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Electromagnetic and Kinematic Mechanics Synchronized in their Common Vector Field: A Mathematical Relation (Extended Republication PI)

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Abstract: The purpose of this chapter is to establish the clear mathematical relations that exist between kinematic mechanics and electromagnetic mechanics, in accordance with Wilhelm Wien's project formulated in 1901. This harmonization was made possible by the integration in kinematic mechanics of the mass increase of the electron as a function of its velocity, as measured by Walter Kaufmann by means of his bubble-chamber experiments, which was confirmed by H. A. Lorentz and all the leading edge physicists who analyzed his data; and the establishment the electromagnetic structures and mutual interactions of the restricted set of stable elementary particles within the framework of trispatial vector geometry, which emerges naturally from the triply orthogonal relationship that Maxwell discovered between the magnetic field, the electric field and the direction of motion of light in a vacuum. Description of the local trispatial vector complexes of the restricted set of stable elementary particles, of their stable combinations up to the atomic level and finally, of the four stable stationary resonance levels of the trispatial vector field. Analysis of the experimental confirmation of the magnetic nature of the electron spin; and establishment of its relation with the concept of magnetic monopole, of covalent molecular bounding, of the filling of electronic orbitals by electron pairs, of the generation of Cooper pairs, and of the related interpretation of the Stern-Gerlach experiment.

Keywords: Kinematic mechanics; Electromagnetic mechanics; Electrostatic recall constant; Restoration force; Gravitation.

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Electromagnetic and Kinematic Mechanics Synchronized in Their Common Vector Field: A Mathematical Relation

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ABSTRACT

The purpose of this chapter is to establish the clear mathematical relations that exist between kinematic mechanics and electromagnetic mechanics, in accordance with Wilhelm Wien's project formulated in 1901. This harmonization was made possible by the inclusion in kinematic mechanics of Walter Kaufmann's measurements of the electron's mass increase as a function of its velocity, which H. A. Lorentz and all of the most cutting-edge physicists who examined his data confirmed; and the establishment of the electromagnetic structures and mutual interactions of the restricted set of stable elementary particles within the framework of the general theory of relativity. Description of the local trispatial vector complexes of the restricted set of stable elementary particles, of their stable combinations up to the atomic level and finally, of the four stable stationary resonance levels of the trispatial vector field. Analysis of the experimental confirmation of the magnetic nature of the electron spin; and establishment of its relation with the concept of magnetic monopole, of covalent molecular bounding, of the filling of electronic orbitals by electron pairs, of the generation of Cooper pairs, and of the related interpretation of the Stern-Gerlach experiment.

Keywords: Kinematic mechanics; electromagnetic mechanics; electrostatic recall constant; restoration force; gravitation.

1. INTRODUCTION

The interaction between particles with electric charge and electromagnetic fields is known as electromagnetism in physics. One of the four basic forces of nature

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is the electromagnetic force. In interactions between atoms and molecules, it is the dominating force. It is possible to think about electromagnetism as a mixture of electrostatics and magnetism, two separate yet interwoven phenomena. Magnetism is an interaction that only happens between charged particles in relative motion, whereas electromagnetic forces happen between any two charged particles, generating an attraction between particles with opposing charges and a repulsion between particles with the same charge. A branch of physics called kinematics, which was evolved from classical mechanics, defines how points, bodies, and systems of bodies (groups of objects) move without taking into account the forces that propel them. The discipline of kinematics is frequently referred to as the "geometry of motion" and is occasionally considered to be a subfield of mathematics. Any known values of the location, velocity, and/or acceleration of points inside the system are declared as initial conditions for a kinematics issue, together with the geometry of the system [1a-1d].

In the early 1900s, there was ongoing discussion about whether the mass of bodies is mechanical in nature, as established by experiments with macroscopic masses, or electromagnetic in nature, as revealed by recent findings from data gathered about the electromagnetic behavior of electrons in Walter Kaufmann's bubble chamber [1] [2] [3] [4], using electron beams that are accelerated and guided on curved paths [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* (1900)[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, from these considerations it seems to me with certainty that the system of our kinematic mechanics up to now is unsuitable for the representation of electromagnetic processes."*

Unbeknownst to him at this point in time, because although Planck had already identified and calculated constant *h* that bears his name from Wien's black body data, it was only in 1924 that this constant was derived from a classical mechanics equation by Louis de Broglie, and much later yet, in 2013, that it was also derived from an electromagnetic equation, as will be put in perspective in **Section 6**, which clearly confirmed that both domains were effectively related by this constant that could be shown to be emergent from both mechanics.

His most important argument in favor of using electromagnetism as a common foundation for both mechanics 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] [11] [12] [13] [14] [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 References [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, which is a conclusion that was 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 acceleration 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 himself [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. Recently, 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 – see **Section 3.3** further on –, that is, electromagnetic photons exceeding ever so slightly the threshold energy of 1.022 MeV, which is twice the 0.511 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 Reference [22].

Of course, the classical 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 base 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 made of 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 mutually induce each other and 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 elementary particles is made, as well as their *carrying energy*, that 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 of 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, irrespective 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 and length of bodies according to velocity as a function of the γ-factor, with the lengths of masses considered as contracting and time considered as 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 energy represented in electromagnetic mechanics by the mutually inducing locally oscillating $\Delta \boldsymbol{E}$ and $\Delta \boldsymbol{B}$ fields representations of its carrying energy, as well as the associated

ΔKmomentum 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, in conformity with the γ-factor being intrinsically accounted for both for the momentum energy and 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 macroscopic masses, 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 are made 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 macroscopic masses interacting with very large macroscopic 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 macroscopic 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 Reference [23].

This summarizes about all that we can directly measure from our macroscopic perspective, of the sum of the electromagnetic interactions that exist between all charged particles occurring at the subatomic level, of which all macroscopic masses are made.

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 [24] [19] [20]. However, this discovery was obviously insufficient to induce reconsideration, because much later, in the 1980s, the opinion of Pais quoted above still was that their relations could only be purely kinematic. However, 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 Reference [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 Figs. 1 and 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.

But whereas Lorenz represents them as *timewise* reaching *simultaneously* their maximum intensity (Fig. 2), Maxwell initially conceived them as *timewise* alternately reaching their maximum intensity while being 180° out of phase (Fig. 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.

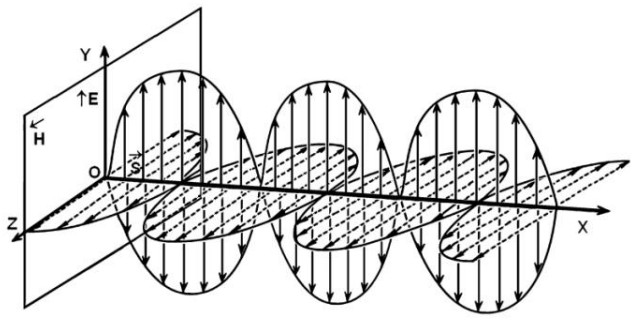

Fig. 1. *Spacewise* orthogonal *E*- and *B*-fields transverse oscillation representation of an electromagnetic pulse propagating in an underlying elastic medium – defined as the *aether* – *spacewise* dephased by 90° and *timewise* dephased by 180°, and mutually inducing each other, involving the assumed existence of a *displacement current* as conceived by Maxwell

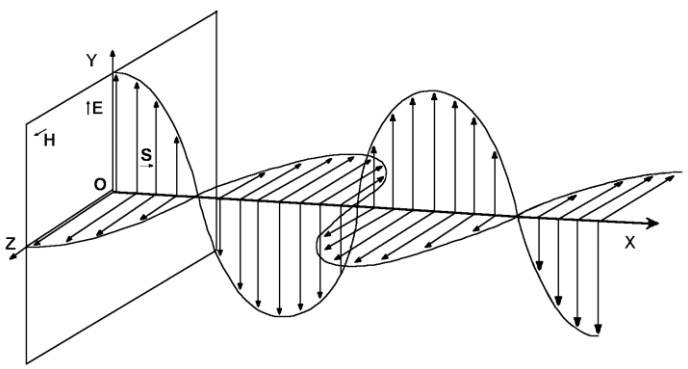

Fig. 2. Standard *spacewise* orthogonal *E* and *B* fields transverse oscillation representation of an electromagnetic pulse propagating in an underlying elastic medium – defined as the *aether* – *spacewise* dephased by 90° and simultaneously peaking *timewise* in phase to maximum intensity, corresponding to the *Lorenz gauge* interpretation

Maxwell's concepts of a *displacement current* and of ***E***- and ***B***-fields treated as separate entities inducing each other by means of an *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 stable elementary particles 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 for 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^{o} from each other to explain the velocity of light in the longitudinal direction in vacuum (Figs. 1 and 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 Reference [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 (Figs. 1 and 2).

$$\frac{\partial^2 \mathbf{B}}{\partial x^2} = \mu_0\,\varepsilon_0\,\frac{\partial^2 \mathbf{B}}{\partial t^2} \text{ and} \qquad \frac{\partial^2 \mathbf{E}}{\partial x^2} = \mu_0\,\varepsilon_0\,\frac{\partial^2 \mathbf{E}}{\partial t^2} \tag{2}$$

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 *absolutelyinvariant speed of light* in vacuum, given that both ε_0 and μ_0, the only two parameters that define the speed of light are themselves known to be absolutely invariant in the close to zero density of the vacuum medium.

The almost immediate adoption by the community of the Lorenz gauge approach (Fig. 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 of 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 3X3D+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 (Fig. 3a). Configuration **3b** and **3c** will be addressed further on.

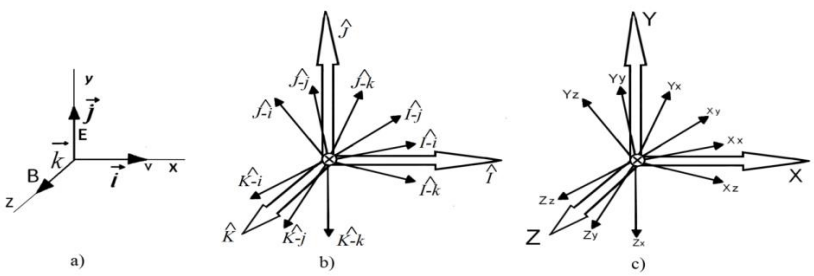

Fig. 3. Major and minor unit vector sets applicable to the trispatial geometry

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, and 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 on 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 Fig. 3a.

In the early 1930's, about 30 years after Einstein published his first 1905 paper on the issue of the possible permanent maintenance of the localization of electromagnetic energy as quanta moving on specific trajectories after emission instead of its spherical propagation from its point source as conceived by Maxwell, 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 moving separately in space, 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).

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

We will now examine with Fig. 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 illustrate the mechanics of this conversion, Fig. 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.

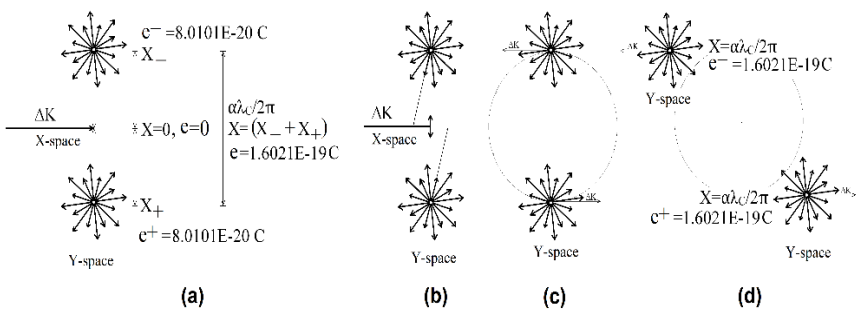

Fig. 4. A 1.022 MeV photon decoupling into an electron-positron pair

Fig. 4a 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 Fig. 4a 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:

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

It was established in Reference [31] that even though the energy of localized photons is represented 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 Fig. 4a:

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

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

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

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):

$$k = -\frac{E_C}{A_C{}^2} = -\frac{8.187104139E-14}{(\alpha\lambda_C/2\pi)^2} = -1.031019177E16\ j/m^2 \quad (8)$$

Thus, as illustrated in Fig. 4a, 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, at which point whose energy will have momentarily completely evacuated Y-space while simultaneously reaching its maximum magnetic *presence* in Z-space:

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

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:

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

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 cause us to hit upon a familiar force value, 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:

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

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:

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

Which tentatively confirms, as initially calculated in Reference [30], that *electrostatic recall constantk*=-1.031019177E16 j/m^2 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 Reference [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, ever so 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 Fig. 4a, while the oscillating energy is simultaneously momentarily immobilized at 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 physical existence of the *fundamental electromagnetic energysubstance*, and that its cause could be related to the intrinsic properties of this energy *substance*. The 4 properties identified in References [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*, which allows the *energy* substance to stretch and contract due to a property of *fluidity*, without its volume varying, due to a property of *incompressibility*, and finally a property of *tending-to-always-remain-in-motion* that renders it physically unable to remain immobile.

As analyzed in depth in References [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 mathematically confirmed in References [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 as illustrated with Fig. 4a.

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 reached by electrons and positrons in the universe as each pair decouples, physically separating into equal parts the entire amount of 1.022+ MeV energy of the photon from which they originated, and which then remains at this maximum return intensity in all

electrons and positrons in the universe, as illustrated with Fig. 4d. It could even be considered that the unit charge of electrons and positrons is nothing other than *the fundamental elastic recall intensity constant 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 obey its *tendency-to-always-remain-in-motion* after reaching maximum extension turn 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 Fig. 6c shown further on.

Having then completely evacuated Y-space as its amplitude reaches zero in this space and as 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 Fig. 6e, 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, all 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 Fig. 4, whose *set of 1.602176462E-19 Coulomb intensity level centers-of-presence* would establish *two opposite signs trispatial vector fields, one on either side of the zero level field*, each element of which constantly seeking to join any 1.602176462E-19 Coulomb intensity level element of the opposite signs level 1 field with the recall intensity established with Equation (8), thus defining *a trispatial gravitational field of level 1 trispatial vector complexes*, and each element of which is 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 ultimately 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

Fig. 4b 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 Fig. 4a, that initiates the usual transfer process to Z-space. This deflection of their return trajectories initiates an orbital motion around the photon *center-of-presence* that will inexorably drive them to reach a circular escape orbit, as analyzed in Reference [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 on that orbit, as shown in Fig. 4c, at which point they will separate to move separately into X-space, sharing the remaining energy of the initial photon, as shown in Fig. 4d. The complete mechanical decoupling cycle of the initial photon into an electron-positron pair is analyzed in depth in reference [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 could only be 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 half of it corresponding to an invariant ***E***-field, given the invariance of its unit charge, while the other half could only correspond to an oscillating ***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 wavelength of the electron rest mass energy (λ_c) –, i.e., a magnetic ***B***-field as discovered by Marmet in 2003 [28], whose oscillation, already determined by Maxwell to mandatorily apply in the case of free moving electromagnetic energy, was experimentally confirmed by similarity with the experiment published in 2013 [38], and was directly confirmed to apply to electrons with the 2014 Kotler et al. experiment [39]. See **Section 10** regarding this experimental confirmation issue.

A first telltale as to which direction should be investigated to allow establishing this mechanical conversion illustrated by Fig. 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 – analyzed in depth in [33] [34] – can be satisfied for localized electromagnetic quanta if the self-sustaining oscillation occurs on *a planeperpendicular to the direction of motionof the energy in space*, a plane already hinted at by the traditional plane wave treatment of energy (Fig. 5a), 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.

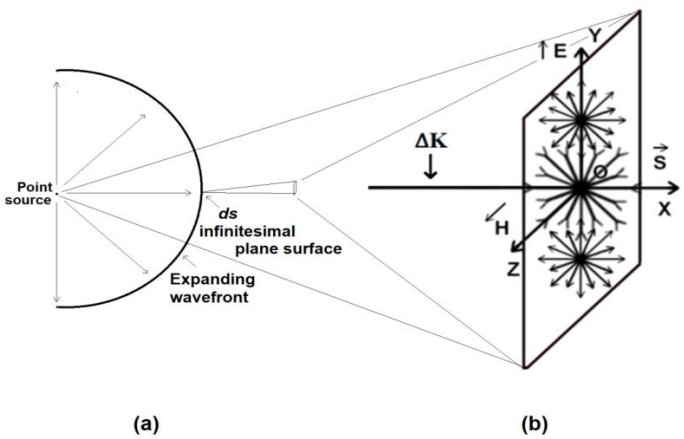

Fig. 5. Comparison between traditional plane wave treatment of the energy of an electromagnetic energy pulse that would be spherically expanding in an underlying medium (the aether) from its point of emission (Fig. 5a), and treatment of the same energy pulse remaining localized as it propagates without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

Let us recall that plane wave treatment in the traditional spherical expanding 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 (Fig. 5a), 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 (Fig. 5b).

> *"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 Fig. 5b, the vector representation is a freeze of the motion of the oscillating energy at step 6d of Fig. 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 all of the photon energy remains contained within its local oscillating volume, its source always remaining local to the *center-of-presence* of the photon all along its trajectory.

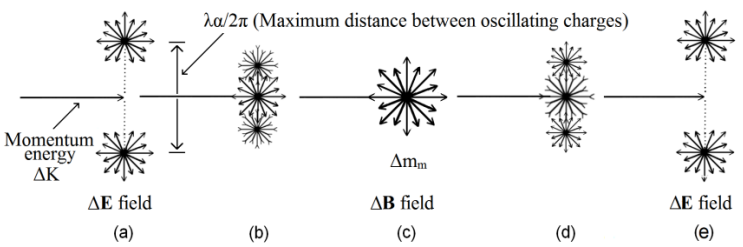

Fig. 6. Representation of the stationary transverse oscillation cycle of the oscillating electromagnetic half-quantum of a free moving photon or of the carrier-photon of an electron

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 (Fig. 3a). When the ***j*** and ***k*** minor unit vectors of *normal space* representing the ***E*** and ***B*** fields are *expanded* into becoming *fully developedmajor 3D vectorial spaces* represented by ***J*** and ***K****major unit vectors*, each possessing its own internal ***ijk*** *minor unit vectors set*, a *fully developed major 3D vectorial normal space*, represented by a *major unit vector* ***I*** emerges by vectorial cross product of the majors vectors ***J*** and ***K***, that also maintains its usual *internal set of minor* ***ijk*** *unit vectors* (Figs. 3b and 3c).

Thus emerged, for visualization purposes, the 3x3D+1 augmented vector space that underpins the trispatial model, with the +1 element of course representing the time dimension. The difficulty for us of mentally visualizing more than 3 perpendicular dimensions at once is solved by treating each of the major 3D vector spaces ***I J K***as if they were folded 3-ribbed umbrellas meeting perpendicularly at their three tips, and which, once folded, reduce the set of major 3x3D vector spaces to the basic 3D cross product vector representation of Fig. 3a. Simply opening the umbrellas one by one, allows visualization in sequence of the movement of the energetic substance as it circulates within each 3D vector space 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 Fig. 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. See Figs. 14 and 15 further on.

The development of the trispatial vector complex is what allowed the development in References [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):

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

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 kinematic 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 (1) 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 additionto* 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 ΔK / ($\Delta m_m c^2$ + $m_0 c^2$) can never reach unity as in the case of Equation (1), in which the energy ratio ΔK / $\Delta m_m c^2$ 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 Reference [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 ($E=m_0c^2$=8.18710414E-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 $\Delta K= \frac{1}{2}m_0v^2$ 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 Reference [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:

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

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 (1) for the photon developed in Reference [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 Reference [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 from an electromagnetic equation in Reference [37],thus demonstrating that the gamma factor is naturally embedded into 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 masses length contraction assumed as a premise in the SR theory.

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

These developments then allowed the establishment of the 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 References [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 is suddenly stopped in its forward motion as it becomes captive of the resonance state of an atom's available orbital after having accelerated to reach this equilibrium state, due to the resistance of its forward moving momentum energy to have its state of motion modified in accordance with Newton's first law of motion, and whose resulting emission mechanics is analyzed in References [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 Reference [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 Reference [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 electromagnetic mechanics of emission is analyzed in Reference [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 ***E*** and ***B*** fields must induce each other in alternance as hinted at by the 1998 experiment (see **Section 10**), 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 carrying energy, a process which must involve by structure the *displacement current* that Maxwell conceived of as being involved on the ***E*** side of the relationship, that would induce the magnetic field ***B*** increasing to its maximum intensity while the ***E*** field reduces to zero, followed by the re-establishment of the *displacement current* of the ***E*** field as the ***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:

$$\Delta \mathrm{E} = \mathrm{d} \cdot \mathrm{F} = \mathrm{d} \cdot \mathrm{q}\mathbf{E} = \mathrm{d} \cdot \mathrm{q}_1 \frac{\mathrm{q}_2}{4\pi\varepsilon_0 \mathrm{d}^2} = \mathrm{d} \cdot \frac{\mathrm{q}_1\mathrm{q}_2}{4\pi\varepsilon_0 \mathrm{d}^2} = \frac{\mathrm{q}_1\mathrm{q}_2}{4\pi\varepsilon_0 \mathrm{d}} = \frac{\mathrm{e}^2}{2\varepsilon_0\alpha\lambda} \qquad (20)$$

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:

$$\Delta K = m_0 c^2 (\gamma - 1) \qquad (21)$$

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:

$$\Delta \mathrm{m}_\mathrm{m} \mathrm{c}^2 = \mathrm{m}_0 \mathrm{c}^2 (\gamma - 1) \qquad (22)$$

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

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

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 $\Delta\boldsymbol{E}$ state and a magnetic $\Delta\boldsymbol{B}$ state that provides 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:

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

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

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

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 $\Delta\boldsymbol{E}/(\Delta\boldsymbol{B} + \boldsymbol{B}_{external})$ 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. See **Section 9** about this specific issue.

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:

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

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

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

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 the same reference [31]:

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

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 ***E*-**field component used in the Lorentz force Equation (24) in relation with the same density ***B***-field to guide electrons on straight line trajectories:

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

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]:

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

an LC equation could be derived in Reference [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:

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

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 Reference [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 Reference [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:

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

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 $\Delta \boldsymbol{E}$ 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:

$$E_e = \Delta E + m_0 c^2 = \Delta K + \Delta m_m c^2 + m_0 c^2 \tag{37}$$

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 the correct energy of any frequency recorded was systematically obtained by the product of the frequency by a smallest common multiplier that he had calculated to have the very precise

value of 6.62606876E-34 that was then symbolized by the letter *h* and given the name of *Planck's constant* to honor his discovery:

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

In his 1924 doctoral thesis, Louis de Broglie then succeeded by a brilliant deduction to relate Planck's constant to the theoretical ground orbit of the electron in the Bohr atom and to bring to light the fact that all frequencies emitted by the hydrogen atom are integer multiples the energy frequency related to the Bohr ground orbit. 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 References [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) ([50], p. iii)

His thesis was finally translated to English only in 2021 by the *Minkowski Institute* [50]. 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.

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 ([48], p.10), which clearly suggests 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 a 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 [49] [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:"*

$$m_0 \oint \mathbf{v} \cdot d\mathbf{l} = 2\pi R\, m_0 v = n\, h \tag{42}$$

Before analyzing in detail this simple classical kinematic mechanics equation that so deeply revolutionized physics, let us review how he conceived of this relation, also explained in introduction to References [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."* ([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].

The critical conclusion of this note is the following:

> *"l'onde de fréquence v et de vitesse c/β doit être en résonance sur la longueur de la trajectoire. Ceci conduit à la condition:"*
>
> *"The wave of frequency v and velocity c/β must be in resonance on the whole length of the trajectory. This leads to condition:"*

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

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

The following year, de Broglie published two more notes [55] [56], to which he refers in Reference ([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 $p=m_0v$ 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 mass 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:

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

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

$$\mathrm{v} = \sqrt{\frac{2 \cdot \Delta \mathrm{K}}{\mathrm{m}_0}} = \sqrt{\frac{2 \cdot 2.179871902\mathrm{E}-18}{9.10938188\mathrm{E}-31}} = 2187691.252\,\mathrm{m} \tag{45}$$

The length of the Bohr orbit is then:

$$\lambda_{\mathrm{R}_1} = 2\pi \mathrm{R}_1 = 2\pi \cdot 5.291772083\mathrm{E}-11 = 3.32491846\mathrm{E}-10\,\mathrm{m} \tag{46}$$

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 References [57] [58]:

$$\mathrm{h} = \lambda_{\mathrm{R}_1}\, \mathrm{m}_0 \mathrm{v} = 6.626068757\mathrm{E}-34\ \mathrm{j} \cdot \mathrm{s} \tag{47}$$

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 Reference [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 Reference [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 [50], for having resolved an issue that had mystified the community ever since Planck had calculated this constant from the blackbody radiation, that is, discovering a way to derive this constant from an already established equation on top of having demonstrated that the energy spectrum emitted by the hydrogen atom involved an integer related resonance sequence!

Incidentally, despite the fact that de Broglie derived Planck's constant as far back as a hundred years ago from a simple classical kinematic mechanics equation, and that it was also derived from an electromagnetic equation in 2013 [30], it is put in perspective in References [57] [58] that it is even definable by a precise set of well-established fundamental constants ($h=e^2/2\varepsilon_0 \alpha c$), despite still being considered in the community as a calculated constant, not derivable from first principles.

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:

$$\nu_{R_1} = \frac{v}{\lambda_{R_1}} = \frac{2187691.252}{3.32491846E-10} = 6.580495968E15\,\text{Hz} \qquad (48)$$

When multiplied by Planck's constant, this frequency provides the exact amount of energy induced by the Coulomb interaction at Bohr ground state R_1distance from the proton in the hydrogen atom:

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

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:

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

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 recovering 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:

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

This is how the 1924 equation allowed the establishment of the following equivalence $E=pc=h\nu=\Delta K+\Delta m_m c^2= 4.359743805E-18$ *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.

So we observe that not only could Planck's constant be calculated from the experimental data collected by means of the black body experiments, but that it could also be derived from the very structure of the classical Bohr atom, thus establishing a clear relation between classical kinematic mechanics and electromagnetic radiation frequencies. Moreover, Planck's constant could also be derived from strict electromagnetic considerations in Reference [30] – see comment following Equation (17) of this Reference – thus relating electromagnetic mechanics and kinematic mechanics at the most fundamental level by means of these derivations of Planck's constant from equations emerging from both mechanics.

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 Reference [31] in the first wave of derivations from Marmet's discovery, from the theoretical total immobilization of the electron incompressible 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 Reference [23], Aram D'Abro's analysis ([59], p. 217), highlighted the fact that when momentum energy is induced in charged particles by externally controlled ***E*** and ***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 energies due to their parallel magnetic spin orientation forced by structure [51] [52] – see **Section 10** –, 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:

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

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):

$$\mathbf{E}_e = \frac{\pi e}{\varepsilon_0 \alpha^3 \lambda_C{}^2} = 2.484979751\text{E}22\ \text{N/C}$$

$$\mathbf{B}_e = \frac{\mu_0 \pi e c}{\alpha^3 \lambda_C{}^2} = 8.289000222\text{E}13\ \text{T} \tag{53}$$

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

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

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

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

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:

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

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 Fig. 4d.
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 which is analyzed in depth in Reference [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 Reference [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 on their part, 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 found to be 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 that of 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 might somehow be very normal electrons and positrons whose characteristics of mass and charge would 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 other 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 Reference [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 $r_e = \alpha\lambda_c/2\pi = 2.817940285E\text{-}15m$ is the classical electron radius, i.e., the amplitude of oscillation of the electron's incompressible rest mass energy in the plane transverse to its direction of motion (see Fig. 4).

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

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

	Rest mass energy wavelength	**Rest mass**	**Charge (elastic recall tension)**
Electronor 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

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 Reference [61].

It is the drift of their energy from the ***E*** field state to the ***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 **Fig. 12** in **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 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:

$$\mathbf{E}_U = \frac{2}{3}\frac{\pi e}{\varepsilon_0 \alpha^3 \lambda_U{}^2} = 8.386806653\mathrm{E}22\ \mathrm{N/C}$$

$$\mathbf{B}_U = \frac{4}{3}\frac{\mu_0 \pi e c}{\alpha^3 \lambda_U{}^2} = 5.595075145\mathrm{E}14\ \mathrm{T} \qquad (58)$$

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

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

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

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

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

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

Which confirms the rest mass of the Up quark state obtained by different means in Reference [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 **Fig. 12** in **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:

$$\mathbf{E}_D = \frac{1}{3}\frac{\pi e}{\varepsilon_0 \alpha^3 \lambda_D{}^2} = 6.709445473\text{E}23\,\text{N/C}$$

$$\mathbf{B}_D = \frac{5}{3}\frac{\mu_0 \pi e c}{\alpha^3 \lambda_D{}^2} = 1.119015054\text{E}16\,\text{T} \tag{62}$$

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

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

The other values for the rest mass of the Down quark state of the electron will then beV_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.

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 (Fig. 9), 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.

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

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 the same Reference [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 unstable $\boldsymbol{\mu}$ 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 Reference [44]:

$$m_e c^2 \vec{\mathbf{0}} = \left[\frac{\varepsilon_0 \mathbf{E}_e^{\,2}}{2} \mathrm{V} \right]_{\mathrm{Y}} \vec{\mathbf{J}}\vec{\mathbf{i}} + \left[2 \left(\frac{\varepsilon_0 \mathbf{V}_e^{\,2}}{4} \right)_{\mathrm{X}} (\vec{\mathbf{I}}\vec{\mathbf{j}}, \vec{\mathbf{I}}\overleftarrow{\mathbf{j}}) \cos^2(\omega t) + \left(\frac{\mathbf{B}_e^{\,2}}{2\mu_0} \right)_{\mathrm{Z}} \overleftrightarrow{\mathbf{K}} \sin^2(\omega t) \right] \mathrm{V}_e \quad (64)$$

in which

$$V_e = \frac{\alpha^5 \lambda_C^{\,3}}{2\pi^2},\quad \mathbf{E}_e = \frac{\pi e}{\varepsilon_0 \alpha^3 \lambda_C^{\,2}},\quad \mathbf{B}_e = \frac{\pi \mu_0 ec}{\alpha^3 \lambda_C^{\,2}} \text{ and } \mathcal{V}_e = \frac{\pi e}{\varepsilon_0 \alpha^3 \lambda_C^{\,2}} \quad (65)$$

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* $\boldsymbol{v}_e$ – Greek letter *nu* – is assumed to behave in the same manner on the X-y/X-z plane within X-space as the ***E*** field energy behaves on the Y-y/Y-z plane in Y-space for free moving photons and for carrier-photons as represented in LC Equation (13), and as analyzed in Reference [29], since that when the sin^2 component equals zero, then the cos^2 component equals 1, and the reverse. This allows easily representing Maxwell's initial interpretation of the oscillation at frequency ωt between the ***E*** and ***B*** field states as mutually inducing each other in alternance while being timewise dephased by 180° (Fig. 1).

In the case of the electron rest mass energy, this oscillation represented in Equation (64) involves rather the $\boldsymbol{v}_e$ 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 $\boldsymbol{v}_e$ field and of the squared $\boldsymbol{B}_e$ field energies at any given moment is always equal by structure to either the squared $\boldsymbol{v}_e$ field energy at maximum or of the squared $\boldsymbol{B}_e$ field energy at maximum.

8. THE OSCILLATING ∆E AND ∆B FIELD ENERGY OF FREE MOVING ELECTROMAGNETIC PHOTONS, CARRIER-PHOTONS AND OTHER ELEMENTARY PARTICLES AND THEIR TRISPATIAL VECTOR COMPLEXES

The first iteration of the trispatial vector field emerged from Gauss's ontological definition of a *potential****E***-field that he conceptualized as centered on the single idealized punctual charge that remained in the Coulomb equation after having removed the other charge – see Equation (79) further on. That is, a *potential* field whose intensity diminishes omnidirectionally from infinity at the location of the remaining charge as a function of the inverse square of the distance within the virtual space thus defined. This of course means that if the charge removed by Gauss is reintroduced anywhere in this potential ***E***-field, the initial Coulomb equation is restored and the actual force in linear action between both charges can again be calculated as a function of the inverse of the square of the linear distance separating them.

Now, Gauss's definition of such a *potential**E***-field centered on a single localized charge, *de facto* establishes that a similar potential ***E***-field can be conceptualized about any existing elementary charge. Consequently, a second potential ***E***-field can also be conceptualized as centered on the second charge. If a third charge is now introduced at any distance from these two charges in the two ***E***-fields now populating the virtual space, a third ***E***-field can also be conceptualized as centered on this third charge, and two new occurrences of the linearly acting Coulomb force interaction come into being between this third charge and each of the two previously introduced charges, and so on for all additional elementary charges introduced in the virtual space until all existing elementary charges in the universe have theoretically been accounted for.

After having been summarily described in References [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 References [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, whose momentum energy component causes photons to self-propel at the velocity of light within X-space according to Equation (14); or applies the pressure within Y-space according to the orientation of this momentum energy within Y-space for charged electrons and positrons, that define the intensity of their charge as described in Reference [29].

Such virtual vector fields typically represent interacting bodies, from elementary particles to galaxies, as local mathematical points for easier analysis of their interactions with other bodies, which is the usual method to mathematically describe such interaction, as in the well understood case of classical mechanic equations meant to calculate the orbit of the Earth about the Sun for example, that theoretically assumes that the whole mass of the Earth as well as that of the Sun are localized at a single point located at their respective centers of mass – their *centers-of-presence* – for ease of calculation. The same method is of course used in the trispatial vector field.

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 vector complexes that account for elementary particles mass and motion at the subatomic level in the virtual universal vector force field in which the *center-of-presence* of each stable elementary particle, either boson (photon) or fermion (electron or positron) and of their more complex nucleonic and atomic assemblies, becomes the site of a specific trispatial vector complex, that will allow mentally zooming into each of their point-like representation in the trispatial vector field to mentally observe their local electromagnetic behavior.

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

representations of trispatial complexes related to the elements listed in the periodic table of elements, of which all masses in the universe are made.

The trispatial LC Equation (13) of the electromagnetic photon, reproduced below for convenience, was established in Reference [33]:

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

This equation was converted to its ***E*** and ***B*** fields equivalent equation in the same article:

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

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 1997 McDonald et al. 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 Reference [29] and summarized previously in **Section 3** in relation with Fig. 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 Fig. 3, oscillates between Z-space and the X-y/X-z plane of X-space, on which the oppositely moving pair of ***v***-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 ***E***-field state components is also likely to be polarized in any direction on the Y-y/Y-z plane, as analyzed in Reference [29].

As part of the trispatial vector field described in References [22] and [23], trispatial vector complexes corresponding to Equations (31) and (64) for the electron and positron are illustrated with Fig. 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 nor to relative physical 90° offset as they must 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 Fig. 3. The vector complex of the electron in motion would then be represented with Fig. 9. This figure is to be visualized as a more detailed description of Fig. 7 and Fig. 8 of References [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.

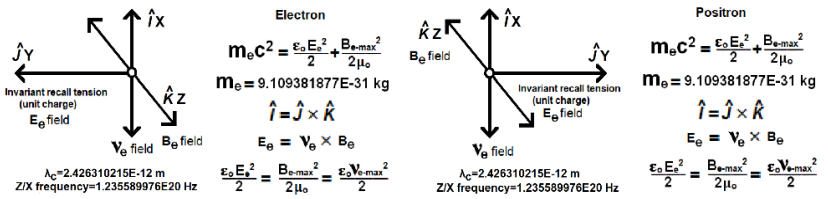

Fig. 7. The trispatial vector complexes of the invariant rest masses of the electron and of the positron – level 1 trispatial vector complexes

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

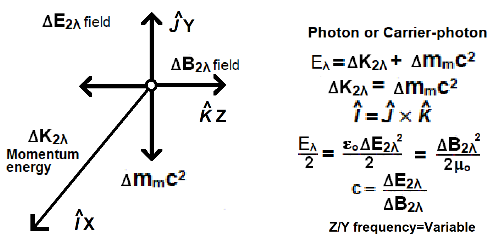

Fig. 8. The trispatial vector complex of a photon or carrier-photon – level 0 trispatial vector complex

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 perpendicularly to 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 of Reference [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.

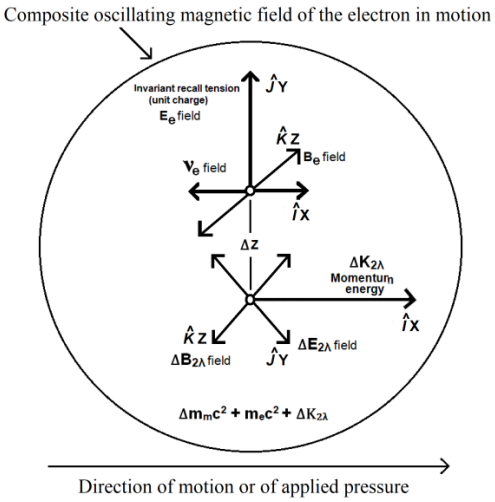

Fig. 9. The trispatial vector complex of the relativistic mass of the electron in motion and of its momentum energy – level 2 trispatial vector complex

We now come to Fig. 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 Reference [42], and also in this article with equations (61) and (63), as well as listed in Table 2.

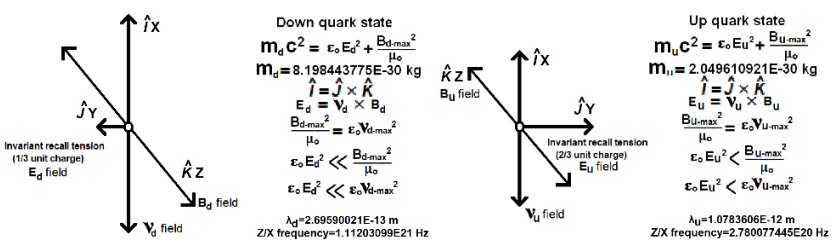

Fig. 10. Trispatial vector structures of electrons and positrons in their confined hyper-stressed Up and Down quark states at rest – level 1 trispatial vector complexes

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

Fig. 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 Fig. 10, when they establish the proton and neutron structures.

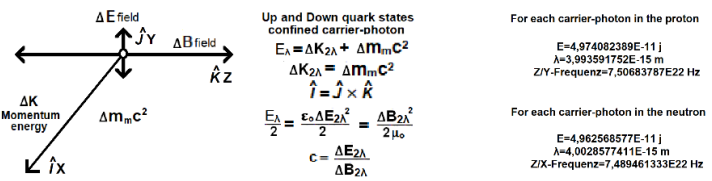

Fig. 11. Confined hyper-stressed carrier-photon for Up and Down quarks – level 0 trispatial vector complex

The analysis carried out in Reference [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 – *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 Reference [42] – reproduced here as Fig. 12 – represent the quarks states only by their *centers-of-presence*, without illustrating their trispatial vector complexes (Fig. 10), and without representing at all their carrier-photons (Fig. 11).

Figs. 13 and 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 (Fig. 8) or carrier-photon (Fig. 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.

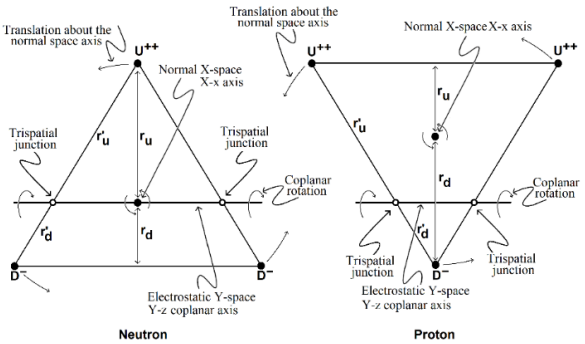

Fig. 12. Rotation and translation axes of the proton and neutron triads – level 2 trispatial vector complexes

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 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 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 Reference [42].

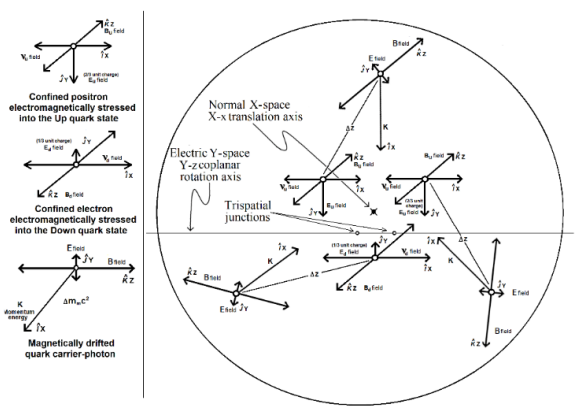

Fig. 13. The proton at rest – level 2 trispatial vector complex

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 (Fig. 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.

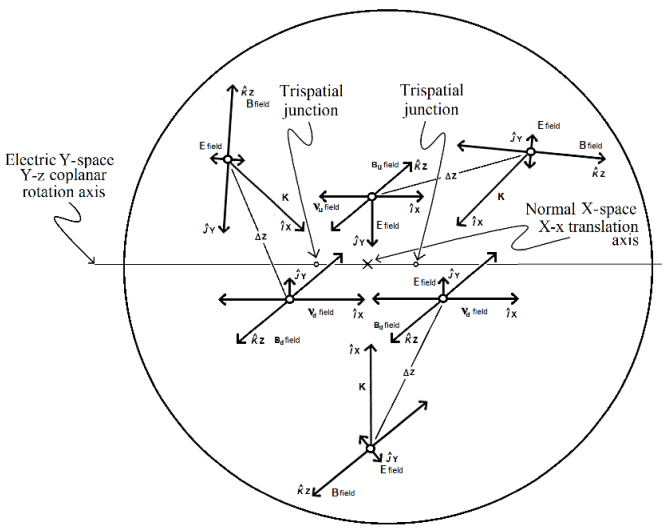

Fig. 14. The neutron at rest – level 2 trispatial vector complex

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 ***B*** field magnetic energies *at maximum* of the 3 constrained carrier-photons, 3) the sum of the constrained ***E*** field energies of the 3 constrained hyper-stressed electrons and positrons, and 4) the sum of the constrained ***B*** field energies *at maximum intensity* of their 3 constrained hyper-stressed electrons and positrons, as represented with Fig. 15.

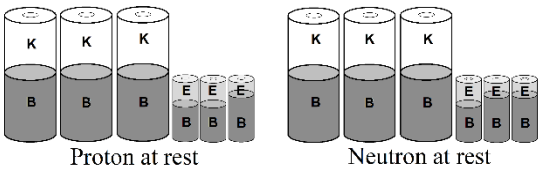

Fig. 15. The energy which is part of the proton and neutron rest masses

The electric ***E*** field energies of the confined carrier-photons (Fig. 11) do not need to be taken account of in calculating the nucleons rest mass since that when the ***B*** field energies reach maximum intensity during the ***E/B*** LC oscillation cycle between Y-space and Z-space, the ***E***-field energy has completely evacuated Y-space and the ***E***-field doesn't exist momentarily. The same consideration applies to the ***v***-field energies of the hyper-stressed electrons and positrons (Fig. 10), since that when the ***B***-field energies reach maximum intensity during the ***v/B*** LC oscillation cycle between X-space and Z-space, the ***v***-field energy has completely evacuated X-space and the ***v***-field doesn't exist momentarily. This is why only the ***K*** momentum energy and the ***B***-field energy of the confined carrier-photons, and the ***E***-field energy and the ***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 ***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 ***E/B***. This means that it suffices to mathematically double the energy of the ***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 $\mathbf{B^2}/2\mu_0$ 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.

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

And for the neutron:

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

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

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

We can now calculate the related ***B***-field:

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

This provides for a ***B***-field energy density of:

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

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:

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

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 of Reference [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):

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

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:

$$T^{00}{}_{Proton} = \frac{1}{c^2}\left[6\left(\frac{\mathbf{B}_{cP}^{\ 2}}{2\mu_0}\right) + 2\left(\varepsilon_0 \mathbf{E}_U^{\ 2} + \frac{\mathbf{B}_U^{\ 2}}{\mu_0}\right) + \left(\varepsilon_0 \mathbf{E}_D^{\ 2} + \frac{\mathbf{B}_D^{\ 2}}{\mu_0}\right)\right] \cong 8.4122408E28\,kg/m^3 \qquad (74)$$

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

$$\lambda_p = \frac{hc}{E} = \frac{hc}{1.492224716E-10} = 1.331197251E-15\,m \qquad (75)$$

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

$$V_{cP} = \frac{\alpha^5}{2\pi^2}\lambda_{cP}^{\ 3} = 2.47300009E-57\,m^3 \qquad (76)$$

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

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

Establishing the density parameters of the neutron rest mass from the known energy of its inner components confined carrier-photons, established in Table III of Reference [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):

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

and its rest mass of ≅1.67492716E-27 kg can be recuperated in a similar manner.

9. GRAVITATION

As observed previously, and vectorially represented with Figs. 13 and 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* (Fig. 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 of Reference [23] for the hydrogen atom, which we will illustrate below.

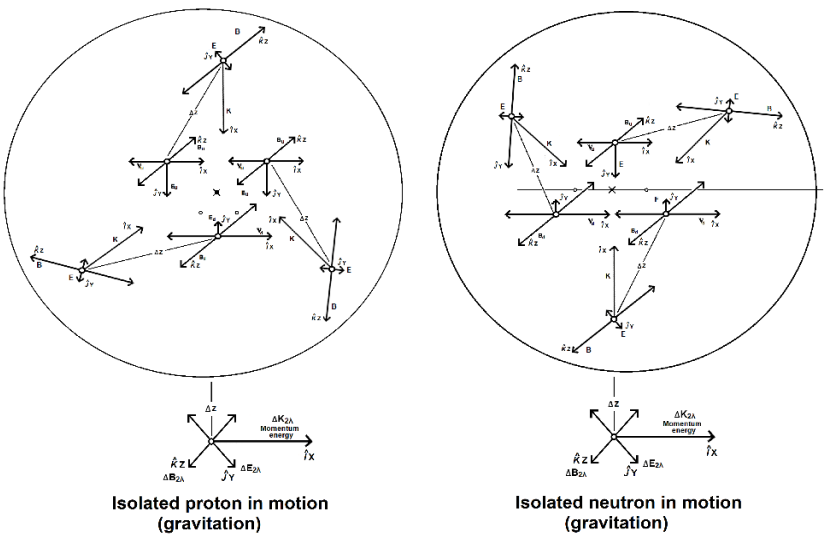

Fig. 16. Isolated proton and neutron in motion – gravitation, level 3 trispatial vector complexes

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

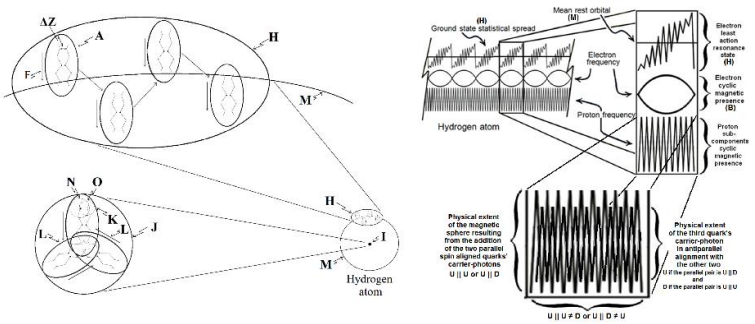

Fig. 17. The isolated hydrogen atom at rest – level 2 trispatial vector complex

We will now represent with Fig. 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.

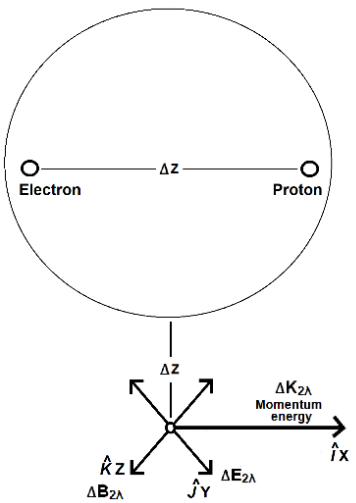

Fig. 18. The hydrogen atom in motion – gravitation, level 3 trispatial vector complex

As put in perspective in Reference [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 References [47] and [22], 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 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:"*

(2) $$\mathrm{m}\frac{\mathrm{d}^2\mathrm{x}}{\mathrm{dt}^2} = \mathrm{e}\mathbf{E}_\mathrm{x}$$ ([69], p. 95)

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**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:

$$\mathrm{F} = \mathrm{e}\mathbf{E} + \mathrm{e}\mathbf{v}\times\mathbf{B} \tag{78}$$

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

$$\mathrm{F} = \frac{q^2}{4\pi\varepsilon_0 r^2}\ \frac{\mathrm{F}}{q} = \frac{1}{q}\frac{q^2}{4\pi\varepsilon_0 r^2} = \mathbf{E} = \frac{q}{4\pi\varepsilon_0 r^2}\ \mathbf{E} = \frac{\mathrm{q}}{4\pi\varepsilon_0 \mathrm{r}^2} \tag{79}$$

So, if we reintroduce the invariant charge of the electron in the resultant Equation (79) 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 his Equation (42) to represent the various radii related to the hydrogen atom orbitals. So the second term of Einstein's Equation (2) now becomes:

$$\mathrm{F} = \mathrm{e}\mathbf{E} = \mathrm{e}\frac{\mathrm{Q}}{4\pi\varepsilon_0 \mathrm{R}^2} = \frac{\mathrm{e}\cdot\mathrm{Q}}{4\pi\varepsilon_0 \mathrm{R}^2} \quad \mathrm{F} = \mathrm{e}\mathbf{E} = \frac{\mathrm{e}\cdot\mathrm{Q}}{4\pi\varepsilon_0 \mathrm{R}^2} \tag{80}$$

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 (80).

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 $e\boldsymbol{vB}$ 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 $\Delta\boldsymbol{E}+\Delta\boldsymbol{B}=\Delta\boldsymbol{B}_{\text{Maximum}}$.

$$\mathrm{ev}\mathbf{B}_{\mathrm{o}} = \gamma\frac{\mathrm{m_o v}^2}{\mathrm{r_o}} \tag{81}$$

Which in context becomes:

$$\mathrm{ev}\left(\mathbf{B}_{\mathrm{e}} + \Delta\mathbf{B}_{\mathrm{Maximum}} + \mathbf{B}_{\mathrm{External}}\right) = \gamma\frac{\mathrm{m_o v}^2}{\mathrm{r_o}} \tag{82}$$

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

$$r_o = \gamma \frac{m_o v}{e\left(\mathbf{B}_e + \Delta\mathbf{B}_{Maximum} + \mathbf{B}_{External}\right)} \tag{83}$$

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 (80) in the following manner; now directly equating the electron carrier-photon energy provided by the Coulomb equation, as illustrated with Fig. 18, with that provided by this amended Lorentz force equation:

$$F = \frac{\Delta K}{r} + q\left[(\mathbf{E}_e \times \Delta\mathbf{E}) + \mathbf{v} \times (\mathbf{B}_e + \Delta\mathbf{B})\right] = \frac{e \cdot Q}{4\pi\varepsilon_0 R^2} \tag{84}$$

In which

$$\Delta K = F \cdot r = \frac{e \cdot Q}{8\pi\varepsilon_0 R} \tag{85}$$

And

$$\Delta m_m = \left(\frac{\varepsilon_0 \Delta\mathbf{E}^2}{2} + \frac{\Delta\mathbf{B}^2}{2\mu_0}\right)\frac{1}{c^2} = \cdot\frac{F \cdot R}{c^2} = \frac{e \cdot Q}{8\pi\varepsilon_0 R}\frac{1}{c^2} \tag{86}$$

The equality of the force between *F=ma* and F=*e**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 Reference [71], is what allowed in Reference [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 Reference [23].

10. ELECTRON SPIN, MAGNETIC MONOPOLES, COVALENT MOLECULAR BOUNDING, ORBITAL PAIR FILLING, COOPER PAIRS ESTABLISHMENT AND THE STERN-GERLACH EXPERIMENT

In 1998, an easily reproducible lab experiment was carried out with magnets both poles of each of which geometrically coincide with the geometric center of each magnet [38]. This experiment led to the major discovery of a large difference between the intensity of the force that applies when two magnets of this type are made to interact with each other, compared with the intensity of the force that applies between two bar magnets, the two static poles of each bar magnet being located at a certain distance from each other inside each bar magnet.

Whereas the traditional force equation applicable to interacting bar magnets is, according to well established reference works, for example ([46], p. 93):

$$F_{\text{Bar magnets}} = \frac{3\mu_0\mu^2}{2\pi d^4} \tag{87}$$

The equation that can be established from the data collected during the 1998 experiment is as follows:

$$F_{\text{Circular magnets}} = \frac{3\mu_0\mu^2}{4\pi d^4} \tag{88}$$

The difference is indeed major, as Equation (87) for bar magnets reveals a force double that revealed by Equation (88) for circular magnets:

$$F = \frac{3\mu_0\mu^2}{2\pi d^4} = \frac{3\mu_0\mu^2}{4\pi d^4} + \frac{3\mu_0\mu^2}{4\pi d^4} \tag{89}$$

At first sight, this difference may seem surprising, for if the distance between the two static poles within each bar magnet could be reduced until the two poles coincide geometrically with each other inside each bar magnet, as is the case by structure within each of the circular magnets used in the 1998 experiment, it should be expected that the two poles of each bar magnet would continue to "be simultaneously present" within each bar magnet, and the force of attraction or repulsion between the bar magnets to continue obeying Equation (87) - see Fig. 19.

But that's not what the collected data reveals, and will reveal to anyone who reproduces this experiment, which is easy enough to carry out, given that

Reference [38] describes every aspect of it precisely to make it easy to reproduce.

Although the repulsive force recorded for the circular magnets in Experiment [38] corresponds to that of the interaction of a single pair of either **N/N** or **S/S** poles statically present within the magnetic bars, i.e. one pole at a time in each circular magnet – see Fig. 19 – it is undeniable that both types of poles do exist within the circular magnets, given that these magnets can also be placed in attractive **N/S** or **S/N** interaction.

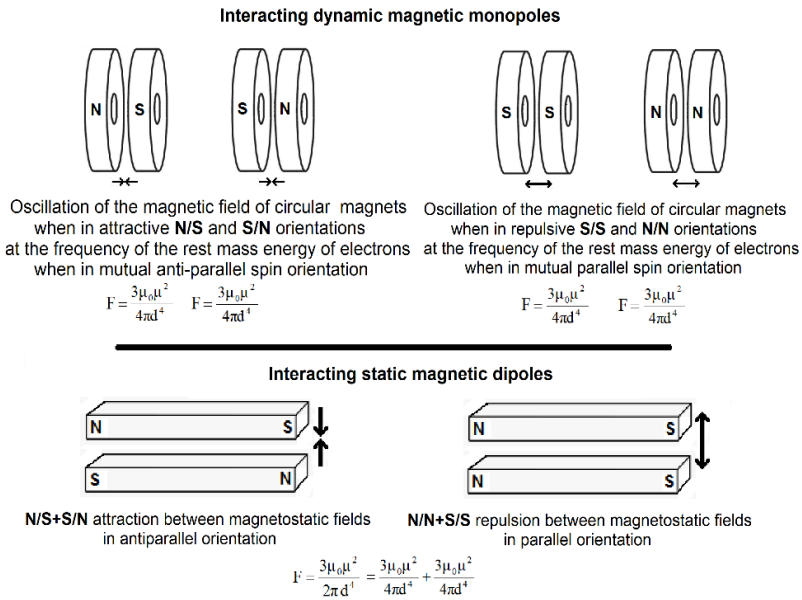

Fig. 19. Comparison between the intensity of the magnetic interaction force between circular magnets and between bar magnets

This behavior can then mean only one thing: that the north and south poles inside such circular magnets behave as if they were not simultaneously present, but are acting in alternance, that is, one at a time in each magnet.

And this can be explained only by a cyclic oscillation of the magnetic energy involved, between *a state of spherical expansion until a state of maximum presence is reached*, followed by *a state of spherical regression until a state of zero presence is reached* – mandatory if only one of the two poles of each magnet is physically present at any given moment – at a frequency that obviously depends on the energy of the electrons whose sum of individual **B**-fields aligned in forced parallel magnetic spin of the unpaired electrons inside each magnet, that constitutes the macroscopic **B**-field of each magnet [38] [72].

If we transpose this alternating dipolar behavior by similarity to the level of elementary electromagnetic particles, such as electrons, whose magnetic field poles for each electron can only coincide geometrically by structure at the *center-of-presence* of the electron, given their confirmed point-like behavior in any collision between such particles, this finding also confirms that *the magnetic aspect of electrons is timewise monopolar by structure at any given instant* given that spherical expansion and regression of the energy substance cannot occur simultaneously, and that it is only the high-frequency of the expansion-regression sequences within each circular magnet that makes the measured magnetic fields appear statically bipolar at the macroscopic level as in bar magnets, but that Equation (88) drawn from the data collected confirms that their poles are dynamically present only one at a time in alternance, spherical expansion corresponding to one pole and spherical regression corresponding to the other pole.

This parallel by similarity between the oscillating behavior of the circular magnets' magnetic fields energy and a similar structure of oscillation of the electron's magnetic field energy through volume *dV* of its trispatial vector complex – see **Section 3.3** – proved justified, as a year after the publication of the account of the experiment with circular magnets in 2013 [38], the account of an experiment performed by Kotler et al. with real electrons [39] was published that proved that this inverse cube force was indeed confirmed for the magnetic interaction between two electrons also placed in repulsive parallel spin orientation!

It is at this point that a relationship can be established with Maxwell's conception that electromagnetic energy in free motion must involve a mutual induction in alternance of its **E** and **B** fields, as described in **Section 2**, i.e. an LC oscillation concretized at the level of individual photons at the subatomic level by Equations (13) and (66) according to their description in **Section 3**, illustrated by Fig. 6, as analyzed in References [33] and [34].

In the case of the electron, this magnetic field oscillation is represented as a reciprocating motion in Equations (31) and (64), illustrated with Fig. 20.

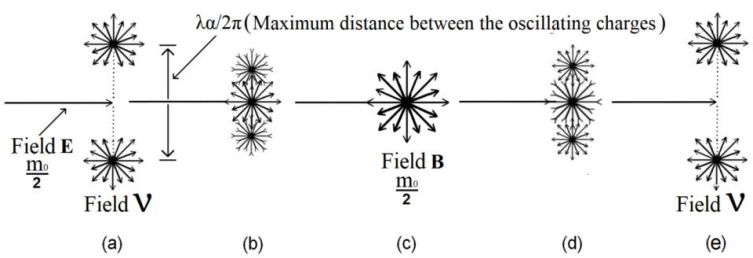

Fig. 20. Representation of the cyclic oscillation of half the electron's rest mass energy between its magnetic B state and its neutrinic double-charge v state, while the other half constitutes the invariant energy of its E-field

Considering Fig. 20, we must remain aware that the magnetic energy of the electron's rest mass oscillates between its two states **B** and 2×**v** at a stable invariant frequency of *1.235589976E20* Hz, corresponding to the electron's Compton wavelength (λ_c=*2.426310215E-12* m), as put in perspective in **Section 3**. It should also be borne in mind that the **20a** and **20c** states are momentary limit states during which the oscillating energy reaches zero velocity at the end of its run before restarting to move in the opposite direction.

The *presence* of the electron's magnetic energy is manifested by its spherical increase from the **20a** state throughout the **20b** phase – which lasts half the complete cycle – until it reaches its *maximum spherical presence* volume at the **20c** limit, to then decrease spherically throughout the **20d** phase – which extends over the other half of the complete cycle – until it *momentarily disappears completely from Z-space* during the brief moment when the **20e** limit is reached, which constitutes the start of the following cycle.

The Kotler et al. experiment confirming that Equation (88) also applies to the electron, implying that its magnetic energy mandatorily oscillates between states **20b** and **20d**, sheds new light on the nature of the electron's spin, considered in classical kinematics as an *intrinsic* property, that is, a transverse rotational motion of the particle – an *intrinsic* angular momentum, hence the name "spin" classically assigned to it – either clockwise or counterclockwise, or, according to the Copenhagen interpretation of Quantum Mechanics, as a simple quantum number to be dealt with for mathematical coherence purposes with no particular physical significance.

Indeed, the confirmed fact that the inverse cube of distance law applies to magnetic interactions between electrons directly explains why two electrons whose unit charges repel each other according to the inverse square of distance law can attract and join in antiparallel spin alignment from a given point of proximity according to the inverse cube of the distance separating them, despite their electrostatic repulsion as a function of the inverse square of the distance separating them – see Fig. 21 – and makes it clear that the *electron spin cannot be an intrinsic property* of angular momentum, but is rather a *relative extrinsic property* of *repulsive* parallel magnetic coupling **20b/20b+20d/20d** involving two electrons, or an *attractive* antiparallel magnetic coupling **20b/20d+20d/20b** involving two electrons.

It is on the other hand quite logical that only a higher exponential power such an inverse cube interaction law could overcome the simultaneously acting inverse square electrostatic interaction law between charged particles, when the particles are close enough to each other for the inverse cube law to dominate.

The point of equilibrium, illustrated in Fig. 21, between the magnetic fields of the electron and of its carrier-photon – Fig. 9 – and those of the charged particles making up the inner structure of the proton and of their respective carrier-photons – Fig. 13 – is found in the hydrogen atom at an average distance from the proton corresponding to the Bohr radius, i.e. the average distance of the axial

resonance trajectory of the electron in the volume of the rest orbital No. 1 in both the Schrödinger equation and of the de Broglie equation [51] [52].

This new development now provides a clear electromagnetic mechanics explanation for a number of phenomena observed at the level of elementary particles for which no common cause had previously been identified, neither in kinematic mechanics, nor in quantum mechanics according to the Copenhagen interpretation, that is, the molecular covalent bonding, the filling of electronic orbitals by electron pairs, the establishment of Cooper pairs at lower temperature levels and, finally, a new explanation to the Stern-Gerlach experimental observations, which we shall now examine.

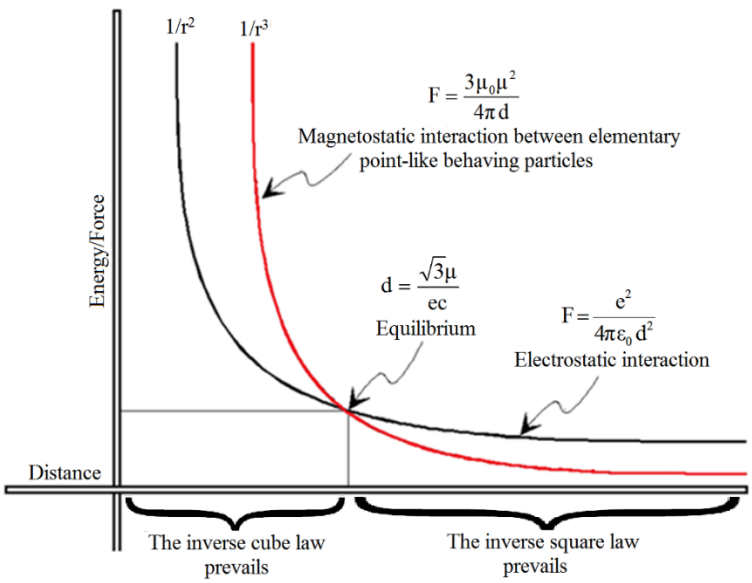

Fig. 21. Intersecting inverse square and inverse cube interaction forces curves

11. MOLECULAR COVALENT BOUNDING

In inorganic chemistry as well as in organic chemistry, all possible cases of covalent bonding are well understood and are clearly explained in the relevant reference works. They are defined as *chemical bonds* between two atoms involving an electron from the outermost electronic layer of each atom to form a very strong electron doublet linking two atoms to each other.

All existing molecules, from the simplest, the hydrogen molecule H_2, to the assembly of hyper-complex molecules supporting the electron transport chain

producing energy-generating ATP molecules in mitochondria [73,74], including its extraordinary rotating proton engine, owe their existence to this covalent bond.

On the physics side, no kinematic theory has been proposed to explain covalent bonding, and only quantum mechanics, itself grounded on resonance processes developed from kinematic mechanics, has ventured to attempt explaining the mechanics of covalent bond establishment, but the theories proposed, based on the elaboration of molecular wave functions, do lead to some incorrect predictions.

Electromagnetic mechanics now proposes the previously described attractive antiparallel magnetic coupling association mechanics **20b/20d + 20d/20b** involving one electron from each atom involved, with reference to the electron magnetic field oscillation sequence illustrated in Fig. 20.

11.1 The Filling of Electronic Orbitals with Electron Pairs

In kinematic mechanics a rule was established according to which each atom orbitals are filed according to the concept of the spin of electron, which is seen as being an *intrinsic permanent angular momentum* of electrons moving around the nucleus as mentioned previously transverse to this direction of motion, that can be oriented either clockwise or counterclockwise. Each orbital being seen as *filled* when two electrons, one with clockwise angular momentum and one with counterclockwise momentum become associated. In chemistry, the *Aufbau principle* and *Hund's rule*, well documented in chemistry reference works, are grounded on this historical definition of *spin*.

On the quantum mechanics side, clockwise angular momentum was assigned the value 1/2, while counterclockwise angular momentum was assigned the value -1/2, and in 1925, Wolfgang Pauli established the principle that two or more identical electrons with the same half-integer spin cannot occupy the same quantum state within a quantum system simultaneously, which logically restricts the number of electrons that can occupy an orbital to only one electron with spin 1/2 plus one electron with spin -1/2.

Although it remains classically linked to the kinematic concept of spin representing an *intrinsic* transverse angular momentum of the electron in either clockwise or counterclockwise direction, it nevertheless disconnects the *spin* of the electron in quantum mechanics from the need for it to be in a closed orbit around the nucleus of the atom, which is already more in line with the definition of electromagnetic mechanics established earlier, according to which spin is a *relative* property that requires the presence of two electrons to have any meaning, without the pair being obliged to orbit the nucleus, which means that the presence of two electrons is required for the parallel repelling magnetic alignment **20b/20b + 20d/20d** and the antiparallel attractive magnetic alignment **20b/20d + 20d/20b** of two electrons to have any meaning.

This means that the *relative spin* orientation – either parallel or anti-parallel – of the odd single electron of the outermost orbital of a non-ionized atoms, or that the relative spin orientation of an odd single electron in an ionized atom, remains undetermined until it is paired in covalent bounding with an electron from another atom in the case of a non-ionized atom, or that it is paired into filling an orbital with an other electron captured from the environment in case of an ionized atom.

Let us note in passing that this electromagnetic mechanics definition of the electron *spin* invalidates in no way the *Aufbau principle* and *Hund's rule*, nor the *Pauli Exclusion Principle*. It simply solidly anchors them on an electromagnetic foundation.

11.2 The Establishment of Cooper pairs

As put in perspective previously, it seems that the only possibility for two electrons to so paradoxically magnetically attract each other when they are at a very short distance from each other despite their mutual electrostatic repulsion, that obeys the inverse square law (see Fig. 21), would be that another force would simultaneously be at play locally that would obey a higher order exponential law than the inverse square law for it to be able to overcome the inverse square law when the particles are very close to each other. The confirmed inverse cube law for magnetic interaction between two electrons confirmed by the Kotler et al. experiment [39] does provide this higher order exponential law.

When an unpaired isolated electron is stabilized already into an orbital in an atom, it is prevented by the local electromagnetic equilibrium tension that captures and stabilizes it from evading the trajectory of any incoming electron accelerating towards its location, which is what allows the incoming electron to reach the proximity distance at which the magnetic inverse cube law starts to dominate (Fig. 21), despite the repelling electrostatic inverse square law that applied all along the trajectory of the incoming electron toward the captive electron due to their identical same sign charges.

The same condition obviously applies when two atoms with unpaired valence electrons available on their outer electronic layer collide in nature, which directly explains why individual atoms systematically combine in the so short time observed, so that at ambient temperatures in our environment, virtually all atoms in nature are by default found only in molecular systems.

The question arises, however, as to whether two free-moving electrons could pair off in this way, when no external electromagnetic tension reaches a level of intensity sufficient to force them to close in towards each other sufficiently for the minimum distance required to be reached for the attractive inverse cube magnetic force to dominate the influence of the repelling inverse square electrostatic force between the electrons (Fig. 21).

This seems highly doubtful in the case of electrons that are actually free to move, but in the case of mobile electron flows that are electrically set in motion in material media, there does seem to be a possibility. Indeed, when the ambient energy level (the temperature) is sufficiently reduced so that only half the energy of each electron's carrier-photon – its momentum energy – and its other half, which oscillates transversely and shakes their motion, are present, it is well established that electron pairs unite into Cooper pairs which then circulate more easily in the medium under consideration, inducing superconductivity.

There seems to be no doubt that this pairing would be due to the same cause that induces covalent molecular coupling and electronic orbital pair filling. That is, anti-parallel magnetic **20b/20d + 20d/20b** electron pair coupling.

The mechanics of such a coupling implies by structure that the momentum energy of the carrier-photon of one of the electrons will reverse its direction to act in counter-pressure to the momentum energy of the carrier-photon of the other electron, reducing the velocity of the system to zero, This will then cause the induction of a new carrier-photon for the double-charge system, the intensity of which will correspond to the energy induced in these double charges by their proximity to the other electrons/Cooper-pairs all moving in the same direction, propelling them at the observed accelerated velocity.

11.3 Interpretation of the Stern-Gerlach experiment

The Stern-Gerlach experiment is significant in context because it brought the proof that the spin of electron is directly related to magnetism and not to an expected intrinsic transverse angular momentum as concluded from the kinematic mechanics perspective.

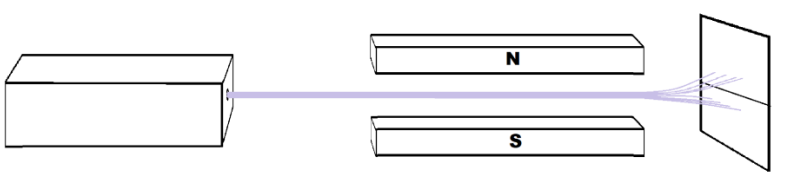

Fig. 22. The Stern-Gerlach experiment

In 1922, Otto Stern and Walther Gerlach carried out an experiment that confirmed the two possible values of electron magnetic spin alignment. By overheating silver to the point of vaporizing away individual silver atoms and causing a beam of these atoms to travel between the poles of a magnet, it was observed that the trajectories of half of the atoms were deflected towards the north pole of the magnet while the other half was deflected towards the south pole, as witnessed by the traces recorded on a target photographic film facing the beam.

What characterizes the silver atom is that, when not ionized, it possesses an odd number of 47 electrons, all of which are stabilized in pairs in their respective orbitals, as described previously, with the exception, of course, of the odd electron in the outermost electronic layer. The paired electrons of each atom do not react as they pass between the poles of the magnet, since each electron of each pair cancels out the magnetic field of the companion electron of its pair through their alignment in antiparallel coupling. The upward or downward deflection of the trajectories of the atoms as they move between the magnet's **N** and **S** magnetostatic poles is therefore attributed to the uncompensated magnetic orientation of each atom's remaining unpaired electron.

It is classically assumed that before entering the magnetic field of the magnet the spin of this unpaired electron of each silver atom of the beam is undetermined, meaning that it could be oriented in any direction in space. This may be true of isolated silver atoms, but it can be expected that due to the proximity of the silver atoms within the beam, that even though the odd electrons of the separate atoms cannot really rigidly pair up due to the distances involved between the separate atoms of the beam, they would magnetically interact to a certain extent with each other. But since the attractive anti-parallel magnetic relation between electrons is a least action state with respect to the repulsive parallel magnetic relation, it can be expected that the unpaired electron of each silver atom would tend to align in anti-parallel relation with respect to the unpaired electrons of the nearby silver atoms in the beam.

We have concrete evidence of this least action dominance of anti-parallel magnetic alignment of unpaired electrons in atoms, aligning by default in this manner with the iron atom, that has two unpaired valence electrons. In ferromagnetic materials such as iron, these unpaired electrons are left free to locally pivot in any direction by the local electromagnetic equilibrium, and their natural tendency is to stabilize in the lowest energy mutually anti-parallel equilibrium configuration possible inside the material, like so many small magnets that would be left to freely swivel close to one another while being prevented from moving towards each other [72].

A clear demonstration of this tendency of these unpaired electrons in the mass of atoms to self-orient by default in this least action state is that when we capture an iron nail with a magnet, it becomes magnetized, meaning that all of the iron unpaired electrons in the mass of the nail align in additive parallel alignment in the direction opposite to the field of the magnet, and the nail becomes itself a magnet able to attract other magnetisable material. But when the nail is taken away from the magnet, it returns to its demagnetized state, meaning that all unpaired electrons in the mass of the nail have returned to their default mutual best fit least action anti-parallel mutual orientation.

This means that even before entering the area between the **N** and **S** poles of the magnet of the Stern-Gerlach experiment, all odd electrons of the separate silver atoms in the beam already are coupled in this default mutual best fit least action anti-parallel mutual orientation. But since they are not as tightly bound together in

direct mutually cancelling polarity as in the cases of covalent binding, Cooper pairs, or orbital pair coupling, as they enter the area between the **N** and **S** poles of the magnet – both poles of which are the magnetostatic macroscopic sum of the parallel aligned magnetic fields of the participating electrons of the magnet [72] – the magnetic fields of each unpaired electron will be more attracted in anti-parallel orientation by the stronger intensity **N** and **S** poles of the magnet than with the weaker nearby anti-parallel field of nearby silver atoms unpaired electrons, that is, in dominating **20b/[X × 20d] + 20d/[X × 20b]** attractive interaction with the poles of the magnet rather than in weaker **20b/20d + 20d/20b** attractive interaction with the unpaired electrons of the nearby other silver atoms, which will deflect the trajectories of the silver atoms as observed during the experiment.

12. CONCLUSION

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 energy of the magnetic field of localized elementary particles, to then allow both mechanics to be used to describe coherently the known properties and interactions of these particles.

It also concludes the description of the various stable resonance 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 the destabilization of sufficiently energetic level 0 photons.

Level 2 then introduces the densest stable nucleon structures that triads of Level 1 particles can establish, while Level 3 deals with the more complex assemblies made possible by combinations of Level 1 and Level 2 particles, i.e. combinations generating all the atoms of the periodic table, as well as all the molecules associated by covalent bonding, from the hydrogen molecule to the most complex molecules of living organisms.

Finally, level 4 concerns all the level-3 accumulations that can be established in the trispatial vector field, all interacting as a function of the tension associated to the electrostatic restoring constant, and the resulting restoring force that induces in all the stabilized vector structures the level-0 carrier-photons that are responsible for their direction of movement, the pressure applied in this direction, and the mass increments added.

In short, this analysis puts in perspective with respectto each other the two possible domains of fundamental mechanics that were developed to describe objective physical reality: *kinematic mechanics*, that traditionally takes no account of the increase in mass of elementary particles as a function of their

velocity or proximity, as an outcome of the decision taken in 1907, and *electromagnetic mechanics*, that does.

From *classical kinematic mechanics* emerged *kinematic wave mechanics* through the relationship that Schrödinger established in developing his wave equation, which describes the electronic resonance volumes linked to the sequence of integers identified by de Broglie in the hydrogen atom, thanks to the remarkable equation published in his doctoral thesis, and which turns out to be a simple classical kinematic mechanics version of Schrödinger's equation, as clearly put into perspective in **Section 6**; soon followed by *kinematic quantum mechanics* with the addition of Heisenberg's statistical method and Feynman's path integral.

On its side, *electromagnetic mechanics* was initially introduced mainly by Maxwell, Heaviside, Searle and H.A. Lorentz, and was finally completed following Marmet's discovery published in 2003.

It is expected that these analyses will allow the eventual development of the differential equations applicable to each domain, grounded on a common electromagnetic 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 References [51] [52], that is, *an electromagnetics grounded quantum mechanics* that will takes into account the mass increase with velocity and proximity of elementary charged particles identified by H.A. Lorentz in the Kaufmann data and the permanent existence of their carrying energy.

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 of Reference [75] – entitled "*Mechanics and Electromagnetism in the Late Nineteenth Century* " by *Roberto de Andrade Martins* – is highly recommended.

COMPETING INTERESTS

Author has declared that no competing interests exist.

REFERENCES

1a. Liu M, Gu Q, Yang B, Yin Z, Liu S, Yin L, Zheng W. Kinematics model optimization algorithm for six degrees of freedom parallel platform. Applied Sciences. 2023;13(5):3082.
1b. Monteiro R. Celestial chiral algebras, colour-kinematics duality and integrability. Journal of High Energy Physics. 2023 Jan;2023(1):1-21.
1c. Cordova C, Ohmori K. Quantum Duality in Electromagnetism and the Fine-Structure Constant. arXiv preprint arXiv:2307.12927. 2023 Jul 24.

1d. Fuentealba O, Henneaux M, Troessaert C. A note on the asymptotic symmetries of electromagnetism. Journal of High Energy Physics. 2023 Mar;2023(3):1-25.

1. Kaufmann W. Die magnetische und electrische Ablenkbarkeit der Bequerelstrahlen und die Scheinbare Masse der elektronen. Vorgelegt in der Sitzung vom 8. November 1901. Göttinger Nachrichten, Math.-phys. Klasse, Jg. 1901;S:143–155.
Availble:https://upload.wikimedia.org/wikipedia/commons/6/62/Kaufmann_magnetische_und_elektrische_Ablenkbarkeit_der_Bequerelstrahlen_1901.pdf

2. Kaufmann W. Über die "Elektromagnetische Masse" der Elektronen, Kgl. Gesellschaft der Wissenschaften Nachrichten, Mathem.-Phys. Klasse. 1903;91-103.
Available:http://gdz.sub.uni-goettingen.de/dms/load/img/?PPN=PPN252457811_1903&DMDID=DMDLOG_0025

3. Kaufmann W. Über die electromagnetische Masse des Elektrons. Göttinger Nachrichten. 1902a;5:291–296.
Available:http://www.digizeitschriften.de/dms/img/?PID=GDZPPN002499444

4. Kaufmann W. Über die electromagnetische Masse des Elektrons. Physikalische Zeitschrift. 1902b;4(1b):54–56.
Available:https://wikilivres.org/wiki/Die_elektromagnetische_Masse_des_Elektrons

5. Lorentz HA. Versuch einer Theorie der electrischen und optischen Erscheinungen in bewegten Körpern, Leiden — E. J. Brill; 1895.
Available:https://archive.org/details/versucheinerthe00loregoog
Available:https://de.wikisource.org/wiki/Versuch_einer_Theorie_der_electrischen_und_optischen_Erscheinungen_in_bewegten_K%C3%B6rpern
Available:https://en.wikisource.org/wiki/Translation:Attempt_of_a_Theory_of_Electrical_and_Optical_Phenomena_in_Moving_Bodies

6. Wien W. Eine neue Beziehung der Strahlung schwarzer Körper zum zweiten Hauptsatz der Wärmetheorie, Sitzungberichte der Königlich-Preußischen Akademie der Wissenschaften (Berlin). 1893;1:55–62.
Available:https://www.biodiversitylibrary.org/item/93363#page/9/mode/1up

7. WienW. Über die Möglichkeit einer elektromagnetischen Begründung der Mechanik, Annalen der Physik. 1901;310(7):S. 501-513
Available:https://zenodo.org/record/1424001/files/article.pdf
Available:https://en.wikisource.org/wiki/Translation:On_the_Possibility_of_an_Electromagnetic_Foundation_of_Mechanics

8. Searle GFC. On the Steady Motion of an Electrified Ellipsoid, Demonstrator in Experimental Physics, Cavendish Laboratory, Cambridge; 1897.
Available:https://zenodo.org/record/1431237/files/article.pdf

9. Heaviside O.Electrical Papers, 1894;2. Macmillan and Company.
Available:https://books.google.ca/books/about/Electrical_Papers.html?id=bywPAAAAIAAJ&redir_esc=y

10. Lorentz HA. Electromagnetic phenomena in a system moving with any velocity smaller than that of light, in: KNAW, Proceedings, 6, 1903-1904, Amsterdam. 1904;809-831.
Available:https://en.wikisource.org/wiki/Electromagnetic_phenomena.
11. Poincaré H. La valeur de la science, France, Flammarion, 1994 Edition; 1905.
12. Bucherer AH. Messungen an Becquerelstrahlen. Die experimentelle Bestätigung der Lorentz-Einsteinschen Theorie. PhysikalischeZeitschrift.1908;9(22):755–762.
13. Neumann G. Die träge Masse schnell bewegter Elektronen. Annalen der Physik. 1914;350(20):529–579.
Available:https://onlinelibrary.wiley.com/doi/10.1002/andp.19143502005
14. Planck M. Die Kaufmannschen Messungen der Ablenkbarkeit der β-Strahlen in ihrer Bedeutung für die Dynamik der Elektronen. Physikalische Zeitschrift. 1906;7(21):753–761.
Available:https://de.wikisource.org/wiki/Die_Kaufmannschen_Messungen_der_Ablenkbarkeit_der_%CE%B2-Strahlen_in_ihrer_Bedeutung_f%C3%BCr_die_Dynamik_der_Elektronen
Available:https://en.wikisource.org/wiki/Translation:The_Measurements_of_Kaufmann
15. Pais A. Subtle is the Lord: The Science and the Life of Albert Einstein. Oxford University Press; 2008.
16. Michaud A. On Adiabatic Processes at the Elementary Particle Level. J Phys Math. 2016;7: 177.
DOI:10.4172/2090-0902.1000177.
Available:https://projecteuclid.org/journals/journal-of-physical-mathematics/volume-7/issue-2/On-Adiabatic-Processes-at-the-Elementary-Particle-Level/10.4172/2090-0902.1000177.full
17. Michaud A.On Adiabatic Processes at the Subatomic Level. In: Dr. Jelena Purenovic, Editor. Newest Updates in Physical Science Research. 2021;4:30–62.
Available:https://doi.org/10.9734/bpi/nupsr/v4/1978F
Available:https://stm.bookpi.org/NUPSR-V4/article/view/1641
18. Einstein A. Zur Elektrodynamik bewegter Körper. Annalen der Physik. 1905c;17(n^{o} 10):891–921.
DOI 10.1002/andp.19053221004,
Available:https://onlinelibrary.wiley.com/doi/epdf/10.1002/andp.19053221004
19. Anderson CD. The Positive Electron, California Institute of Technology, Pasadena, California (Received February 28, 1933); 1933.
Available:https://journals.aps.org/pr/pdf/10.1103/PhysRev.43.491
20. Blackett PMS, Occhialini G. Some photographs of the tracks of penetrating radiation, Proceedings of the Royal Society. 1933;139:699-724.
Available:https://www.jstor.org/stable/96057
21. McDonald K, et al.Positron Production in Multiphoton Light-by-Light Scattering, Phys.Rev.Lett.1997;79:1626.

Available:http://www.slac.stanford.edu/exp/e144/.
Available:http://journals.aps.org/prl/abstract/10.1103/PhysRevLett.79.1626.

22. Michaud A. Our Electromagnetic Universe. In: Dr. Mohd Rafatullah, Editor. Newest Updates in Physical Science Research. 2021;12:64-82.
Available:https://doi.org/10.9734/bpi/nupsr/v12/11459D
23. MichaudA. Demystifying the Lorentz Force Equation. Journal of Modern Physics. 2022;13(5).
DOI:10.4236/jmp.2022.135046
Available:https://www.scirp.org/pdf/jmp_2022053015080692.pdf
24. Cockcroft JD, Walton ETS. Disintegration of Lithium by Swift Protons. Nature. 1932;129:649.
Available:https://www.nature.com/articles/129649a0
25. James Clerk Maxwell Foundation.
Available:https://clerkmaxwellfoundation.org/
26. Meyer, Kirstine; Pihl, Mogens. L.V. Lorenz. Dansk BiografiskLeksikon; 2011.
Available: https://biografiskleksikon.lex.dk/L.V._Lorenz
27. Michaud A. Deriving ε_0 and μ_0 from First Principles and Defining the Fundamental Electromagnetic Equations Set. International Journal of Engineering Research and Development e-ISSN: 278-067X, p-ISSN: 2278-800X. 2013;7(4):32-39.
Available:http://ijerd.com/paper/vol7-issue4/G0704032039.pdf
28. Marmet P. Fundamental Nature of Relativistic Mass and Magnetic Fields. International IFNA-ANS Journal. 2003;3(19):9. Kazan State University.
Available:http://www.newtonphysics.on.ca/magnetic/index.html
29. Michaud A. The Mechanics of Electron-Positron Pair Creation in the 3-Spaces Model. International Journal of Engineering Research and Development e-ISSN: 2278-067X, **p**-ISSN: 2278-800X. 2013;6(10):01-10.
Available:http://ijerd.com/paper/vol6-issue10/F06103649.pdf
30. Michaud A. The Expanded Maxwellian Space Geometry and the Photon Fundamental LC Equation. International Journal of Engineering Research and Development, e-ISSN: 2278-067X, p-ISSN: 2278-800X. 2013;6(8):31-45.
Available:http://ijerd.com/paper/vol6-issue8/G06083145.pdf.
31. Michaud A. Field Equations for Localized Individual Photons and Relativistic Field Equations for Localized Moving Massive Particles,International IFNA-ANS Journal. 2007;2(28):123-140, Kazan State University, Kazan, Russia.
Available:https://www.researchgate.net/publication/282646291_Field_Equations_for_Localized_Photons_and_Relativistic_Field_Equations_for_Localized_Moving_Massive_Particles
32. Michaud A. Inside planets and stars masses. International Journal of Engineering Research and Development. e-ISSN: 2278-067X, p-ISSN: 2278-800X. 2013;8(1):10-33.
Available:http://ijerd.com/paper/vol8-issue1/B08011033.pdf
33. Michaud A. On De Broglie's Double-particle Photon Hypothesis. J Phys Math. 2016;7:153.
DOI:10.4172/2090-0902.1000153.

Available:https://www.hilarispublisher.com/open-access/on-de-broglies-doubleparticle-photon-hypothesis-2090-0902-1000153.pdf

34. MichaudA. De Broglie's Double-Particle Photon. In: Dr. JelenaPurenovic, Editor. Newest Updates in Physical Science Research. 2021;4:63–102.
Available:https://doi.org/10.9734/bpi/nupsr/v4/1979F
Available:https://stm.bookpi.org/NUPSR-V4/article/view/1642
35. Michaud A. Electromagnetism according to Maxwell's Initial Interpretation. Journal of Modern Physics. 2020;11:16-80.
Available:https://doi.org/10.4236/jmp.2020.111003.
Available:https://www.scirp.org/pdf/jmp_2020010915471797.pdf.
36. Michaud A. Emphasizing the Electromagnetism according to Maxwell's Initial Interpretation. In: Dr. Thomas F. George, Editor. Chapter 4 In New Insights into Physical Science Vol. 10. West Bengal, India: Book Publisher International; 2020.
Available:http://dx.doi.org/10.9734/bpi/nips/v10.
Available:https://bp.bookpi.org/index.php/bpi/catalog/book/350
37. Michaud A. From Classical to Relativistic Mechanics via Maxwell, International Journal of Engineering Research and Development, e-ISSN: 2278-067X, p-ISSN: 2278-800X. 2013;6(4):01-10.
Available:https://www.researchgate.net/publication/282353551_From_Classical_to_Relativistic_Mechanics_via_Maxwell
38. Michaud A.On The Magnetostatic Inverse Cube Law and Magnetic Monopoles.International Journal of Engineering Research and Development e-ISSN: 2278-067X, p-ISSN: 2278-800X. 2013;7(5):50-66.
Available:http://www.ijerd.com/paper/vol7-issue5/H0705050066.pdf
39. Kotler S, Akerman N, Navon N, Glickman Y, Ozeri R. Measurement of the magnetic interaction between two bound electrons of two separate ions. Nature magazine. doi:10.1038/nature13403. Macmillan Publishers Ltd. 2014;510:376-380.
Available:https://www.nature.com/articles/nature13403.epdf?referrer_access_token=yoC6RXrPyxwvQviChYrG0tRgN0jAjWel9jnR3ZoTv0PdPJ4geER1fKVR1YXH8GThqECstdb6e48mZm0qQo2OMX_XYURkzBSUZCrxM8VipvnG8FofxB39P4lc-1UIKEO1
40. De Broglie, L.La physique nouvelle et les quanta, Flammarion, France 1937, 2nd Edition 1993, with new 1973 Preface by Louis de Broglie; 1993. ISBN: 2-08-081170-3.
41. Einstein A. Über einen die Erzeugung und Verwandlung des Lichtes betreffenden heuristischen Gesichtspunkt. Annalen der Physik. 1905a;17(n^{o} 6):132–148.
DOI 10.1002/andp.19053220607,
Available:https://onlinelibrary.wiley.com/doi/epdf/10.1002/andp.19053220607
Available: http://users.physik.fu-berlin.de/~kleinert/files/eins_lq.pdf
42. Michaud A. The Mechanics of Neutron and Proton Creation in the 3-Spaces Model. International Journal of Engineering Research and Development. e-ISSN: 2278-067X, p-ISSN : 2278-800X. 2013;7(9):29-53.
Available:http://ijerd.com/paper/vol7-issue9/E0709029053.pdf

43. Michaud A. On an Expanded Maxwellian Geometry of Space.Proceedings of Congress-2000 – Fundamental Problems of Natural Sciences and Engineering. 2000;1, St.Petersburg, Russia, pages 291-310. Available:https://www.researchgate.net/publication/357527119_On_an_Expanded_Maxwellian_Geometry_of_Space
44. Michaud A. The Mechanics of Neutrinos Creation in the 3-Spaces Model. International Journal of Engineering Research and Development. e-ISSN: 2278-067X, p-ISSN: 2278-800X. 2013;7(7):01-08. Available:http://www.ijerd.com/paper/vol7-issue7/A07070108.pdf
45. Sears F, Zemansky M, Young H. University Physics, 6th Edition, Addison Wesley; 1984.
46. Resnick R, Halliday D. Physics. John Wyley & Sons, New York; 1967.
47. MichaudA. Introduction to Electromagnetism according to Maxwell - Electromagnetic Mechanics, Generis Publishing; 2020. ISBN 978-9975-3238-3-3. Available:http://generis-publishing.com/book.php?title=introduction-to-electromagnetism-according-to-maxwell-electromagnetic-mechanics
48. Archives néerlandaises des sciences exactes et naturelles. La société hollandaise des science à Harlem. Série II, Tome V. Available:https://archive.org/details/archivesnerlan0205holl/page/n7/mode/2up
49. De Broglie L. Recherche sur la théorie des quanta, Annales de Physique, Masson & Cie, Éditeurs. Paris; 1925. Available:https://theses.hal.science/file/index/docid/47078/filename/tel-00006807.pdf
50. De BroglieL. Research on the Theory of Quanta, Minkowski Institute Press. Edited by Vesselin Petkov. Montreal. Canada; 2021. Available:https://www.amazon.ca/Research-Theory-Quanta-Louis-Broglie/dp/1927763983?asin=1927763983&revisionId=&format=4&depth=1
51. Michaud A. The Hydrogen Atom Fundamental Resonance States. Journal of Modern Physics. 2018;9:1052-1110. DOI: 10.4236/jmp.2018.95067. Available:https://www.scirp.org/journal/paperinformation.aspx?paperid=84158
52. Michaud A. An Overview of The Hydrogen Atom Fundamental Resonance States. In: Dr. Mohd Rafatullah, editor. New Insights Into Physical Science. West Bengal, India: Book Publisher International. 2020;6. Available:http://bp.bookpi.org/index.php/bpi/catalog/book/265
53. Einstein A, Schrödinger E, Pauli W, Rosenfeld L, Born M, Joliot-Curie IF, Heisenberg W, Yukawa H, et al. Louis de Broglie, physicien et penseur. Éditions Albin Michel, Paris; 1953.
54. De Broglie L. Ondes et Quanta. Comptes rendus T. 1923;177 :507-510. Available:http://www.academie-sciences.fr/pdf/dossiers/Broglie/Broglie_pdf/CR1923_p507.pdf
55. De Broglie, L. Sur la définition générale de la correspondance entre onde et mouvement. Comptes rendus de l'Académie des Sciences. (Paris). 1924;179 :39.

56. De Broglie L. Sur un théorème de Bohr, C. R. Acad. Sci. (Paris) 179, 676, Comptes rendus de l'Académie des Sciences. (Paris). 1924;179 :39.
57. Michaud A. The Last Challenge of Modern Physics. J Phys Math. 2017;8: 217.
DOI: 10.4172/2090-0902.1000217**.**
Available:https://www.hilarispublisher.com/open-access/the-last-challenge-of-modern-physics-2090-0902-1000217.pdf
58. Michaud A. The Last Challenge of Modern Physics: Perspective to Concept and Model Analysis. In: Dr. Jelena Purenovic, Editor. Newest Updates in Physical Science Research. 2021;4:1–29.
Available:https://stm.bookpi.org/NUPSR-V4/article/view/1640
59. d'Abro, Aram. The Rise oft he New Physics. Dover Publications, New York; 1951.
60. Breidenbach M. et al. Observed Behavior of Highly Inelastic Electron-Proton Scattering, Phys. Rev. Let., 1969;23(16):935-939.
Available:http://www.slac.stanford.edu/pubs/slacpubs/0500/slac-pub-0650.pdf
61. Michaud A. On the Electron Magnetic Moment Anomaly**,** International Journal of Engineering Research and Development. e-ISSN: 2278-067X, p-ISSN: 2278-800X. 2013;7(3):21-25.
Available:http://ijerd.com/paper/vol7-issue3/E0703021025.pdf
62. Raines F, Cowan CL. Jr. Free Antineutrino Absorption Cross Section. I. Measurement of the Free Antineutrino Absorption Cross Section by Protons, Physical Review. 1959;113(1):273-279.
Available:https://journals.aps.org/pr/abstract/10.1103/PhysRev.113.273
63. MichaudA. Gravitation, Quantum Mechanics and the Least Action Electromagnetic Equilibrium States. J Astrophys Aerospace Technol. 2017;5: 152.
DOI:10.4172/2329-6542.1000152
Available:https://www.hilarispublisher.com/open-access/gravitation-quantum-mechanics-and-the-least-action-electromagneticequilibrium-states-2329-6542-1000152.pdf
64. Michaud A. Gravitation, Quantum Mechanics and the Least Action Electromagnetic Equilibrium States. In: Amenosis Lopez, editor. Prime Archives in Space Research. Hyderabad, India: Vide Leaf. 2020; 2020.
Available:https://videleaf.com/gravitation-quantum-mechanics-and-the-least-action-electromagnetic-equilibrium-states/
65. Van Leunen H. The Standard Model of Particle Physics and the Hilbert Repository. The Hilbert Book Model Project; 2021.
DOI: 10.13140/RG.2.2.24853.04325
Available:https://vixra.org/abs/2103.0188
66. Van Leunen H. Elemental and Structured Spaces. The Hilbert Book Model Project; 2021.
Available:https://vixra.org/abs/2102.0087
67. Michaud A. Electromagnetic Mechanics of Elementary Particles. 2nd Edition. Scholar's Press. Saarbrücken, Germany; 2016. ISBN: 978-3-330-65345-0.

Available:https://www.morebooks.de/store/gb/book/electromagnetic-mechanics-of-elementary-particles/isbn/978-3-330-65345-0

68. EinsteinA. Le Principe de relativité et ses conséquences dans la physique moderne. Traduit de l'allemand par E. Guillaume. Archives des sciences physiques et naturelle. 1910;29:5-28; 125-144.
Available:https://einsteinpapers.press.princeton.edu/vol3-doc/169
Available:https://einsteinpapers.press.princeton.edu/vol3-doc/193
69. EinsteinA. The Principle of Relativity and its Implications in Modern Physics. Translated by André Michaud and Fritz Lewertoff. In: Vesselin Petkov, Editor. Relativity: Meaning and Consequences for Modern Physics and for our Understanding of the World. Minkowski Institute Press. Montreal. Canada;2021.
Available:http://www.minkowskiinstitute.org/mip/books/einstein2.html
70. Humphries S. Jr. Principles of Charged Particle Acceleration, John Wiley & Sons; 1986.
Available:http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.382.7882&rep=rep1&type=pdf
71. Michaud A. Unifying All Classical Force Equations, International Journal of Engineering Research and Development, e-ISSN: 2278-067X, p-ISSN: 2278-800X. 2013;6(6):27-34.
Available:http://www.ijerd.com/paper/vol6-issue6/F06062734.pdf
72. MichaudA. On the Einstein-de Haas and Barnett Effects, International Journal of Engineering Research and Development. e-ISSN: 2278-067X, p-ISSN: 2278-800X, www.ijerd.com 2013;6(12):07-11.
Available:http://ijerd.com/paper/vol6-issue12/B06120711.pdf
73. Lewertoff F. On the Importance of ATP Energy in Biology with Regard to Viruses, Open Journal of Biophysics. 2021;11:225-232.
DOI: 10.4236/ojbiphy.2021.113008.
Available:https://www.scirp.org/journal/paperinformation.aspx?paperid=109418
74. Gerlach W, Stern O. Der experimentelle Nachweis der Richtungsquantelung im Magnetfeld. In: Zeitschrift für Physik. Band. 1922;9:349–352.
DOI:10.1007/BF01326983
Available:https://link.springer.com/article/10.1007/BF01326983
75. Capria MM, Editor. Physics Before and After Einstein, IOS Press; 2005. Amsterdam. ISBN 1-58603-462-6.
Available:https://www.semanticscholar.org/paper/Physics-before-and-after-Einstein-Capria/d0466a81e73ade1c180923e2be33dae36293ec5b

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