}}{2\mu_0}\right) + 2\left(\varepsilon_0\boldsymbol{E}^2_U + \frac{\boldsymbol{B}^2_U}{\mu_0}\right) + \left(\varepsilon_0\boldsymbol{E}^2_D + \frac{\boldsymbol{B}^2_D}{\mu_0}\right)\right] \cong 8.4122408\text{E}28\ \text{kg/m}^3 \tag{74}$$

From the total energy of the 3 confined carrier-photons obtained from Table III in [42]—1.492224716E−10 joules—a pseudo-wavelength corresponding to this total amount of the energy can be established:

$$\lambda_p = \frac{hc}{E} = \frac{hc}{1.492224716\text{E}-10} = 1.331197251\text{E}-15\ \text{m} \tag{75}$$

and the *theoretically immobilized incompressible isotropic energy volume* of the 3 carrier-photons of a proton can be calculated:

$$V_{cP} = \frac{\alpha^5}{}\frac{\lambda^3_{cP}}{2\pi^2} = 2.47300009\text{E}-57\ \text{m}^3 \tag{76}$$

Finally, the rest mass of the proton can be obtained:

$$m_P = \frac{1}{c^2}\left[6\left(\frac{\boldsymbol{B}^2_P}{2\mu_0}\right)V_{cP} + 2\left(\varepsilon_0\boldsymbol{E}^2_U + \frac{\boldsymbol{B}^2_U}{\mu_0}\right)V_U + \left(\varepsilon_0\boldsymbol{E}^2_D + \frac{\boldsymbol{B}^2_D}{\mu_0}\right)V_D\right] \cong 1.67262158\text{E}-27\ \text{kg} \tag{77}$$

Establishing the density parameters of the neutron rest mass from the known energy of its inner components confined carrier-photons, established in Table III in [42] as 4.962568577E−11 joules, will allow the density of the rest mass energy of the neutron to be recuperated by resolving Equation (68), which will allow its rest mass of ≅1.67492716E−27 kg to be recuperated in a similar manner.

9. Gravitation

As observed previously, and vectorially represented with **Figure 13** and **Figure 14**, the momentum energies of the 3 confined carrier-photons, that maintain the inward pressure that establishes the stationary action resonance of the charged particle triad by counteracting the default mutual magnetic and electric repulsion between the three charged particles involved, mutually cancel each others' motion by all three being symmetrically oriented toward the geometric center of the proton and neutron at 120˚ angles from each other, which leaves no momentum energy available to sustain their motion in space.

What allows isolated and omnidirectionally inert protons and neutrons to move—corresponding to trispatial vector structures *of level* 2—can therefore only be the introduction of an additional carrier-photon of trispatial *level* 0 (**Figure 16**), that defines its velocity in space as a function of the distances separating its three *charges* from those of all the surrounding elementary particles of opposite charge, an example of which has been provided in Section 13 in [23] for the hydrogen atom, which we will illustrate below.

Figure 9 and **Figure 10** in [51] and [52], reproduced here as **Figure 17**, represented various aspects of the hydrogen atom *at rest*.

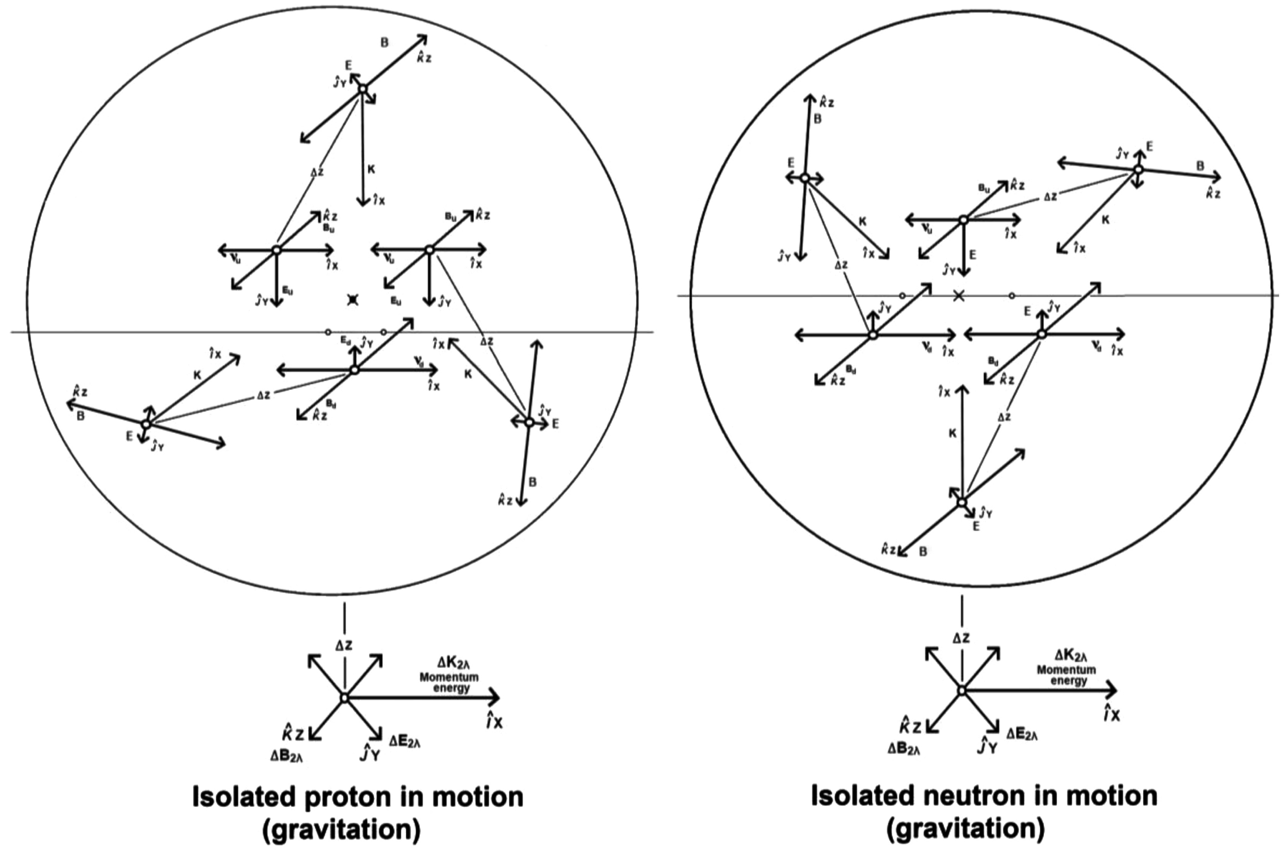

Figure 16. Isolated proton and neutron in motion-gravitation, level 3 trispatial vector complexes.

We will now represent with **Figure 18** this isolated hydrogen atom, which becomes in the trispatial vector geometry *a level* 3 vector object, with its *level* 0 carrier-photon vector complex representation, to explain its motion or the pressure it exerts in space. The representation is obviously not to scale.

As put in perspective in [23], it was a conclusion reached by Einstein in an article published in 1910, that strangely had been available only in French for more than a century [68] due to the German original having been lost, until it was finally formally translated to English in 2021 [69], that provided the bridge required between kinematic and electromagnetic mechanics that eventually allowed clearly relating the Coulomb restoration force to the gravitational force as analyzed in [22] and [48], and analyzed further in **Section 3** of this paper.

"*On peut, par exemple, obtenir de cette façon les équations du mouvement d'un point matériel de masse m portant une charge électrique e* (*par exemple un électron*) *et soumis à l'action d'un champ électromagnétique. On connaît, en effet, les équations du mouvement d'un point matériel à l'instant où sa vitesse est nulle. D'après les équations de Newton et la définition de l'intensité du champ électrique, on a*:" Albert Einstein (1910) ([68], p. 143).

"*We can, for example, obtain in this way the equations of motion of a material point of mass m carrying an electric charge e* (*for example an electron*) *and subjected to the action of an electromagnetic field. We know, in fact, the equations*

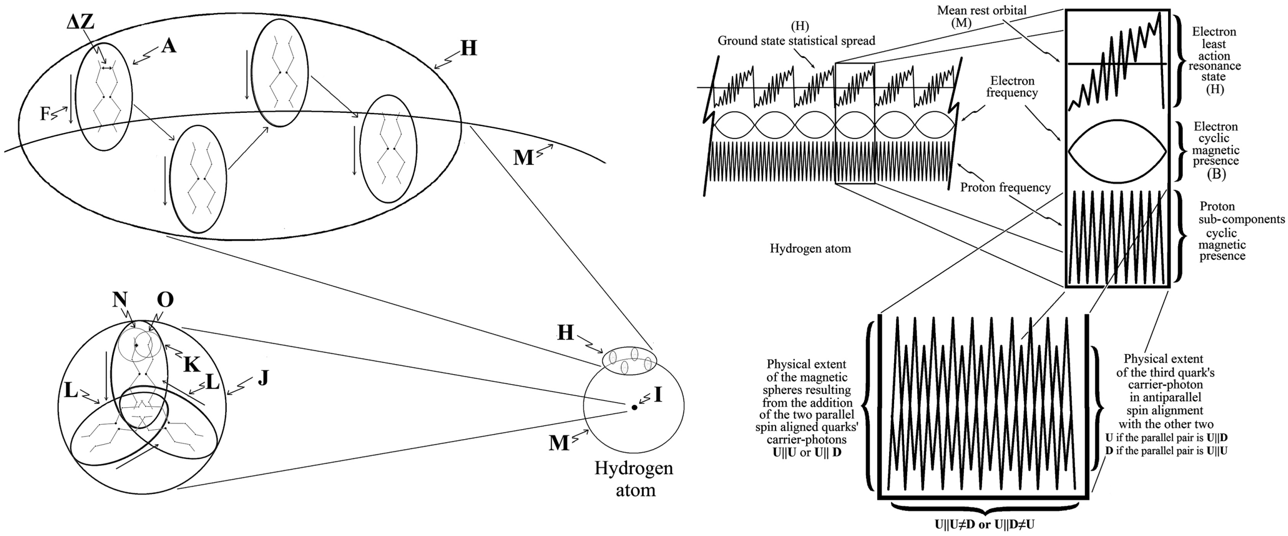

Figure 17. The isolated hydrogen atom at rest—level 2 trispatial vector complex.

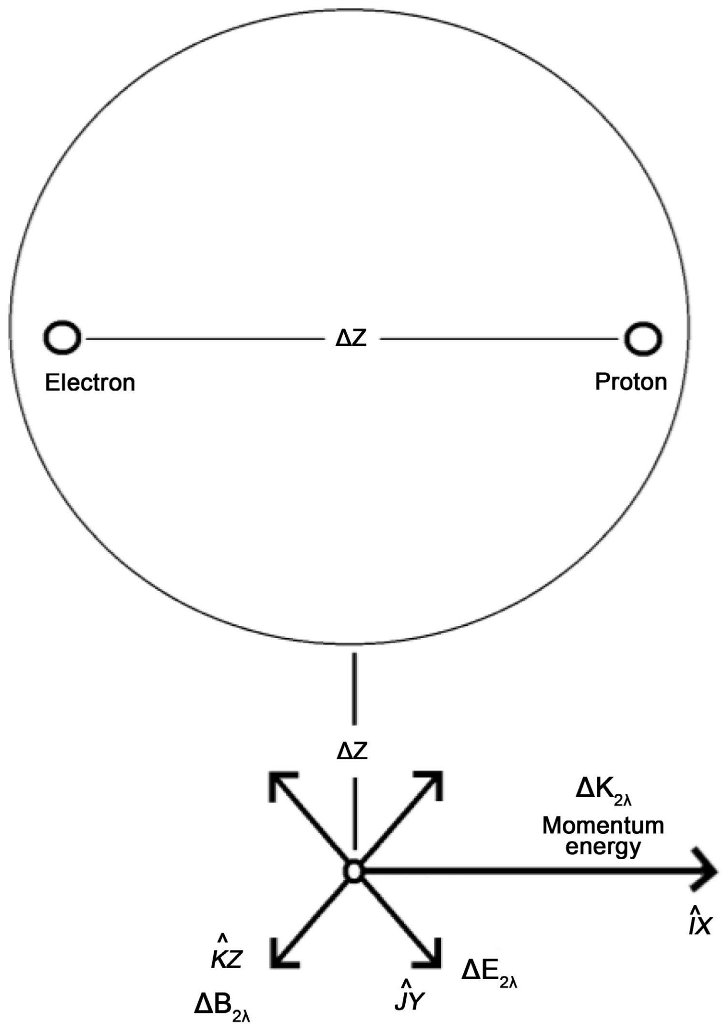

Figure 18. The hydrogen atom in motion—gravitation, level 3 trispatial vector complex.

of motion of a material point at the moment when its velocity is zero. According to Newton's equations and the definition of the electric field strength, we have":

$$m\frac{\mathrm{d}^2 x}{\mathrm{d}t^2} = e\boldsymbol{E}_x \quad \text{([69], p. 95, Equation (2))} \tag{78}$$

Let us emphasize that this equality was deemed valid by Einstein specifically between the force calculated from *the invariant rest mass* of the electron in Newton's kinematic acceleration equation—that is, $F = ma$, first term of Einstein's Equation (2)—and the force calculated from *the invariant charge of the electron* in Lorentz's electromagnetic force equation's first term—that is, $F = e\boldsymbol{E}$, second term of Einstein's Equation (2). The Lorentz force Equation (24) is reproduced here for convenience, replacing the generic charge q with the unit charge e of the electron, to make the relation with Einstein's Equation (2) more obvious:

$$F = e\boldsymbol{E} + e\boldsymbol{v} \times \boldsymbol{B} \tag{79}$$

When Gauss defined the **E** field, he did so by removing one charge from the Coulomb equation:

$$F = \frac{q^2}{4\pi\varepsilon_0 r^2}, \quad \frac{F}{q} = \frac{1}{q}\frac{q^2}{4\pi\varepsilon_0 r^2} = \boldsymbol{E} = \frac{q}{4\pi\varepsilon_0 r^2}, \quad \boldsymbol{E} = \frac{q}{4\pi\varepsilon_0 r^2} \tag{80}$$

So, if we reintroduce the invariant charge of the electron in the resultant Equation (80) as in Einstein's Equation (2), we recuperate the fundamental Coulomb equation by relating the charge of the electron, with Q now redefining the remaining q as representing the sum of all charges of opposite sign in the environment, with which this single electron is now interacting, and R redefining r as the mean distance separating the unit charge of the electron from the mean distance at which the resultant sum Q of the surrounding charges of opposite sign are located, thus using the same symbolism used by de Broglie in Equation (42) to represent the various radii related to the hydrogen atom orbitals. So the second term of Einstein's Equation (2) now becomes:

$$F = e\boldsymbol{E} = e\frac{Q}{4\pi\varepsilon_0 R^2} = \frac{e \cdot Q}{4\pi\varepsilon_0 R^2}, \quad F = e\boldsymbol{E} = \frac{e \cdot Q}{4\pi\varepsilon_0 R^2} \tag{81}$$

The Coulomb equation provides the momentum energy, plus an equal amount of energy that self-orients perpendicular to the direction of motion or applied pressure and that establishes the two opposing forces of the transverse $\Delta\boldsymbol{E}$ and $\Delta\boldsymbol{B}$ fields whose transverse action antagonize each other to maintain the particle on a default straight-line path if no external force interferes.

Magnetic fields being additive, if some external $\boldsymbol{B}_{\text{external}}$ field is applied from outside in addition to the default $\Delta\boldsymbol{B}$ field provided by the local Coulomb interaction between charges e and Q that defines the equal intensity $\Delta\boldsymbol{E}$ and $\Delta\boldsymbol{B}$ fields, the trajectory of charge e will be deflected according to the intensity ratio modified from default 1/1 to the new intensity ratio $\Delta\boldsymbol{E}/\Delta\boldsymbol{B} + \boldsymbol{B}_{\text{external}}$.

But we know from the carrying-photon internal structure as described with Equation (66) that the energy represented by the $\Delta\boldsymbol{E}$ and $\Delta\boldsymbol{B}$ fields of the Lorentz force Equation (25) oscillates between these two states, and that they constitute only half of the energy induced by the Coulomb Equation (81).

This is why in high energy accelerators, the traditional method used to introduce the momentum energy related to ratio $\Delta\boldsymbol{E}/\Delta\boldsymbol{B} + \boldsymbol{B}_{\text{external}}$ consists in first equating $ev\boldsymbol{B}$ with the relativistic version of Newton's kinetic energy equation multiplied by 2 as clearly explained in Reference [70], in which $\Delta\boldsymbol{B}$ is kept at maximum value to account for the sum of the energies $\Delta\boldsymbol{E} + \Delta\boldsymbol{B} = \Delta\boldsymbol{B}_{\text{Maximum}}$.

$$ev\boldsymbol{B}_o = \gamma \frac{m_o v^2}{r_o} \tag{82}$$

which, in context becomes:

$$ev\left(\boldsymbol{B}_e + \Delta\boldsymbol{B}_{\text{Maximum}} + \boldsymbol{B}_{\text{External}}\right) = \gamma \frac{m_o v^2}{r_o} \tag{83}$$

From which can be isolated the radius of the curved trajectory that one wishes an isolated electron to follow:

$$r_o = \gamma \frac{m_o v}{e\left(\boldsymbol{B}_e + \Delta\boldsymbol{B}_{\text{Maximum}} + \boldsymbol{B}_{\text{External}}\right)} \tag{84}$$

So, for straight line motion of an electron, for the Lorentz force equation as previously developed as Equation (25) to account not only for energy oscillating between the $\Delta\boldsymbol{E}$ and $\Delta\boldsymbol{B}$ fields mutually inducing each other in alternance, but also for the other half of the energy induced by the Coulomb interaction between the unit charge e and the sum Q of the charges of opposite sign in the environment, Equation (25) could be written in relation with Equation (81) in the following manner; now directly equating the electron carrier-photon energy provided by the Coulomb equation, as illustrated with **Figure 18**, with that provided by this amended Lorentz force equation:

$$F = \frac{\Delta K}{r} + q\left[\left(\boldsymbol{E}_e \times \Delta\boldsymbol{E}\right) + \boldsymbol{v} \times \left(\boldsymbol{B}_e + \Delta\boldsymbol{B}\right)\right] = \frac{e \cdot Q}{4\pi\varepsilon_0 R^2} \tag{85}$$

In which

$$\Delta K = F \cdot r = \frac{e \cdot Q}{8\pi\varepsilon_0 R} \tag{86}$$

And

$$\Delta m_m = \left(\frac{\varepsilon_0 \Delta\boldsymbol{E}^2}{2} + \frac{\Delta\boldsymbol{B}^2}{2\mu_0}\right)\frac{1}{c^2} = \cdot\frac{F \cdot R}{c^2} = \frac{e \cdot Q}{8\pi\varepsilon_0 R}\frac{1}{c^2} \tag{87}$$

The equality of the force between $F = ma$ and $F = e\boldsymbol{E}$ observed by Einstein in the case of the electron, combined with this detailed confirming analysis of the Lorentz force equation, both demonstrated as being the same electromagnetic force in [71], is what allowed in [23] the establishment of the method to calculate the energy induced by the trispatial vector level 4 mass of the Earth, made up of atoms and molecules representable by level 3 trispatial vector complexes by means of using a level 3 hydrogen atom that would theoretically be lying on the ground at its surface.

The composite attractive charge of the Earth could then be calculated, leading to calculating the number of elementary charges of which the trispatial vector level 4 mass of the Sun is made, and so on for the astronomical level, as calculated in [23].

10. Conclusions

This paper completes the analysis in which kinematic mechanics and electromagnetic mechanics can be harmonized by adapting the equations of Newtonian mechanics to account for the magnetic field of localized elementary particles, which then allows the kinematic and electromagnetic equations to be used to describe both the properties and interactions of these particles.

It also concludes the description of the various levels of the trispatial vector field, which introduces the level 0 of elastic tension as corresponding to the center-of-presence of the trispatial vector complexes that account for the properties of electromagnetic photons; level 1 introducing the universal electrostatic recall constant and the resulting universal Coulomb restoring force which are established as a consequence of the stabilized separation of electrons and positrons from destabilization of sufficiently energetic level 0 photons.

Level 2 then introduces the densest stable nucleon structures that triads of level 1 particles can establish, level 3 concerning the more complex assemblies allowed by combinations of level 1 and level 2 particles, that is, assemblies representing the complete set of elements of the periodic table, and finally level 4 concerning all of the level 3 accumulations that can be established in the trispatial vector field, all of which interact as a function of the tension provided by the electrostatic recall constant, and the resulting restoration force that induces in all stabilized vector structures the level 0 carrier-photons that are responsible for their direction of motion, applied pressure in this direction, and added mass increments.

It is expected that these analyses will allow the eventual development of differential equations applicable to each domain from a common basis as envisioned by Wien, and also the eventual development of the set of complex wave equations required to account for the beat frequencies of free moving electrons, as well as for the more complex beat frequencies of their various stationary action states in atoms, as analyzed in [51] [52].

For a thorough analysis of the historical development of electromagnetic theory that lead to Wilhelm Wien's project [7] to establish mechanics on an electromagnetic foundation, the remarkably well-researched and documented Chapter 2 in [72]—entitled "*Mechanics and Electromagnetism in the Late Nineteenth Century*" by *Roberto de Andrade Martins*—is highly recommended.

Conflicts of Interest

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

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