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Preface

This book covers key areas of physical science. The contributions by the authors include imaginary numbers, quaternions, special theory of relativity, principle of light speed nonexceedance, relativistic formulas, parallel universes, portals, dark matter, dark energy, dark space, multiverse, hyperverse, imensional analysis, dimensionless relationships, characteristic length, fundamental constants, golden number, measurement units, new SI, variable gravitational "constant", space travel, greater than the speed of light, weak force, nonlinear integrability, group theory, Weierstrass P-Elliptic function, wave function, electron resonance states, elementary electromagnetic particles, electromagnetism, hydrogen atom, fundamental constants of physics, uncertainty principle for energy and time, quantum theory, actuators, electromagnetic engineering education, energy storage, finite element method, magnetic forces etc. This book contains various materials suitable for students, researchers and academicians in the field of physical science.

Chapter 1
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Explanation of Dark Matter and Dark Energy, Discovery of Dark Space[1]

Alexander Alexandrovich Antonov[1*]

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ABSTRACT

It is currently a generally accepted opinion in astrophysics that the phenomenon of dark matter and dark energy can be explained only by existence of yet unknown physical entities in our visible universe only. This assumption seems to be quite reasonable, since the Monoverse hypothesis following from the postulate of light speed not-exceedance in the special theory of relativity leaves no place for dark matter and dark energy anywhere but our visible universe.
However, the assumption is erroneous, since, as shown in the article, the phenomenon of dark matter and dark energy is actually created by invisible parallel universes that coexist along with our visible universe in the Multiverse, which has been, therefore, called hidden. Research that has allowed for proving this assumption has been performed using previously unknown experiments that proved the general scientific principle of physical reality of concrete imaginary numbers. In the existing version of the special theory of relativity this principle has refuted the postulate of light speed non-exceedance, as well as the statement of uniqueness of our visible universe following there from. It has also allowed for recognition of fallacy and correction of relativistic formulas. Existence of the hidden Multiverse follows from the corrected relativistic formulas. The article explains the nature of mutual invisibility of parallel universes of the hidden Multiverse.
The hypothesis of the hidden Multiverse has explained the nature of dark matter and dark energy. Dark matter is a kind of gravitational image (a sort of a shadow), in our visible universe, of invisible parallel universes of the hidden Multiverse adjacent thereto, whereas dark energy is a gravitational image, in our visible universe, of other parallel universes of the hidden Multiverse. According to the hypothesis, the hidden Multiverse is connected through portals to other Multiverses, forming dark space. Multiverses of dark space together with the hidden Multiverse form a Hyperverse.
The hypothesis of the hidden Multiverse is verifiable, since existence of invisible universes can be experimentally proved by astronomical observations of the starry skies in portals and record of its constellations that are invisible outside the portals.

Keywords: Imaginary numbers; quaternions; special theory of relativity; principle of light speed non-exceedance; relativistic formulas; parallel universes; portals; dark matter; dark energy; dark space; Multiverse; Hyperverse.

1. INTRODUCTION

In the twentieth century, two extremely important scientific discoveries were made in astrophysics [1-4]. The first of them was made in 1932-33 by Jan Hendrik Oort [5] and Fritz Zwikky [6] and called dark matter. The second one, called dark energy, was made in 1998-1999 by Saul Perlmutter [7], Brian P. Schmidt [8] and Adam G. Riess [9] who were awarded the Nobel Prize for the discoveries.

[1]*This chapter was written as a result of conflation of publications "Antonov, A.A. (2017) Hypothesis of the Hidden Multiverse Explains Dark Matter and Dark Energy. Applied Physics Research, 9(2), 30-41. doi:10.5539/apr.v9n2p30" and "Antonov, A.A. (2020) How to See Invisible Universes. Journal of Modern Physics, 11, 593-607. https://doi.org/10.4236/jmp.2020.115039"*

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However, the discoveries turned out to be quite incomprehensible. In any range of electromagnetic waves, dark matter and dark energy are absolutely invisible. Besides, none of chemical elements known to us has been detected in dark matter and dark energy. Consequently, the discoveries has presumably discredited such fundamental scientific terms as 'atom', 'molecule' and 'matter' and set back the development of science by millennia. Therefore, over the past decades much attention has been paid to finding an explanation of the phenomenon of dark matter and dark energy, and intensive scientific research has been done. However, the phenomenon has not been explained.

This situation has naturally made us wonder what the reason is for such a result. What was the mistake in problem formulation? What might be the direction of possible alternative research according to Albert Einstein: *"Insanity: doing the same thing over and over again and expecting different results"?*

The reason for inexplicability of the phenomenon is that names of these scientific discoveries have been understood too literally. Yet, it was impossible to give them more specific names because of the extreme incomprehensibility of the subject of discovery. Nevertheless, the names of the discoveries and facts known about them have suggested that explanation of dark matter and dark energy should be sought in some new structure (most likely in a microstructure) of our visible universe. Moreover, it seemed that there was nowhere else to look for explanation of dark matter and dark energy due to the hypothesis of the visible Monoverse[2] following from the principle of light speed non-exceedance in the special theory of relativity (STR).

However, this assumption turned out to be erroneous, since dark matter and dark energy are actually gravitational images created by invisible parallel[3] universes of the Multiverse. They are invisible because the structure of the Multiverse is described by physically real hyper-complex numbers.

Physical reality of complex, and even more so, hyper-complex numbers has so far been completely unfeasible, since the special theory of relativity (STR) denies physical reality of imaginary numbers by the principle of light speed non-exceedance due to inability to explain it. It would seem to have a reason, since physical reality of imaginary numbers discovered five hundred years ago by Scipione del Ferro, Niccolò Fontana Tartaglia, Gerolamo Cardano, Lodovico Ferrari and Rafael Bombelli [10], has remained unproved despite considerable efforts.

Besides, this problem turned out [11] to have no purely mathematical solution, as it is actually interdisciplinary. Therefore, according to the statement by Oliver Heaviside "*Mathematics is an experimental science*" the solution should be supported by experiments. The article describes the experiments, proving physical reality of imaginary numbers and allowing for, in the long run, explanation of the phenomenon of dark matter and dark energy. Moreover, it also allowed for discovery and explanation of the phenomenon of dark space.

2. PROOF OF PHYSICAL REALITY OF IMAGINARY NUMBERS

Let's begin the research of the phenomenon of dark matter and dark energy with the proof of physical reality of imaginary numbers, as further presentation is based on the general scientific principle. We presents only one of its known proofs [12-16], since it is simplest and convincing enough. This proof, as well as other proofs [11], [17-26], unlike the axiomatic approach popular in modern physics, has been obtained as a result of conducting previously unknown experiments being the only decisive argument[4] in science, rather than using certain postulates (i.e., unproved assumptions). Herewith, only real experiments are actually meant and never the so-called 'mental experiments' in the STR, which are nothing but reasoning.

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[2] *That is, the only universe existing in nature*
[3] *Since they never intersect despite their infinity*
[4] *Driven by the same reasons, Cardinal Richelieu ordered in the Thirty Years' War to inscribe upon cannons the following text: "Ultima ratio regum" i.e. the last argument of king; while experiments are the last argument of a scientist.*

The proof involves the Ohm's law[5] which is known to all educated people. However, Ohm's law is applied only in later interpretation proposed by Charles Proteus Steinmetz [27], which is known as a symbolic method for calculating linear electric circuits. The proof based on such an interpretation of the Ohm's law is as follows. Resistance of resistor R is assumed to be equal to a real number R, the value of which does not depend on frequency ω of sinusoidal voltage applied thereto. Reactance of inductor L is assumed to be equal to a positive imaginary number[6] $j\omega L$, the value of which does depend on frequency ω of voltage applied thereto. Reactance of capacitor C is assumed to be equal to a negative imaginary number $-j/\omega C$, the value of which also depends on frequency ω of voltage applied thereto.

Therefore, impedance $Z(j\omega)$ of any electric LCR circuit will be equal to a concrete complex number, the value of which depends on frequency ω of applied voltage. If imaginary inductive and capacitive reactances are physically existent, the magnitude of current flowing through the electric LCR circuit would depend on frequency ω of applied voltage and vice versa. Otherwise, they would be imaginary, i.e. physically nonexistent both by name and nature.

Consequently, an experiment determining whether imaginary inductive and capacitive reactances and hence imaginary numbers in general are physically existent is very simple. The only thing to do is to change frequency of sinusoidal voltage applied to any electric LCR circuit and check whether magnitude of current flowing through it changes.

Millions of electric and radio engineers all over the world conduct such experiments in the course of their daily work. Therefore, they all know that magnitude of current flowing through electric LCR circuit changes with frequency of voltage applied thereto. These changes can be seen on oscilloscope screen. Moreover, instruments for measuring frequency characteristics registering such changes have been industrially produced many decades.

Using this knowledge, engineers create, by changing frequency characteristics of electric LCR circuits, a variety of filters, without which existence of radio engineering, telecommunication, television, radiolocation, radio navigation and other exact sciences would not have been possible.

Besides, if inductive and capacitive reactances were physically nonexistent, resonance discovered by Galileo di Vincento Bonaiuti de'Galilei [7] [28] in 1602, without which radio engineering, telecommunication, television, radiolocation, radio navigation also could not exist, would also have been impossible in electric LCR circuits.

Consequently, any experiment involving the Ohm's law in the interpretation of Steinmetz definitely proves physical reality of imaginary numbers, and thus refutes and obviates the principle of light speed non-exceedance in the STR.

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[5] *In 1826 Georg Simon Ohm discovered the law that now bears his name as a result of nine years of experimental research. Its complexity was evidenced by the fact that there were no electric measuring instruments at that time. Moreover, scientific research in physics was done differently that it's done today. Famous physicist Alexander Grigorievich Stoletov wrote in this regard: "...physics especially tempted natural philosophers. What a favorable theme were electrical phenomena for the most riotous imaginations... Attractive and vague deductions were in the foreground: hard work of experimenter and exact mathematical analysis were not honored; they seemed superfluous and harmful in the study of nature..." Therefore, contemporaries of Ohm gave to his discovery quiet a lukewarm support. In 1828 Ohm was even fired by personal order of Minister of Education for publishing his physics discoveries. A senior official believed that the use of mathematics in physics was unacceptable.*

[6] *In electrical engineering, unlike mathematics, the imaginary unit* $\sqrt{-1}$ *is usually denoted by the letter* j*, since* i *denotes electric current*

[7] *However, definitely not in electric circuits*

It is also notable that as the theory of Charles Proteus Steinmetz was developed in 1893 [27] and the STR [29-31] was developed by Joseph Larmor [32], Nobel Prize laureate Hendrik Antoon Lorentz [33], Jules Henri Poincaré [34] and Nobel Prize laureate Albert Einstein [35] in 1897-1905, the existing version of the STR could be refuted by the above arguments even before its creation.

And if authors of the STR could be excused for not knowing this, nowadays everyone including scientists, engineers, university professors, university and even school students has to know that imaginary numbers are physically real. Everyone should know that not only a visible world, but also a no less real invisible and still unknown physical world exists alongside and around us. However, nothing has been written about this in textbooks.

3. CORRECTION OF THE SPECIAL THEORY OF RELATIVITY

Therefore, now as a hundred years ago the universally accepted version of the STR has denied physical reality of imaginary numbers, referring to the principle of light speed non-exceedance postulated in the STR. The principle is substantiated by the following arguments. According to the Lorentz-Einstein formula

$$m = \frac{m_0}{\sqrt{1-(v/c)^2}} \tag{1}$$

where m_0 is the rest mass of a moving body (e.g. elementary particle);

m is the relativistic mass of a moving body;
v is the velocity of a physical body;
c is the speed of light,

$\lim_{v \to c-0} m(v) = +\infty$. This means that relativistic mass m assumes real values approaching to infinitely large values at velocities of physical bodies v approximate to the speeds of light c, given that $v < c$. Hence, it follows that overcoming of light speed barrier requires infinite energy. Authors of the STR concluded that overcoming the barrier was impossible. Therefore, they believed that there was nothing behind the light speed barrier and people lived in a Monoverse. In this regard, imaginary mass has allegedly no physical sense at $v > c$ in the formula (1).

However, such quite convincing, at first sight, arguments are refuted even by the simplest everyday events. For example, inability to overcome a barrier in the form of a wall dividing the room we are in and the adjacent rooms of our home does not mean that there is no way to get into the adjacent room through a door. It neither means that the adjacent invisible room does not exist or contains nothing. Undoubtedly, the universe is organized more intricate than our home. It actually contains many physical entities and processes still unknown to us, as well as their peculiar capabilities. Consequently, reasoning about Monoverse existence by authors of the STR seems false.

Therefore, arguments for the principle of light speed non-exceedance have not been considered convincing by all physicists. In 2011 OPERA Collaboration published results of the sensational experiment [36], which supposedly refuted the principle of light speed non-exceedance and thereby proved physical reality of imaginary numbers. However, in half a year the OPERA experiment was refuted by the ICARUS experiment [37].

Even earlier, in 2008-2010 there were alternative experiments[8] [17-21] which successfully solved the problem of proving physical reality of imaginary numbers by studying special processes in linear

[8] *Much earlier, Steinmetz proposed his own interpretation of the Ohm's law, which, as shown above, also allowed for verification of physical reality of imaginary numbers*

electric LCR circuits. And since the experiments can be repeated and verified in any electrical engineering and electronic laboratory, they are quite reliable and verifiable, unlike the unsuccessful unique OPERA experiment. And no one has refuted them over the past years. Therefore, the OPERA experiment turned out to be needless, as it attempted to solve the already-solved problem.

Thus, imaginary relativistic mass m is physically real at hyper-light speeds, given that $v > c$ and, therefore, has to be explained [38], [39]. However, the formula (1) does not allow for doing this, since it is valid only in the range $0 \le v < c$, whereas in the range $c \le v < \infty$ it corresponds to a physically unstable process that cannot exist. Therefore, to change the range of velocities $0 \le v < c$ the formula (1) should be corrected as follows

$$m = \frac{m_0 i^q}{\sqrt{1-(v/c - q)^2}} = \frac{m_0 i^q}{\sqrt{1-(w/c)^2}} \qquad (2)$$

where $q = \lfloor v/c \rfloor$ is the 'floor' function of argument v/c in discreet mathematics;

v is the velocity measured from our tardyon universe, which shall therefore be called tardyon velocity;
$w = v - qc$ is the local velocity for each universe, which can take values only in the range $0 \le w < c$;

Other relativistic formulas of the STR can be corrected in a similar manner.

Albert Einstein did not exclude the correction of the STR in future. He wrote: "*No single idea, which I would be sure that it will stand the test of time"*. He also asserted: *"We can't solve problems by using the same kind of thinking we used when we created them".*

4. HYPOTHESIS OF THE HIDDEN MULTIVERSE

Physical sense of the corrected formula (2) can be explained as follows [40-43]. Different integral[9] values of the quantity q in the formula (2) correspond to different parallel universes: the quantity $q = 0$ corresponds to our universe (as $i^0 = 1$), and the quantity $q = 1$ corresponds to another universe (as $i^1 = i$), in which there are tachyons and which shall be, for definiteness, referred to as tachyon. For similar reasons, our universe is called tardyon. Tachyon universe is behind the horizon of events and therefore, is invisible for us, since $c \le v < 2c$ for tachyon universe. Consequently, in the range $c \le v < 2c$ the formula (2), in contrast to formula (1), corresponds to an invisible universe in the Multiverse, which shall be referred to as the hidden Multiverse.

However, the hidden Multiverse can contain more than two parallel universes. It is shown below that they can actually be even more than twenty. In this regard, the quantity $q = 2$ in the hidden Multiverse would correspond to tardyon antiverse (for which $i^2 = -1$), the quantity $q = 3$ would correspond to tachyon antiverse (for which $i^3 = -i$), the quantity $q = 4$ would correspond to

[9] *A quantity q takes non-integer values in the portals considered below, in which it varies (from entry to exit) from one integer value to another integer value corresponding to parallel universes between which there are portals*

another tardyon universe (for which $i^4 = 1$), the quantity $q = 5$ would correspond to another tachyon universe (for which $i^5 = i$), etc.

But where are these parallel universes, if they do not intersect? In what space?

Space is determined by an extra dimension q in the formula (2). It implies that space of such a hidden Multiverse is four-dimensional[10]. Three dimensions x, y, z of space determine mutual spatial position of physical content of each parallel universe, and the fourth dimension q in the hidden Multiverse determines mutual spatial position of parallel universes. Therefore, such a four-dimensional structure can be described by a complex number $f_q(x, y, z) + iq$.

Besides, due to continuous drifting all parallel universes in the fourth dimension of the hidden Multiverse can touch their adjacent universes and even slightly penetrate into them generating many portals[11] [44], [45]. They are denoted by single two-sided arrows in Figs. 1 and 2. Portals on Earth are so-called anomalous zones [46] that can be everywhere: on, above and below its surface. Adjacent universes can exchange their physical content through portals. Therefore, mass-energy of parallel universes of the hidden Multiverse should have been substantially averaged over billions of years of their existence.

Taking into account this circumstance, we will analyse possible structures of the hidden Multiverse, which can have the form shown in Figs. 1 and 2. As can be seen, these are open screw structures, as the quantity q differs by more than one in the universes adjacent to two different terminal universes in such a structure.

Therefore, contrary to the statement of the STR such hidden Multiverses are not unique, since they can't have edges, behind which there is something unknown. They are invariably connected through portals to other Multiverses: two Multiverses (as in Fig. 2) or, which is unlikely, twice to the same Multiverse (as in Fig. 1). Thus, they form a larger structure, which shall be called a Hyperverse.

5. EXPLANATION OF DARK MATTER AND DARK ENERGY

In view of the above the phenomenon of dark matter and dark energy is explicable. It has been actually inexplicable only within the Monoverse hypothesis. There have been so far persistent, but unsuccessful attempts to explain the phenomenon using the hypothesis.

Therefore, seeking explanation of the phenomenon of dark matter and dark energy within other hypotheses of structure of the world we live in is not only justified but even necessary. The explanation becomes not only possible, but also obvious within the hypothesis of the hidden Multiverse. In all likelihood

- dark matter and dark energy are merely a certain image (gravitational, rather than optical and still less electromagnetic), a sort of a shadow, of other invisible universes in our visible universe;
- herewith, dark matter is a gravitational image created by parallel universes of the hidden Multiverse adjacent to ours;
- dark energy is a gravitational image created by the rest, except our and adjacent, universes of the hidden Multiverse;
- chemical composition of the content of dark matter and dark energy cannot be determined because such gravitational images contain neither molecules nor atoms nor subatomic particles.

[10] *But this is not Minkowski space, since time is not the fourth coordinate*
[11] *Which are not 'wormholes' in the general theory of relativity*

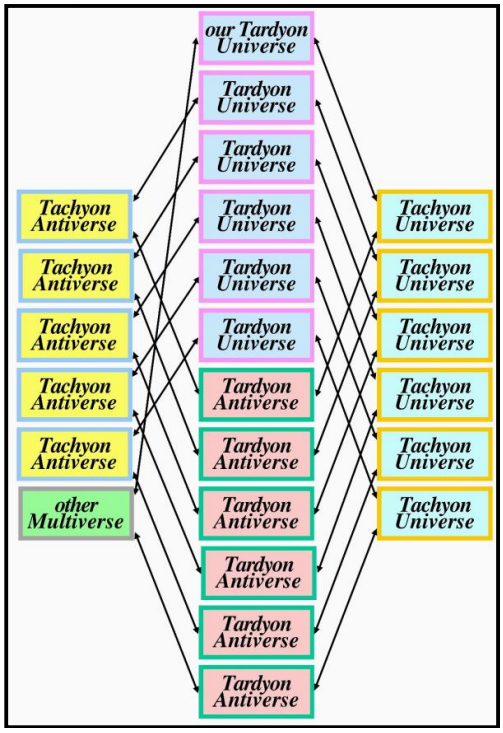

Fig. 1. Structure of the hidden Multiverse corresponding to the principle of physical reality of complex numbers

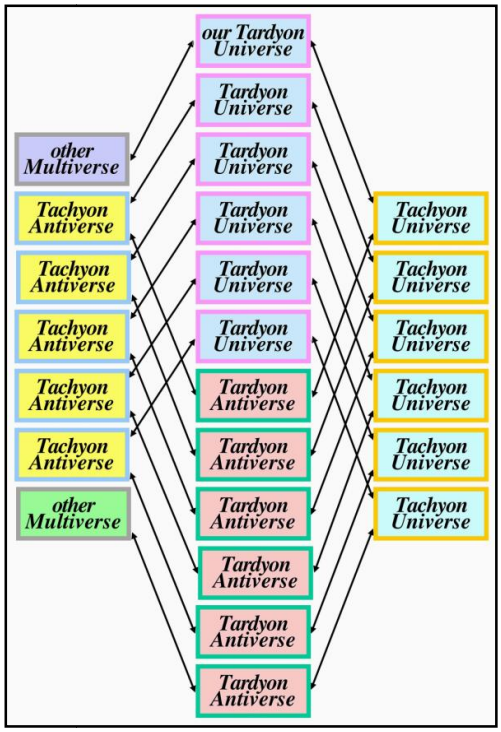

Fig. 2. Another structure of the hidden Multiverse corresponding to the principle of physical reality of complex numbers

Consequently, dark matter and dark energy are not some inherently different physical entities whose incomprehensible nature can be recognized at the Large Hadron Collider. They are not material at all, unlike, for example, our shadow on earth on a sunny day. They are just very unusual gravitational images of other universes of our hidden Multiverse. Therefore, they contain neither molecules nor atoms nor any other material substances. This circumstance must be, in particular, taken into account for correct understanding of the below Fig. 6, in which the short names "universes of dark matter", "universes of dark energy" and "universes of dark space" actually mean universes that create phenomena corresponding to these names.

6. ANALYSIS OF WMAP AND PLANCK SPACECRAFT DATA

Data obtained by the WMAP [47] and Planck [48] spacecraft allow for substantial refinement of structure of the hidden Multiverse. Thus, according to the measurements of the WMAP spacecraft, the entire universe (in fact, the entire hidden Multiverse) is composed of 4.6% baryonic matter, 22.4% dark matter and 73.0% dark energy. According to the later measurements of the Planck spacecraft, the entire universe (again, in fact, the entire hidden Multiverse) is composed of 4.9% baryonic matter, 26.8% dark matter and 68.3% dark energy.

These data, therefore, suggest that [49-59]:

- the hidden Multiverse contains $100\%/4{,}6\% = 21{,}7$ universes according to the WMAP data and $100\%/4{,}9\% = 20{,}4$, i.e. $20...22$, parallel universes according to the Planck data;
- dark matter is created by $22{,}4\%/4{,}6\% = 4{,}9$ according to the WMAP data and by $26{,}8\%/4{,}9\% = 5{,}5$, i.e. $5...6$, parallel universes according to the Planck data;
- dark energy is created by $73{,}0\%/4{,}6\% = 15{,}9$ universes according to the WMAP data and by $68{,}3\%/4{,}9\% = 13{,}9$, i.e. $14...16$, parallel universes according to the Planck data.

And such a result could obviously be foreseen by no postulates in the 20th century.

The structure of the hidden Multiverse found as a result of calculations allows us to explain not only the phenomenon of dark matter and dark energy, but also where tachyons are [60-65]. They turn out to be in numerous tachyon universes and antiverses (relative to adjacent tardyon universes and antiverses). Therefore, the assertion that they cannot exist, since they allegedly violate the principle of causality, is erroneous. In fact, this is not so, because tachyons and tardyons are in different parallel universes.

The structure of the hidden Multiverse also convincingly explains where antimatter is [64], [66-72]. It can be found in antiverses. There are a lot of pairs of universes-antiverses. Universes and antiverses do not annihilate, because tardyon and tachyon universes and antiverses are interspersed in the structure of the hidden Multiverse.

7. CORRECTION OF THE SPECIAL THEORY OF RELATIVITY (CONTINUED)

However, the above explanation of the structure of the hidden Multiverse, which is apparently quite consistent, is not entirely perfect. The first thing to be noticed is that our tardyon universe should have five or six adjacent parallel universes, rather than two (one tachyon universe and one tachyon antiverse), as in Figs. 1 and 2. This difference is too great to be referred to the error of WMAP and Planck measurements.

This means that another explanation is needed. It is as follows. There is an error in arguments referring to Figs. 1 and 2. The error is due to the assumption that there is only one extra dimension q in the hidden Multiverse. Therefore, the hidden Multiverse supposedly corresponds to physically real complex numbers $f_q(x,y,z)+iq$ containing only one imaginary unit.

There should actually be three extra dimensions q, r, s for explanation of the structure of the hidden Multiverse in which our tardyon universe can have six other adjacent universes: three tachyon universes and three tachyon antiverses. Consequently, the structure of the hidden Multiverse should correspond to physically real quaternions $\sigma + i_1\omega_1 + i_2\omega_2 + i_3\omega_3$ [73], containing exactly three imaginary units i_1, i_2, i_3, which are related as follows

$$i_1^2 = i_2^2 = i_3^2 = 1 \tag{3}$$

$$i_1 i_2 i_3 = i_2 i_3 i_1 = i_3 i_1 i_2 = -1 \tag{4}$$

$$i_1 i_3 i_2 = i_2 i_1 i_3 = i_3 i_2 i_1 = 1 \tag{5}$$

Therefore, the corrected relativistic formula (2) given above should be corrected once again as follows

$$m = \frac{m_0 (i_1)^q (i_2)^r (i_3)^s}{\sqrt{1 - [v/c - (q + r + s)]^2}} = \frac{m_0 (i_1)^q (i_2)^r (i_3)^s}{\sqrt{1 - (w/c)^2}} \tag{6}$$

where q is the total number of parallel universes, penetration into which is made through portals, corresponding to the imaginary unit i_1, with increasing distance from our tardyon universe;

r is the total number of parallel universes, penetration into which is made through portals, corresponding to the imaginary unit i_2, with increasing distance from our tardyon universe;

s is the total number of parallel universes, penetration into which is made through portals, corresponding to the imaginary unit i_3, with increasing distance from our tardyon universe;

$q + r + s$ is the parameter characterizing the degree of remoteness of a universe with q, r, s coordinates from our tardyon universe;

v is the velocity measured from our tardyon universe, which, therefore, should be called tardyon velocity;

c is the speed of light;

$w = v - (q + r + s)c$ is the local velocity for corresponding universe, which can take values only in the range $0 \le w < c$.

Other relativistic formulas can be corrected similarly, for example

$$\Delta t = \Delta t_0 (i_1)^q (i_2)^r (i_3)^s \sqrt{1 - [v/c - (q + r + s)]^2} = \\ = \Delta t_0 (i_1)^q (i_2)^r (i_3)^s \sqrt{1 - (w/c)^2} \tag{7}$$

$$l = l_0 (i_1)^q (i_2)^r (i_3)^s \sqrt{1 - [v/c - (q + r + s)]^2} = \\ = l_0 (i_1)^q (i_2)^r (i_3)^s \sqrt{1 - (w/c)^2} \tag{8}$$

where Δt_0 is the rest time of a moving body;

Δt is the relativistic time of a moving body;

l_0 is the rest length of a moving body;

l is the relativistic length of a moving body;

The relativistic formulas (6) - (8) could not actually be obtained in the 20th century, since the results of the WMAP and Planck spacecraft research were not known at that time. Moreover, these formulas could not be correctly interpreted at that time, since the principle of physical reality of imaginary numbers had not yet been experimentally proved.

It can also be argued that physical reality of quaternions proves also physical reality of other hyper-complex numbers.

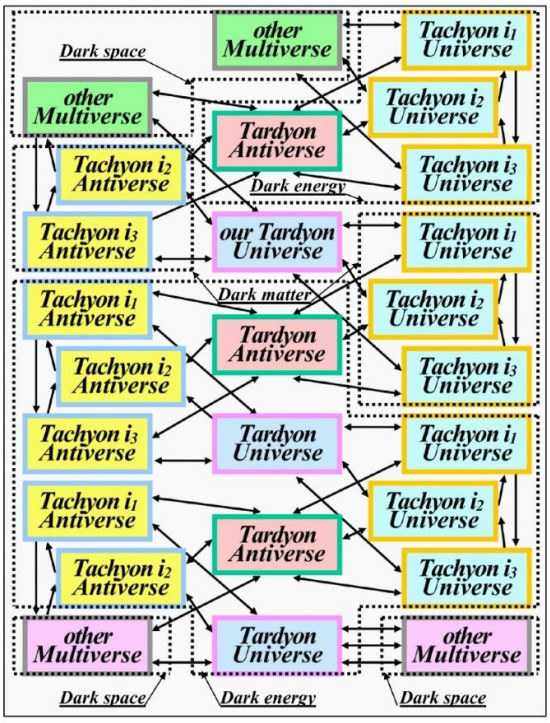

Fig. 3. Structure of the hidden Multiverse corresponding to the principle of physical reality of quaternions

8. DISCOVERY OF DARK SPACE

Let's begin consideration of quaternion structures of the hidden Multiverse [74], corresponding to the formulas (6) – (8), with the structure given in the Fig. 3. As can be seen, in this screw structure, in contrast to the similar structure shown in Fig. 2, five, rather than two, parallel universes (three tachyon universes i_1, i_2, i_3 and two tachyon antiverses i_2, i_3) are now adjacent to our universe. Such a six-dimensional structure is described by a quaternion $f_{q,r,s}(x,y,z)+i_1q+i_2r+i_3s$, where the function of three real variables $f_{q,r,s}(x,y,z)$ corresponds to the distribution of material content in the respective parallel universe, and the expression $i_1q+i_2r+i_3s$ determines coordinates of this universe.

Another difference of this structure from the one shown in Fig. 2 is that it contains unidirectional portals corresponding to the formulas (4) and (5), in addition to bidirectional portals corresponding to the formula (3). The principle of unidirectional portals functioning is explained in detail in [75].

The screw structure given in Fig. 3 can contain eight universes in each turn and therefore it could contain twenty-four universes in three turns. However, it contains only twenty-two parallel universes, which is consistent with the data obtained by the WMAP and Planck spacecraft. Therefore, such a quaternion structure of the hidden Multiverse has edges that are connected to other Multiverses through the corresponding portals in place of the missing universes. And these other Multiverses are a new astrophysical object, a dark space [76]. Together with the hidden Multiverse, they form the Hyperverse.

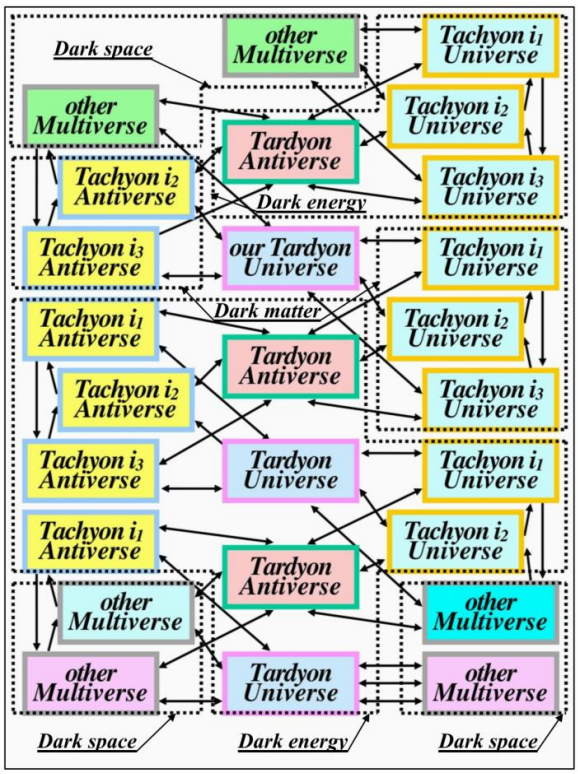

Fig. 4. Another structure of the hidden Multiverse corresponding to the principle of physical reality of quaternions

Other possible structures of the hidden Multiverse corresponding to the WMAP and Planck data and taking into account the existence of dark space are shown below in Figs. 4 and 5. Fig. 4 shows the quaternion structure of the hidden Multiverse containing twenty parallel universes. This hidden Multiverse is connected to two other Multiverses, with which it forms the Hyperverse.

Fig. 5 shows one more quaternion structure of the hidden Multiverse containing twenty-one parallel universes. This hidden Multiverse is connected to three other Multiverses, with which it forms the Hyperverse.

Figs. 3-5 show which parallel universes in the structure of the hidden Multiverse create the dark matter phenomenon and which parallel universes create the dark energy phenomenon. Other Multiverses that are not contained in the hidden Multiverse concerned, but contained in the Hyperverse and together form dark space, are also shown. Dark space is in all respects even darker, i.e. more invisible and incomprehensible (or rather, absolutely unstudied), than dark matter and dark energy. Physical manifestation of dark space, unlike that of dark matter and dark energy, has not

yet been recorded, because universes referring thereto are even farther away from our tardyon universe than universes of dark energy. Dark space has been discovered only due to mathematical processing of data received by WMAP and Planck spacecraft with the use of an adequate data interpretation.

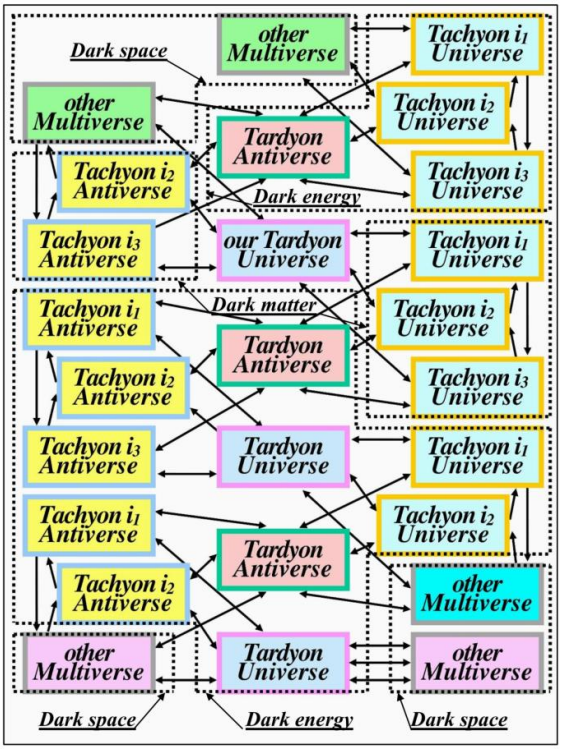

Fig. 5. One more structure of the hidden Multiverse corresponding to the principle of physical reality of quaternions

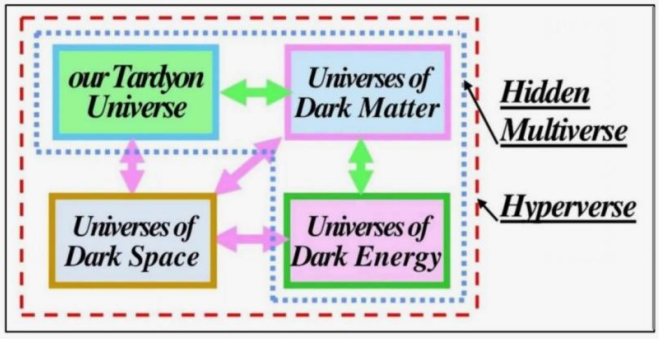

Fig. 6. Relative spatial position of our universe, as well as universes of dark matter and dark energy and Multiverses of dark space

Now let's get a little distracted. Since our universe is called tardyon in all the figures, the following questions could have long arisen: Why isn't it called otherwise? Why isn't it called a tachyon universe or antiverse or a tardyon antiverse? And now this question can already be answered. As can be seen from Figs. 3-5, only tardyon universes can have five-six adjacent universes, which is consistent with WMAP and Planck data. As for the tardyon antiverses, they are no different from tardyon universes by their astrophysical functional properties.

Structures of the hidden Multiverse shown in Figs. 3-5 can be explained by additional Fig. 6. This figure shows relative spatial position of our universe and universes that create the phenomena of dark matter, dark energy and dark space. As can be seen, universes that evoke the phenomenon of dark matter are adjacent to our universe. Universes that evoke the phenomenon of dark energy are behind them. And Multiverses that evoke the phenomenon of dark space are farthest from us. And they are all invisible to us, since they exist in other dimensions. In other words, not only visible, but also invisible and unknown world exists alongside and around us.

Thus, the hidden Multiverse can contain either twenty or twenty-one or twenty-two parallel universes. There are many structures, similar to those shown in Figs. 3-5, i.e. fully consistent with the results of WMAP and Planck data analysis. However, experimental data available are not enough to clarify which of them is real. Therefore, additional astrophysical and astronomical studies are needed.

9. VERIFIABILITY OF THE HYPOTHESIS OF THE HIDDEN MULTIVERSE

Hypothesis of the hidden Multiverse considered in the article, in contrast to the large number of previously proposed unverifiable Multiverse hypotheses [77-85], is verifiable [86], because:

- It has experimental confirmation, such as dark matter and dark energy, which are actually generated by other parallel universes of the hidden Multiverse, except ours.
- Its another experimental confirmation is experiments at the Large Hadron Collider and other accelerators of subatomic particles, having shown that total mass of subatomic particles after acceleration is smaller than total mass of the particles before acceleration. The result can be explained by formation of tachyons due to acceleration of subatomic particles and their transition to tachyon universes and antiverses through micro portals.
- And finally, the most convincing experimental evidence of existence of the hidden Multiverse would be astronomical and geophysical studies of portals on the Earth, as well as our subsequent penetration into adjacent parallel universes through them, if we are actually allowed by inhabitants of behind-the-portal supercivilizations [87].
  Therefore, the proposed hypothesis of the hidden Multiverse has every reason to be called a theory.

10. HOW TO SEE INVISIBLE UNIVERSES

It follows from the foregoing that the concept of the invisible universe[12] that has allowed for simple and clear explanation of many inexplicable things in astrophysics is extremely important. For example, the phenomenon of dark matter and dark energy. Location of tachyons and antimatter is also simply and clearly explained within the concept of invisible universes. It is even stated in the previous section that existence of invisible universes is proved by existence of dark matter and dark energy. But this is not convincing enough, since explanation of either one or another hasn't yet been confirmed by a simple and clear experiment.

Therefore, new convincing experiments have yet to be done to believe in the concept of invisible universes and in the above explanation of the phenomenon of dark matter and dark energy. Such experiments have already been described in the literature [76], [88-90], but have not yet been conducted. The point of such experiments is easy to understand if you use the following comparison. To see the contents of the adjacent room that is invisible from the room we are in, you need to come in this room or at least to come to its door and look inside. Similarly, in order to see constellations in the starry skies of invisible universes that are absent in the starry sky of Earth, you need to travel to these adjacent universes through portals. However, since portals are also invisible and it is very difficult to travel to adjacent universe through them, it is easier to get lost therein, you need at least entering these portals. And since starry sky maps in different parallel universes are extremely different, starry sky maps on Earth would gradually be replaced by a starry sky map of an adjacent universe, when you move through portals. It would look as if the stars in the sky are moving,

[12] *For example, in mathematics, the concept of imaginary numbers is similarly extremely important*

appearing and disappearing. Anyway, even a slight advance into the portal would reveal new constellations, unseen on Earth. Even amateur astronomers could register them, as these experiments are much simpler than the similar experiment conducted by Sir Arthur Stanley Eddington in 1919 [91].

Therefore, such evidence of invisible adjacent universes outside the portals would certainly be most convincing. And their discovery would be much more significant for human civilization than the discovery of America by Columbus.

11. CONCLUSION

Thus, the data obtained by WMAP and Planck spacecraft allow not only determining the distribution of mass-energy between visible universe, dark matter and dark energy in the hidden Multiverse, but also discovering the existence of dark space unknown to us so far.

Finding out information about existence of dark space in the WMAP and Planck data has required an adequate interpretation of the data. Fallacy of certain fundamental provisions of the existing version of the STR, namely, the principle of light speed non-exceedance and the Monoverse hypothesis following therefrom has had to be also proved for this purpose. This, in turn, has required experimental studies in the theory of linear electric circuits, which, unlike the unsuccessful OPERA experiment, has definitely proved the validity of the general scientific principle of physical reality of imaginary numbers.

Use of the principle of physical reality of imaginary numbers has proved fallacy of relativistic formulas of the existing version of the special theory of relativity. Therefore, the corrected relativistic formulas from which existence of the hidden Multiverse follows have been given in the article. The reason for mutual invisibility of parallel universes of the hidden Multiverse has been explained. The hypothesis of the hidden Multiverse has been shown to be verifiable.

The hypothesis of the hidden Multiverse has proved that the phenomenon of dark matter and dark energy is explained by existence of parallel universes that form it. In particular, dark matter is explained by existence of other parallel universes adjacent to our universe, and dark energy is explained by existence of the rest parallel universes. In addition, the proposed hypothesis of the hidden Multiverse has explained where antimatter is and why it does not annihilate with matter, as well as where tachyons are and why they do not violate the principle of causality.

Analysis of WMAP and Planck spacecraft data has determined that the hidden Multiverse has a quaternion structure in six-dimensional space and contains twenty to twenty-two parallel universes; dark matter contains five or six parallel universes; and dark energy contains fourteen to sixteen parallel universes. Besides, the hidden Multiverse is connected through its portals to other Multiverses, forming a new astrophysical object, referred to as dark space. Dark space is much darker than dark matter and dark energy, since Multiverses contained therein are farther away from us than universes contained in dark energy. The hidden Multiverse and Multiverses of dark space form a Hyperverse.

And most importantly, it has been explained how existence of invisible universes can be proved by astronomical observations made in portals, which will allow for recording in their starry skies new constellations never seen before, and thereby discovering these invisible universes outside the portals.

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COMPETING INTERESTS

Author has declared that no competing interests exist.

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After graduating from graduate school and defending a dissertation at the Leningrad Institute of Aviation Instrumentation in Russia he worked as an associate professor at the Department of Radio Engineering, and then at the Department of Higher Mathematics of the Tula Polytechnic Institute. Using the results of his joint scientific work with the Tula “Arsenal” Plant, he published several articles in which he proved the physical reality of imaginary numbers. Then he worked as a leading researcher at the Institute for Information Recording of the Academy of Sciences of Ukraine. In 2008-2010 he has published five articles in which he proved physical reality and explained the physical nature of imaginary numbers. And thereby made the OPERA experiment unnecessary. In subsequent years, he published twelve more articles in which he proposed two other experimental proofs of the physical reality of imaginary numbers. His research proved that the existing version of SRT is incorrect. Therefore, he created an alternative version of STR, from the relativistic formulas of which followed the existence in nature of mutually invisible universes, forming a hidden Multiverse. The hypothesis of the hidden Multiverse made it possible to explain the phenomenon of dark matter and dark energy, as well as solve some other problems of astrophysics. He also explained that the existence of invisible universes can be proved by astronomical observations in portals where constellations are visible that are not visible outside the portals.

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Certain "Curiosities" in Physics Established by Dimensional Analysis

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ABSTRACT

In this article are presented some more special relationships established between the fundamental constants by applying dimensional analysis. Dimensional analysis is a working method well known to engineers and researchers. Dimensional analysis has been used in many fields of research from aerodynamics, hydraulics, electromagnetics, chemical engineering processes, nuclear blast up, to biology or even economics. In this article, dimensional analysis was used to highlight unknown relationships that exist between fundamental constants and implicitly between the natural phenomena. The speed of light, the Planck constant, the gravitational constant, the fine structure constant, the Avogadro number, the proton/electron mass ratio and other constants were taken into account. The values of the fundamental constants taken into consideration for the analysis are those recommended by the CODATA in 2018 to be used for technical and scientific purposes. The relationships obtained are particularly interesting not only by their originality but also by the possibilities offered by them for practical applications. The results and conclusions presented in the article are completely original and were obtained by applying a special method of analysis imagined by the author. Some researchers have tried to find an explanation of these results using certain conventional approaches known in current physics. Whereas they have not found a classic physical background to explain these results, they considered them mere "curiosities". Even if these results are mere "curiosities" highlighted by the author as a result of his pure intellectual interest, they may still have their importance since the pure curiosity without an immediate material benefit can have a revolutionary effect on human activity.

Keywords: Dimensional analysis; dimensionless relationships; characteristic length; fundamental constants; golden number; measurement units; new SI.

1. INTRODUCTION

Using dimensional analysis, new relationships, existing between universal phenomena, were established on the base of an unconventional approach. For such an analysis, there were considered universal phenomena such as light, gravity, quantum state, electricity, temperature, pressure etc. The analysis of these phenomena, as a whole, emerged from the fact that there is a universal equilibrium between them, expressed by the fundamental constants. Current practice proved that always the following quantities are constant: the speed of light in vacuum; the ratio of the minimum energy of radiation (quanta) and its frequency; the ratio of the two masses attracted by gravitation and the square of the distance between them; the ratio of two electric charges that repel and the square of the distance between them; the ratio of the volume pressure product and temperature; the ratio of the spectral lines and wavelengths or frequencies and thereof; all the elements in the periodic table are only an orderly presentation of constants obtained by dividing the atomic masses of chemical elements to a reference masse (C_{12} carbon atom).

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But for a real comparison between natural phenomena, it must be established a "common measurement" that could provide the "liaison" between them all. The author of this chapter has proposed a method for establishing such a "common measurement" and this is presented below.

1.1 Analysis Method

To establish a "common measurement" for universal phenomena, we started from the International System of Units - SI. The most recent and significant revision of SI was made at the 26th meeting of the CGPM that took place in 2018 at Versailles in France [1]. This meeting approached in a completely new way the definitions of the units of measurement. Following Resolution 1 of the CGPM at its 26th meeting: The International System of Units, the SI, is the system of units in which: (1) the unperturbed ground-state hyperfine transition frequency of the caesium 133 atom $\Delta\nu_{\mathrm{Cs}}$ is 9 192 631 770 Hz, (2) the speed of light in vacuum *c* is 299 792 458 m/s, (3) the Planck constant *h* is 6.626 070 15 × 10^{-34} J s, (4) the elementary charge *e* is 1.602 176 634 × 10^{-19} C, (5) the Boltzmann constant *k* is 1.380 649 × 10^{-23} J/K, (6) the Avogadro constant N_A is 6.022 140 76 × 10^{23} mol^{-1}, (7) the luminous efficacy of monochromatic radiation of frequency 540×10^{12} Hz, K_{cd}, is 683 lm/W [2].

In this way, the definitions of the new SI units are established in terms of this set of seven defining constants. This set of constants is the most fundamental feature of the definition of the entire system of units.

On the base of these seven constants, the new SI units were established. They are second (*s*) for time, meter (*m*) for length, kilogram (*kg*) for mass, ampere (*A*) for electric current, kelvin (*K*) for thermodynamic temperature, mole (*mol*) for the amount of substance, candela (*cd*) for luminous intensity. What is truly revolutionary about the new SI is that the measurement units are defined on the base of the unperturbed ground-state hyperfine transition frequency of the caesium 133 atom $\Delta\nu_{\mathrm{Cs}}$ equal to 9 192 631 770 Hz. Only the amount of substance mole is not defined based on $\Delta\nu_{\mathrm{Cs}}$.

It is known that the dimension of each physical quantity can be expressed as a power-law form [3].

Consequently, a fundamental constant could be expressed as a general equation having the format:

$$Q=(s^{n1})(m^{n2})(kg^{n3})(A^{n4})(K^{n5})(mol^{n6})(cd^{n7}), \quad (1)$$

where the exponents $n_1 \ldots n_7$ are integer real numbers.

In eq.1 all units are defined based on$\Delta\nu_{\mathrm{Cs}}$ apart from the mole. Even if at the moment *mol* is defined only base on Avogadro number author of this chapter proved that it can also be included in the general scheme by which the new SI units are defined [4,5].

At the same time, in eq. 1 the meter is defined on the base of the speed of light *c*. This definition is established by the new SI [2].

In these circumstances from eq. 1 a *proper length* -express by meters- for each fundamental constant, can be identified. This proper length is named „*characteristic length*" since it is a special characteristic of each natural phenomenon in part.

In this way, each fundamental constant can be expressed having as a base such a„ *characteristic length*" -x_{cr}. All other fundamental quantities could be expressed as a global term T_G. It is emphasized that the characteristic length is not chosen at random but it is of the order of Planck length magnitude, so 10^{-35} *m*. The global term T_G is not neglected but it is considered as being proportional with the powers of number *2*. Why was this way of expressing chosen? It is not new, the fact that every universal phenomenon has two components: two masses attract each other, two charges reject (draw) each other, two particles of matter and antimatter give two energy quanta, on an atomic orbital there are two electrons having contrary spin, the nucleus of an atom positively charged is surrounded by negative electrons etc. In this way, the number *2* can express any kind of relationship on symmetry, dualism, partnership etc existing between universal phenomena. It is superfluous to

explain why the number *2* was chosen to express the relations of symmetry, duality, partnership, etc existing between these phenomena, but it is worth mentioning that such an idea came up after the lecture of several books whose subjects refer to physics [6,7,8,9,10,11,12,13,14,15].

It may seem surprising that in an article on physics with great academic pretensions, the author indicates in the bibliography the only popularization works. He does not refer to sophisticated theories of physics. This approach seems particularly simplistic.

But it should be noted that the dimensional analysis method is based only on the experimental data. It does not use complicated mathematical tools. It can be considered to some extent an empirical method. One of the parent of dimensional analysis the Nobel laureate for physics Percy W. Bridgman who publishes fist time in 1922 the monograph *Dimensional Analysis* [3] said: "The method is of great generality and mathematical simplicity" [16].

In this context every fundamental constant has been expressed most simply by the following mathematic formula:

$$Q = x_{cr}^{n1}\, T_G\, 2^n, \tag{2}$$

where: $T_G = [(s^{n1})\ (kg^{n3})\ (A^{n4})(K^{n5})(mol^{n6})(cd^{n7})]$ (see eq. (1) is a global term expressing, as a whole, all fundamental quantities respectively: time, mass, electric charge, temperature, amount of substance etc; x_{cr} is a characteristic length for every fundamental constant in the range of Planck length (10^{-35} *m*); n_1 is the proper exponent for every characteristic length and *n* is the exponent of number 2.

Considering these elements, the characteristic length for each constant can be calculated from the following equation:

$$x_{cr} = (Q / T_G\, 2^n)^{1/n1}. \tag{3}$$

If the characteristic length x_{cr} of every fundamental constant is related to the characteristic length x_c of the speed of light *c* a normalized value X_{cr} for every constant can be calculated by the formula:

$$X_{cr} = x_{cr} / x_c \tag{4}$$

The normalized values X_{cr} are dimensionless fundamental constants and their numerical value does not depend on the system of units. Their characteristic as the fundamental constants is now reinforced by the fact that the new SI units are defined on the same basis that is $\Delta\nu_{Cs}$.

The author introduced the analysis method described above, for the first time, at the National Conference of Physics in 2005 [17] and then he published articles and books in which the results obtained by applying this method are presented [4,5,18,19,20].

These results proved to be more and more interesting as the fundamental constants were measured with increasing precision. The following are presented the most relevant results and conclusions obtained so far by the author.

2. CHARACTERISTIC LENGTHS AND NORMALIZED VALUES

Based on the new definitions of the base units set up by the SI in 2018, the CODATA recommended new and more accurate values of the fundamental constants for using in scientific and technical purposes [21].

These data recommended by CODATA - 2018 are used by the author to explain the method of analysis and to present some truly relevant results and conclusions that can be obtained by applying it. On the base of the data recommended by CODATA -2018, the characteristic lengths and the normalized values for some of the most important fundamental constants were calculated. The results are presented in Table 1.

Table 1. Normalized values for fundamental constants

	Symbol	Constants expressed by the„characteristic lengths"	Normalized values
0	1	2	3
1	c	$c = 2.99792458\times10^{8}\ m\ s^{-1} =$ $= (1.344315875\times10^{-35}\ m)\ (2^{144}\ s^{-1})$	$X_c = 1.0$
2	h	$h = 6.62607015\times10^{-34}\ m^2\ kg\ s^{-1} =$ $= (1.1163446084\times10^{-35}\ m)^2\ (2^{122}\ kgs^{-1})$	$X_h = 0.83041837783$
3	ħ = h/2π	$ħ = 1.0545718176\times10^{-34}\ m^2\ kg\ s^{-1} =$ $= (1.259659999\times10^{-35}\ m)^2\ (2^{119}\ kg\ s^{-1})$	$X_ħ = 0.93702679751$
4	ħ*= h/2π*	$ħ^*=1.05457181765\times10^{-34}\ mkg\ s^{-1} =$ $=(1.318214772\times10^{-35}\ m)(2^{3}\ kg\ s^{-1})$	$X_{ħ^*} = 0.98058409957$ [1)]
5	G	$G = 6.67430\times10^{-11} m^3\ kg^{-1}\ s^{-2} =$ $= (1.259879\times10^{-35}\ m)^3\ (2^{314}\ kg^{-1}\ s^{-2})$	$X_G = 0.93719012$
6	$k = R / N_A$	$k = 1.380649\times10^{-23}\ m^2\ kg\ s^{-2}\ K^{-1} =$ $(1.229424828\times10^{-35}\ m)^2\ (2^{156}\ kg\ s^{-2}\ K^{-1})$	$X_k = 0.91453567659$
7	R	$R = 8.314462618\ m^2\ kg\ s^{-2}\ mol^{-1}\ K^{-1} =$ $=(1.2271357315\times10^{-35}\ m)^2\ (2^{235}\ kg\ s^{-2}\ mol^{-1}K^{-1})$	$X_R = 0.912832879643$
8	$pV_m = RT$	$pV_m = 2271.0954641067\ m^2\ kg\ s^{-2}\ mol^{-1} =$ $= (1.2675737059\times10^{-35}\ m)^2\ (2^{243}\ kg\ s^{-2}\ mol^{-1})$	$X_{pVm} = 0.94291358846$ [2)]
9	T	$X_T = X_{pVm} - X_R$	$X_T = 0.03008070882$ [2)]
10	e	$e = 4.80320471257\times10^{-10}\ cm^{3/2}g^{1/2}\ s^{-1} =$ $= (1.24842114412\cdot10^{-33}cm)^{3/2}(2^{133}g^{1/2}s^{-1})$	$X_e = 0.928666518878$ [2)]
11	$(\alpha^{-1})^2$	$10(\alpha^{-1})^2 m = 187788.6504486\ m / 2^{133} =$ $= 1.72456638867\times10^{-35} m$	$X_{10\alpha} = 1.28285801012$ [2)]

[1)] *ħ*- Planck constant where 2π has the dimension of a length (see details in the text, rel. 6)*
[2)] *concerning to the normalized values:X_{pVm}, X_T, X_e and $X_{10\alpha}$see additional information in the text*

Since the algorithms for establishing the normalized values for *ħ*,pV_m,T=273.15K*, *e*, and *$(\alpha^{-1})^2$* are slightly different from the one used for the other constants, some additional elements are presented below:

Where circular movement is taken into consideration, the Planck constant usually is related to *2π*. The resulting constant is called the reduced Planck constant or Dirac constant - *ħ*. It is equal to the Planck constant divided by *2π*. Similarly, with *h* the SI fundamental units for *ħ* are *$m^2\ kg\ s^{-1}$*.

Having in mind these aspects the following relation can be written:

$$ħ\ [m^2\ kg\ s^{-1}] = h/2π\ [m^2\ kg\ s^{-1}]. \quad (5)$$

where *2π* is pure mathematical value, a dimensionlessnumber resulting from the circumference/diameter ratio. When we apply dimensional analyses, we suppose that the Planck constant *h* is not related to a dimensionless value equal to *2π* but to a circumference of a circle equal to *2π* meters (*m*) or radius equal to *1* meter.

In these circumstances above relationship can be written as:

$$ħ = h\ [m^2\ kg\ s^{-1}] / 2π\ [m] = h/2π\ [m\ kg\ s^{-1}]. \quad (6)$$

From rel. 6 appears that numerical value of the constant *ħ* is the same but dimensions are different *$m\ kg\ s^{-1}$* instead of *$m^2\ kg\ s^{-1}$*. This "amended" Planck constant is denoted *ħ** and it has dimensions *$m\ kg\ s^{-1}$*. Just like other fundamental constants, *ħ** can be expressed using a characteristic length and based on this length, a normalized value noted *$X_{ħ^*}$*can be calculated (s. row 4, in Table 1).
For establishing normalized values for constant product *pV_m* and *T=273.15 K* the universal gases law *$pV_m=RT$* (when *p* is equal to *100kPa*) is taken into consideration. If it is had in view the molar gas

constant $R=8.314462618\ Jmol^{-1}K^{-1}$ and absolute temperature $T=273.15K$, in accordance with $pV_m=RT$, is obtained: $pV_m = 8.314462618\ Jmol^{-1}K^{-1} \times 273.15K = 2271.0954641067\ Jmol^{-1}$. If it is considered that $Jmol^{-1}$ is equal to $m^2kgs^{-2}\ mol^{-1}$ a normalized value for X_{pVm} can be established (see row 8, in Table 1). From the difference X_{pVm} and X_R a normalized value $X_T= 0.03008070882$ results for the temperature T (s. row 9,in Table 1).

In the SI, electric charge e is expressed in C(coulombs). It is well known when e is expressed in C an explicit connection between this dimension and a characteristic length is not possible to be established. But in the cgs System, there is an explicit relationship between electric charge, e, and cm as a unit for length. In the cgs System elementary electric charge, $e$is expressed by statcoulomb (statC) or franklin (Fr). A statcoulomb is expressed in $g^{1/2}cm^{3/2}s^{-1}$. Between coulombs, C, and statcoulomb, statC, there is the following conversion relationship [22]:

1 C ↔ 2997924580 statC.

In this context elementary electric charge $e = 1.602176634 \times 10^{-19}\ C$ recommended by CODATA 2018 [21] is equal to $4.80320471257 \times 10^{-10}\ g^{1/2}cm^{3/2}s^{-1}$.

Having in view this dimension equal to $g^{1/2}cm^{3/2}s^{-1}$for electric charge e, that includes cm as a unit of length, a characteristic length and a normalized value for e can be established (s. row 10, Table 1).

Within the relationships established between fundamental constants, the square of the fine structure constant multiplied by 10, respectively $10(\alpha^{-1})^2$, plays an important role [19,20]. The square of the fine structure constant $(\alpha^{-1})^2$ can be expressed as a ratio between the atom Bohr radius $a_o = 5.29177210903\times10^{-11}\ m$, and the classical electron radius $r_e = 2.8179403262\times10^{-15}\ m$, equal to $(\alpha^{-1})^2 = a_o / r_e = 18778.8650449$. This means that if the Bohr radius a_o is related to the tenth part of the classical electron radius r_e is obtained $10(\alpha^{-1})^2 = 187788.650449$ that is, in fact, a dimensionless ratio of two lengths. If 187788.650449 is expressed in m, for the square of the fine structure constant $(\alpha^{-1})^2$, a "characteristic length", having the order of magnitude in the Planck length range (10^{-35} m), can be calculated (s. row 11, in Table 1). If this "characteristic length" for $10(\alpha^{-1})^2\ m$ equal to $1.72456638867\times10^{-35}\ m$ is related to the characteristic length for speed of light equal to $1.344315875237\times10^{-35}\ m$ is obtained $X_{10\alpha}=1.28285801012$(s. row 11, col. 3, in Table 1), where $X_{10\alpha}$ is considered "a special normalized value" for $10(\alpha^{-1})^2 m$.

The calculation method of these more characteristic lengths was presented above quite briefly. For detail elements, the reader can consult the following works of the author [4,18,19,20].

3. RESULTS AND DISCUSSIONS

3.1 Results

Below are introduced some of the results obtained based on the normalized values presented in Table 1:

(1) The difference between the normalized value $X_c=1$ for the speed of light c (s. row 1, in Table 1) and the normalized value $X_h=0.83041837783$ for the Planck constant h (s. row 2, in Table 1) is equal to:

$$X_c - X_h = 1 - 0.83041837783 = 0.169581622 \quad (7)$$

If this result is multiplied by 2^{260} is obtained:

$$0.169581622 \times 2^{260} = 3.141793652\times10^{77}, \quad (8)$$

a value very close to π.

(2) The difference between the normalized value $X_c=1$ for the speed of light (s. row 1, Table 1) and the normalized value $X_{\hbar^*}=0.98058409957$ for the Planck constant $\hbar^*$(s. row 4 , in Table 1) is equal to:

$$X_c - X_{\hbar^*} = 1 - 0.98058409957 = 1.941590043\times10^{-2}. \quad (9)$$

If this value is divided by $(\varphi-1)$ where $\varphi=1.618033988479$ is root of eq. $x^2-x=1$or so-called golden number, golden section, middle section etcis obtained:

$$(X_c - X_{\hbar^*}) / (\varphi-1) = 1.941590043\times10^{-2} / 0.618033988479 = 3.141557938\times10^{-2}, \quad (10)$$

a value very close to $\pi\ 10^{-2}$. Why rel. 10 is divided by $(\varphi-1)$ is explained below.

(3) The difference between X_c normalized value for the speed of light c (s. row 1 in Table 1) and X_G the normalized value for gravitational constant G (s. row 5, in Table 1) is equal to:

$$X_c - X_G = 1.0 - 0.93719012 = 6.280988\times10^{-2} = 3.140494\times10^{-2} \approx 2\pi10^{-2}, \quad (11)$$

a resultclose to $2\pi10^{-2}$.

(4) The difference between X_c normalized valuefor the speed of light c (s. row 1 in Table 1) and X_R the normalized value for gas constant R (s. row 7, in Table 1) is:

$$X_c - X_R = 1 - 0.912832879643 = 0.0871671203. \quad (12)$$

If the value 0.0871671203 is considered having the dimension of a length respective $0.0871671203\ m$ and this length is related to the characteristic length of the speed of light equal to $1.344315875237\times10^{-35}m$(s. row 1, col. 2, in Table 1) and the result is divided by $2^{300}$is obtained:

$$(0.0871671203\ m / 1.344315875237\times10^{-35}\ m) / 2^{300} = 0.31831175\times10^{-56}. \quad (13)$$

The inverse of 0.31831175 is equal to 3.141574245 a value very close to π.

(5) One of the most interesting relationships established by dimensional analysis is that between normalized values of the gravitational constant G, Planck constant h and square of the fine structure constant $(\alpha^{-1})^2$ having the following form [19,20]:

$$(2 X_G) / [X_{10\alpha} / (2X_h)]^2 \approx \pi, \quad (14)$$

where X_G, X_h and $X_{10\alpha}$are normalized value for gravitational constant G, Planck constant h and the square of the fine structure constant $(\alpha^{-1})^2$ (s. row 11, Table 1).

If in the eq. 14 the normalized values for X_G, X_h and $X_{10\alpha}$ presented in Table 1 are taken into account the following result is obtained:

$$(2\times0.93719012) / [1.28285801012 / (2\times0.83041837783)]^2 = 3.141625489 \approx \pi, \quad (15)$$

that is a value very close to number π.

3.2 Discussions

It is easy to notice that the above results are directly related to π or φ numbers.

For this study, only the ratios close to the numbers π and φ have been taken into account. In these cases is undoubted that we are discussing a circular shape. In these cases, it does not matter if the π number is multiplied by the powers of 10 or divided by them since a circle is a circle even if it is large

or small. The normalized values are not absolute, they are dimensionless relative quantities that can be compared with each other. In this context, all circles can be compared to each other. The difference between the circles is given only by the diameters which are some lengths.

Someone might object: anyone can get values close to π or φ if they multiply or divide random numbers by the powers of 2. This observation is correct but the relationships obtained from this analysis method are very important and relevant, whereas they are obtained as the dimensionless ratios of the characteristic lengths of the fundamental constants. What relationship between two lengths may be more conclusive than the one expressed by a circle? And this circle "appears" from pure experimental data that have no connection with any previously assumed circular shape.

It is easy to notice that in the above relations the ratios between the normalized values are close to π but are not equal to it. The differences are sometimes larger -to the third decimal- and sometimes smaller - to the fourth decimal. This proves that there are more subtle relationships between these normalized values as presented below.

To exemplify such a more subtle connection the relationships between normalized values of the gravitational constant *G*, Planck constant *h* and square of the fine structure constant $(\alpha^{-1})^2$ are taken into consideration.

It has been shown that between these three normalized value there are rel. 14 and 15 very close to π.

If in rel. 15, the normalized value $X_{10\alpha} = 1.28285801012$ is replaced by a little bit higher value equal to *1.282864713* this relation become equal to π as the following:

$$(2\times 0.93719012) / [1.282864713 / (2\times 0.83041837783)]^2 = \pi. \quad (16)$$

On the other hand, the difference between normalized value X_{pVm} for constant product pV_m(s. row 8, Table 1) and normalized value X_k for Boltzmann constant (s. row 6, Table 1) is equal to:

$$X_{pVm} - X_k = 0.94291358846 - 0.91453567659 = 0.0283779119 \quad (17)$$

If similarly to rel.13 the value *0.0283779119* is considered having the dimension of a length respective *0.0283779119 m* and this length is related to the characteristic length of the speed of light equal *to* $1.344315875237\times 10^{-35} m$(s. row 1, col. 2, in Table 1) and the result is divided by 2^{210} is obtained:

$$(0.0283779119\ m / 1.344315875237\times 10^{-35}\ m) / 2^{210} = 1.28286223\times 10^{-30}, \quad (18)$$

a result close to normalized value for the square fine structure constant $(\alpha^{-1})^2$ equal to *1.28285801012* (s. row 11, in Table 1) but closer to the value *1.282864713* when rel. 15 became equal to π (see rel. 16). If in rel. 16, *1.282864713* is replaced by *1.28286223* is obtained:

$$(2\times 0.93719012) / [1.28286223 / (2\times 0.83041837783)]^2 = 3.14160482 \approx \pi \quad (19)$$

a value closer toπ than *3.141625489* in rel. 15.

From the above results, it appears that between $X_{G,}$ X_h and $X_{10\alpha}$there is a relationship close to π (s. rel. 14 and 15) but this relationship is even closer to π if we take into account the difference $X_{pVm} - X_k$ (s. rel. 17).

Here is introduced only one example of subtle relationship but the author presents many other relationships like this in his published articles and books [4,19,20].

The calculations show that between normalized values there are relationships not only with the number π but also with the number φ or $(\varphi - 1)$ (s. rel. 10).

The other relationship in which the φnumber appears is that between normalized value $X_c=1$ for speed of light (s. row 1, in Table 1) and normalized value $X_T$for temperature (s. row 9, Table 1). The difference $X_c - X_T$is equal to:

$$X_c-X_T=1.0 - 0.030080559=0.969919441. \quad (20)$$

If 0.969919441 is divided by 2^{190} is obtained:

$$0.969919441 / 2^{190} = 6.180683264\times10^{-58}, \quad (21)$$

a value very close to $\varphi -1$.

As a conclusion, it can be said that between the normalized values of the fundamental constants, there are relationships that are similar to those existing between perfect geometric figures (s. Fig. 1).

4. WHAT COULD SUCH RELATIONSHIPS BE USEFUL FOR?

Below some examples of the usefulness of such relationships are presented:

4.1 Establishing a more Precise Value for the Gravitational Constant *G*

It is known that the gravitational constant *G* is still measured with low accuracy (rsu 2.2 10^{-5}). The debates around its measurement are still intense [23,24,25].

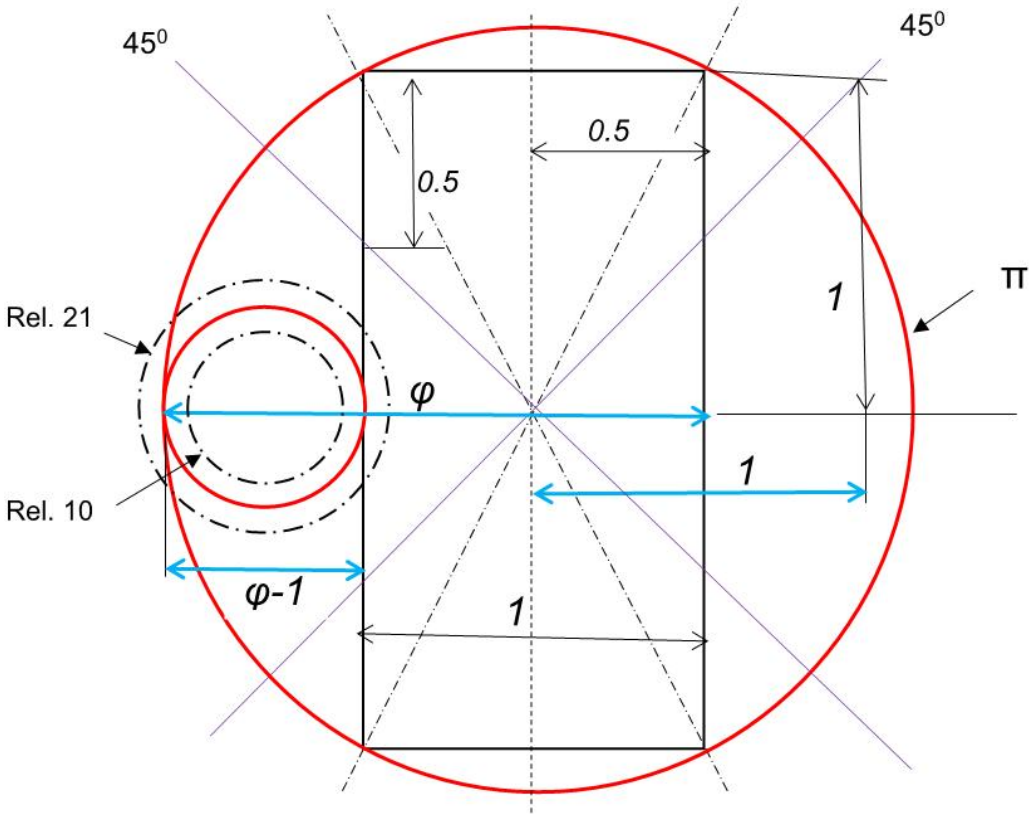

Fig. 1. Relationships between numbers *π, φ* , circle and square

Considering that the gravitational constant *G* is measured less accurately than the Planck constant *h*, the Boltzmann constant *k*, product constant pV_m and the fine structure constant *α,* the normalized value X_G of the gravitational constant *G* was calculated from rel. 19 when this relation is equal to *π* as the following:

$$X_G = \{\pi\, [1.2828622301 / (2\times 0.83041837783)]^2\} / 2. \quad (22)$$

From the rel. 22 results for X_G the value:

$$X_G = 0.937186491. \quad (23)$$

If X_G **=***0.937186491* is taken into account for the calculation of the gravitational constant is obtained for *G* the value $G=6.674222489\times 10^{-11}\ m^3\ kg^{-1}\ s^{-2}$ comparative with the experimental one $G= 6.6743 \times 10^{-11}\ m^3\ kg^{-1}\ s^{-2}$ (s. row 5, Table 1).

At this moment, we cannot say that the value $6.674222489\times 10^{-11} m^3\ kg^{-1}\ s^{-2}$is the real one. What we can say is that the value X_G**=** *0.937186491* is really important since it correlates very well the normalized values of other fundamental constants such as $X_c$for speed of light and X_h for Planck constant *h* that the following relationship:

$$[(X_c - X_G) / (X_G - X_h)\ ]\ 2^{318} =$$

$$[(1-0.937186491) / (0.937186491 - 0.83041837783)]\ 2^{318} = 3.14159439\times 10^{95} \quad (24)$$

where the result is very close to *π* (differs to the sixth decimal).

If in rel. 24 $[(X_c - X_G)$ is multiplied by 2^2 and $(X_G - X_h)$ is divided by 2^2 the exponent of number *2* will be equal to *314* the same that appears in the relation by which the characteristic length for the gravitational constant *G* was calculated (s. row 5, Table 1).

Concerning these results, it is considered that the relationship $X_G = \pi[X_{10\alpha} /(2X_h)]^2 / 2$ could be taken into account when the new recommendations for choosing the most appropriate experimental value for the gravitational constant *G* will be made. Than this relationship could be had in view and used as an additional and nonconventional tool in this process. Regarding this relationship see also Avogadro's number at 4.3.

4.2 An Interesting Model on the Proton/Electron Mass Ratio

Whereas the speed of light *c* is expressed in $m\cdot s^{-1}$ and the Planck constant$\hbar^*$in$m\cdot s^{-1}\cdot kg$ the difference between normalized values $X_c - X_{\hbar^*} = 1.941590043\times 10^{-2}$(s. rel. 10) equal to $\pi\times 0.6180273056\times 10^{-2}$ reflects only the mass influence. Having in view this aspect it is considered that the value $\pi\times 0.6180273056\times 10^{-2}$ very close to $\pi(\varphi-1)10^{-2}$,could be associated with the normalized value of a mass of an *elementary physical entity*having a circular shape. In this context $0.6180273056\times 10^{-2}$ corresponds to the diameter and $\pi\times 0.6180273056\times 10^{-2}$ to the circumference.

We suppose there is a physical entity having a normalized value for mass equal to *6.180273056* (corresponding to *10* elementary physical entities) that is very close to *10 (φ-1).* If*6.180273056* is multiplied by *2* eight times and following each multiplication a normalized value equal to *1* is added is obtained finally:

$$6.180273056\times 2+1]\cdot 2+1]\cdot 2+1]\cdot 2+1]\cdot 2+1]\cdot 2+1]\cdot 2+1]\cdot 2+1]= 1\ 836.149902336. \quad (25)$$

The result is very close to *1 836.15267343* the experimental proton/electron mass ratio. Having in view this result means that the proton mass could be obtained starting from *10* physical entities having their mass associated with a normalized value equal to *6.180273056*very close to *10(φ-1).*From rel. (25) it is noticeable that value*,* obtained by calculations starting from *6.180273056,* is smaller than the experimental value $m_p/m_e=1836.15267343.$ For obtaining a value equal to the

experimental ratiom_p/m_e=*1836.15267343*, the normalized value for the mass of *10* entities must be equal to *6.18028388059,* as resulting from rel. (26):

$$1836.15267343 :2\text{-}1] :2\text{-}1]:2\text{-}1]:2\text{-}1] :2\text{-}1] :2\text{-}1]:2\text{-}1] :2\text{-}1]=6.18028388059. \quad (26)$$

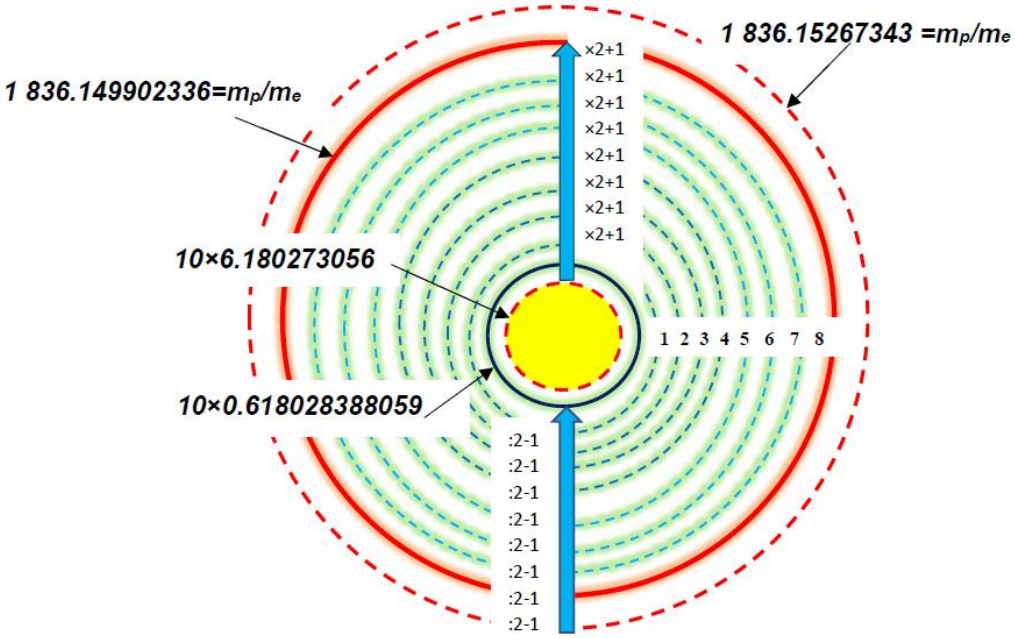

Fig. 2. Schematic representation of how the proton mass could be „engendered" from the electron mass

The difference between experimental value *6.1802730566* and calculated value *6.18028388059* is too small and influenced by experimental errors, to draw a clear conclusion about it, at this moment. But certainly determining experimental values more accurately will be able to provide such a possibility. If such a model of the relationship between the mass of the proton and the mass of the electron proves to be real then many practical applications based on it could be imagined.

4.3 The Connection of the Avogadro Number N_A to the New SI

If we look carefully at the *mol* definition by the Avogadro number N_A [2] we can remark there is not a relationship between Avogadro's number N_A and the unit of time -second- respective the hyperfine transition $\Delta\nu_{Cs}$ basis of SI units. The calculations presented below show that dimensional analysis can be used to establish such a relationship.

Avogadro constant N_A is equal to $6.02214076\times10^{23}\ mol^{-1}$. Its signification is a constant number of physical entities existing in a molar volume V_m. If it is taken into account that the relationships presented in this chapter are based on the powers of number 2, it is easy to notice that $N_A = 6.02214076\times10^{23}$ is very close to $2^{79} = 6.044629098 \ldots \times10^{23}$. Having in view this last value, we can consider that 2^{79} could be similar to an "ideal Avogadro constant" noted $N_{A0} = 2^{79}\ mol^{-1}$, containing 2^{79} elementary ideal physical entities. The volume containing 2^{79} elementary ideal physical entities is considered an ideal volume. In this context two normalized values could be defined:

$$X_{NA0}= 2^{79}\ mol^{-1} / N_{A0}\ mol^{-1}=1, \quad (27)$$

for "ideal Avogadro constant N_{A0}" and

$$X_{NA} = N_A / N_{A0} = 6.02214076\times10^{23}\ mol^{-1} / 2^{79}\ mol^{-1} = 0.9962796165, \quad (28)$$

for Avogadro constant N_A.

If it is taken into consideration inverse of X_{NA} respective $1 / X_{NA}$ is obtained:

$$1 / X_{NA} = 1.003734276393. \quad (29)$$

This ratio reflects how much "empty space" is allocated from the ideal Avogadro constant N_{A0} equal to 2^{79} to each physical entity existing in N_A (Fig. 3a).

It was considered that this "empty space" that appears as the difference between N_{A0} and N_A is similar with the "empty space" existing between the center of an atom where could be a particle having a radius of the electron r_e and the Bohr radius of the atom a_0 (see. Fig. 3b). This "empty space" is represented by the ratio a_0 / r_e equal to $a_0 / r_e = (\alpha^{-1})^2 = 18778.86504486.$

It is re-call that a normalized value equal to $X_{10\alpha}=1.28285801012$ for square the fine structure constant $(\alpha^{-1})^2$ was calculated (s. row 11, Table 1).

Since between $(\alpha^{-1})^2 = 18778.86504486$ and the empty space in the atom there is a direct relationship it is considered reasonable that between the normalized value $X_{10\alpha}=1.28285801012$ and this empty space in an atom must be a relationship.

The ratio of these two "empty space", one corresponding to the Avogadro number and another one to the atom, has the following value:

$$1.003734276393 / 1.28285801012 = 0.782420399 \quad (30)$$

If this value is multiplied by 2^{91} results:

$$0.782420399\times2^{91} = 1.937179079\times10^{27}. \quad (31)$$

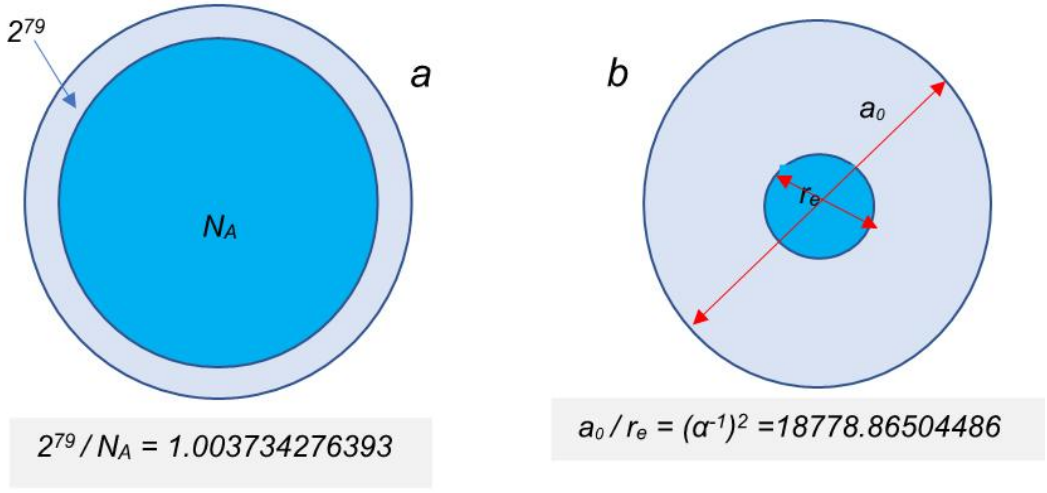

Fig. 3. Schematic representation of the two "empty spaces":

It is interesting that this result is very close to the sum of the normalized value $X_c = 1$ of the speed of light c and the calculated normalized value $X_G = 0.937186491$ of the gravitational constant G (s. rel. 23). If in rel. 31 is considered instead of 0.937179079 an exact value $X_c - 0.02\pi = 0.937168147$ close

to X_G=*0.937186491*, is obtained from rel. 14, 22, 30 and 31 the value X_G = *0.9371909* that is very close to the experimental one X_G = *0.93719012* (s. row 5, in Table 1). In this way, it appears that the ratio of the two "empty spaces" is directly related to the light and gravity. So, the empty space would be the result of a condensation process of the elementary physical entities -they could be photons- from the ideal number N_{A0} equal to2^{79} to the Avogadro number N_A, under the effect of gravity.

4.4 An "Image of the Time"

The new SI defines the units of measure based on the transition frequency of the caesium 133 atom $\Delta\nu_{Cs}$ .The second (*s*) is equal to the duration of 9 192 631 770 periods of the radiation (pr) corresponding to the transition between the two hyperfine levels of the unperturbed ground state of the 133Cs atom.

We suppose that this time -duration- is formed by 1 period of radiation (pr) multiplied by powers of number 2.

Calculus shows that:

$$9\ 192\ 631\ 770 = 1.070163185941 \times 2^{33}\ pr. \tag{32}$$

If *1.070163185941pr* is related to *1*period of radiation (pr) results:

$$1.070163185941\ pr\ /\ 1pr = 1.070163185941, \tag{33}$$

that is a dimensionless value where *0.070163185941* is a fraction of time (o fraction of *1*pr).

The problem is what represents the dimensionless fraction *0.070163185941* that is a value directly related to time (1 period of the radiation)?

If the inverse of this value respective *1 / 0.070163185941* is multiplied twice successively by 2*π* and the result is multiplied 2^{314} it is obtained:

$$(1\ /\ 0.\ 070163185941) \times (2\pi)^2 \times 2^{314} = 18778.8535109 \times 10^{93}, \tag{34}$$

a value very close to the square of the fine structure constant $(\alpha^{-1})^2$= *18778.8650449* or ratio the Bohr radius a_o / the classical electron radius r_e.

The above-presented results show the following:

1. There is a time fraction that related to the *π* number (a circle) is in direct relationships with the square of the fine structure constant $(\alpha^{-1})^2$and powers of number 2.
2. In this relationship, the power exponent of number 2 is equal to 314 the same that appears in the relation by which the characteristic length for the gravity constant *G* was calculated (s. row 5 Table 2).

From here two interesting questions arise:

1. Is the time constituted by discrete circular entities as the calculation shows?
2. Is a relationship between these circular entities and gravity, because the power of the number 2 equal to 2^{314} is the same as the one that appears when the characteristic length for the gravity constant *G* is calculated?

These "curiosities" should not be surprising because it is known there are theories that suppose that time is not continuous but discrete. This model of the discrete-time, quanta, is discussed in the attempt to unify the quantum gravity theory with the general relativity theory [26].

5. CONCLUSIONS

The fundamental constants can be rewritten using a power-law model by taking number 2 as the basis, and a so-called "characteristic lengths". If the "characteristic length" for a fundamental constant is related to the "characteristic length" of the speed of light, for every fundamental constant could be calculated a normalized value.

Calculations show that between the normalized values associated with the fundamental constants, the number π, the numbers φ orφ -1 (where φ is the root of the equation $x^2 - x - 1 = 0$) and the powers of the number 2, there are certain relationships.

The relationships between the normalized values are similar to the relationships existing between elementary geometric figures (quadratic, circular). In this context, they could be presented in a unitary, coherent and synthetic way in a graphical construction where the key elements are a circle and a square (s. Fig. 1).

These relationships can be used as a nonconventional and additional tool for establishing more exact value for the gravitational constant G, and other fundamental constants and for highlighting more subtle connections existing between fundamental phenomena. These relationships are becoming increasingly interesting as the fundamental constants will be measured more and more precisely.

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The results and conclusions presented in this chapter are completely original and were obtained by applying a special method of analysis imagined by the author.

Some researches have tried to find an explanation of these results using certain conventional approaches known in current physics. Whereas they have not found a classic physical background to explain these results, they considered them mere "curiosities".

Even if these results are mere "curiosities" obtained by the author as a result of his pure intellectual curiosity, they may still have their importance having in view what Frederick Seitz wrote about curiosity:
„Things that people learn purely out of curiosity can have a revolutionary effect on human affairs".

„Individual curiosity, often working without practical ends in mind, has always been a driving force for innovation"[27].

COMPETING INTERESTS

Author has declared that no competing interests exist.

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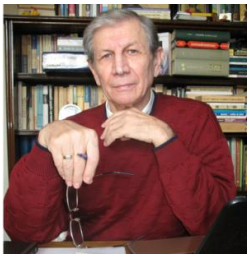
Biography of author(s)



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He was born on February 21, 1947, in Alba County (Transylvania) in Romania. In 1969 he graduated from the Faculty of Chemical Engineering in the Polytechnic University of Bucharest, Romania's capital. Between 1969 and 1990 he worked as a scientific researcher at an institute for environmental protection where his activity focused mainly on: the removal of organic pollutants from industrial chemical wastewater by the biological processes, the oxygen transfer in aerobic biological reactors and the mathematical modelling of biological processes. During this period, he obtained a doctorate with a thesis entitled "*Modelling and simulation of the biochemical reactors*" presented at the Faculty of Chemical Engineering in the Polytechnic University of Bucharest. The results of his research were published in scientific journals in the country but also in prestigious international journals (Water Res., Biotechnol. &Biochem. Eng.). He has also written two books on the biological wastewater treatment processes. Starting with 1990, he worked in the administrative field, being a technical advisor and director in the Romanian Ministry of Environment where he coordinated the technical groups that set up the new laws on the management of dangerous substances and hazardous waste for preparing Romania's accession to the European Union. He participated as a member of Romania's delegations in the conferences of the parties of the international conventions as the Basel Convention on hazardous waste, the Rotterdam Convention on PIC (prior informed consent), the Stockholm Convention on POP's (persistent organic pollutants). Between 2009-2011 he was Romania's representative in the Management Board of the European Agency for Chemicals - EChA in Helsinki. Between 1978 and 2000 he was an associate professor at the Faculty of Chemical Engineering in the Polytechnic University of Bucharest. In 2011 he retired and since then he has been interested in dimensional analysis out of pure intellectual curiosity. In this field, he has published several articles and three books.

Chapter 3
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Recent Focus on a New Perspective on Advanced Space Travel

Peter Bissonnet[1*]

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ABSTRACT

This paper attempts to delve into the mystery of space travel. Consequently, it will be necessary to re-examine concepts which scientists hold dear. In addition, it is the author's contention that the so-called weak force is the seat of a powerful new energy source which can be used to propel spacecraft to unheard of velocities utilizing a variable scalar gravitational "constant". One of the major obstacles faced is that normally the so-called "arc length" ds will be equal to zero at the speed of light (because of its dependence upon relative velocity), and since ds is used in the denominator of equations of motion, such equations will become meaningless. This paper will continue to use the arc length ds, along with its implied proper time; however, this paper will use a different method of approach to this problem which will involve divorcing ds from its dependence upon relative velocity as a result of the aforementioned generalization. The approach will be to use a complex mass-velocity vector (not momentum vector) over the usual four dimensional space-time manifold domain. The mass-velocity vector is introduced, because it is assumed that a gradient in φ or$\varphi^{/\mu}$ (to be controlled from within the spacecraft) will cause not only a change in the velocity of the spacecraft, but also a change in the apparent inertial/gravitational mass $m_o$of the spacecraft in a coordinated way. This is the guiding principle of this paper!

Keywords: Variable gravitational "constant"; space travel; greater than the speed of light; weak force.

1. INTRODUCTION

This paper is dedicated to military pilots who have the audacity to take off in experimental aircraft, and, witheven greater audacity, have high expectations of landing such complicated machinery in one piece. Perhaps their descendents will fly craft mathematically described in this paper, or, more ominously, perhaps some military pilots, both past and present, have already encountered such craft in their nearby airspace!

This paper attempts to delve into the mystery of space travel. Consequently, it will be necessary to re-examine concepts which scientists hold dear. In addition, it is the author's contention that the so-called weak force is the seat of a powerful new energy source which can be used to propel spacecraft to be unheard of velocities utilizinga variable scalar gravitational "constant" (see Section 9).

The approach will be to use a complex mass-velocity vector (not momentum vector) over the usual four dimensional space-time manifold domain. This complex mass-velocity vector is considered to be a function of the underlying four dimensional coordinates of this manifold domain.

The Lorentz space-time metric$g_{\mu\nu(L)}$is the one used in deep space with a signature in a Lorentzian spacetimeof (−1 −1 −1 + 1) and will be used to raise and lower indices and is not considered changed or modified by any of the above considerations; however,$g_{\alpha\beta(L)}u^{\alpha}u^{\beta}$will be essentially interpreted from a new point of viewby introducing a generalization. One of the major obstacles faced is that

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normally the so-called "arc length" ds will be equal to zero at the speed of light (because of its dependence upon relative velocity), and since ds is used in the denominator of equations of motion, such equations will become meaningless. This paper will continue to use the arc length ds, along with its implied proper time; however, this paper will use a different method of approach to this problem which will involve divorcing ds from its dependence upon relative velocity as a result of the aforementioned generalization.

The advent of the problem of galaxy rotation due to the presence of so-called "dark matter" seems to imply that a majority of the solar systems in a galaxy move through their respective galaxy at roughly the same velocity implying that there is a background differential time coordinate dt which can be considered to be approximately the same most everywhere where these solar systems are in that part of the galaxy rotation curve which denotes a constant speed.

2. MASS-VELOCITY VECTOR [1]

The mass-velocity vector will be defined as follows:

$$\mathrm{d}\xi_{(1)}{}^{\mu} = \left[a u^{\mu} + ib\phi^{/\mu} \right] \mathrm{d}s \tag{1}$$

where $a = (|\eta| m_o c^2)^{1/2}$ and $b = (m_o c^2)^{1/2}$ and $|\eta| = |G/G_o|$ where $|G|$ is the absolute magnitude of a variable scalar gravitational "constant" and is assumed to be generally complex, and, hence; dependent upon space and time coordinates (and therefore capable of being Fourier analyzed or at least to a degree, stochastic, such as the time dependence of raindrops on a roof). G_o is the usual gravitational "constant"; m_o is the mass of the spacecraft in its rest frame, and u^{μ} is the four velocity $\mathrm{d}x^{\mu}/\mathrm{d}s$.

φ must have the dimensions of cm since $\varphi^{/\mu}$ is dimensionless. φ is produced by the new "electric" dipole p(esu·cm) of the weak force. The simplest way to define φ is to just let $\varphi = p/q$, where $p = q(R_{oc} - R)$ and where p has the dimensions of esu cm (see Section 9).

The mass-velocity vector is introduced, because it is assumed that a gradient inφor *i.e.*$\varphi^{/\mu}$(to be controlled from within the spacecraft) will cause not only a change in the velocity of the spacecraft but, in addition, will also cause a change in the apparent inertial/gravitational mass $m_o$of the spacecraft in a coordinated way. This is the guiding principle of this paper! This is not so outlandish as one would assume, simply because of the following example.

Suppose an asteroid, located quite a distance from the earth yet still within the gravitational attraction of thee arth, entered a small region of space which was governed by a different gravitational constant G. The gravitational force on the asteroid would then be

$$F = GM_{\text{earth}} m_{\text{asteroid}} / R^2$$

where R is the distance from the center of the earth. This can be recast into the standard form such as follows

$$F = \left(G_o M_{\text{earth}} / R^2 \right) m_{\text{apparent}} .$$

where$m_{\text{apparent}} = (G/G_o) m_{\text{asteroid}}$.

Thus, we see that the apparent inertial/gravitational mass of the asteroid has changed due to the factorG/G_o. This is why $|\eta|$ appears in **a**.

The author is further assuming that the creation of this macroscopic field φ is somewhat similar to the creation of a laser beam, that is, that a large number of tiny effects from the many nucleons of the

many atoms/molecules of the spacecraft that they are associated with, when add together, will form a large macroscopic effect surrounding the spacecraft.

We now need to determine the dependence of φ upon η. From Section 9, we have $p = q(R_{oc} - R)$ from which we can calculate that $p = qR_{oc}(1 - \eta^{1/2})$ and hence $= p/q = R_{oc}(1 - \eta^{1/2})$. $\varphi^{/\mu} = -1/2R_{oc}\eta^{-1/2}\eta^{/\mu}$ At once we can see that as $\eta \to 0(\text{or } G \to 0)$that $\varphi^{/\mu} \to \infty$. Also, as $G \to G_o$, then $\eta \to 1$ and $\varphi^{/\mu} \to 0$.

The gradient of φ is given by

$$\phi^{/\alpha} = g_{(L)}^{\alpha\beta}\phi_{/\beta} = g_{(L)}^{\alpha\beta}\,\partial\phi/\partial x^{\beta}$$

The method of attack on this problem will be as follows.$i = (-1)^{1/2}$will be treated as a "vector" in complexspace, in the sense that we will be taking a product in the $+I$ direction, then a product in the $-I$ direction then adding these two products together and taking an average. We therefore introduce a second mass-velocity vector

$$\mathrm{d}\xi_{(2)}{}^{\nu} = \left(au^{\nu} + ib\phi^{*/\nu}\right)\mathrm{d}s \tag{2}$$

where $\varphi^{*/V}$ is the complex conjugate of $\varphi^{/V}$ but with a diff erent vector index from (1).

Consequently, we must also allow the following mass-velocity vectors

$$\mathrm{d}\xi_{(3)}{}^{\mu} = \left(au^{\mu} - ib\phi^{*/\mu}\right)\mathrm{d}s \tag{3}$$

and

$$\mathrm{d}\xi_{(4)}{}^{\nu} = \left(au^{\nu} - ib\phi^{/\nu}\right)\mathrm{d}s \tag{4}$$

We now form the following asymmetric tensor

$$\begin{aligned}
&\frac{1}{2}\left[\left(\mathrm{d}\xi_{(1)}{}^{\mu}/\mathrm{d}q\right)\left(\mathrm{d}\xi_{(2)}{}^{\nu}/\mathrm{d}q\right) + \left(\mathrm{d}\xi_{(3)}{}^{\mu}/\mathrm{d}q\right)\left(\mathrm{d}\xi_{(4)}{}^{\nu}/\mathrm{d}q\right)\right] \\
&= \frac{1}{2}\left[\left(au^{\mu} + ib\phi^{/\mu}\right)\left(au^{\nu} + ib\phi^{*/\nu}\right) + \left(au^{\mu} - ib\phi^{*/\mu}\right)\left(au^{\nu} - ib\phi^{/\nu}\right)\right] \\
&= a^2u^{\mu}u^{\nu} - \frac{1}{2}b^2\left(\phi^{/\mu}\phi^{*/\nu} + \phi^{*/\mu}\phi^{/\nu}\right) + i\frac{1}{2}ab\left[\left(\phi^{/\mu}u^{\nu} - \phi^{/\nu}u^{\mu}\right) - \left(\phi^{*/\mu}u^{\nu} - \phi^{*/\nu}u^{\mu}\right)\right]
\end{aligned} \tag{4a}$$

$$a^2 = |\eta| m_o c^2$$

$$b^2 = m_o c^2$$

Let $\mathcal{L}^{\mu\nu}$ =Equation 4(a).

$$\mathcal{L}^{\mu\nu} = T^{\mu\nu} - V^{\mu\nu} + iL^{\mu\nu} \tag{5}$$

where $\mathcal{L}^{\mu V}$ can be interpreted as a rarely defined Lagrangian tensor and

$$T^{\mu V} = a^2u^{\mu}u^{V} = |\eta| m_o c^2 u^{\mu}u^{V} \text{ with the dimensions of energy} \tag{5a}$$

$T^{\mu\nu}$can be defined as the kinetic energy part of this Lagrangian tensor

$$V^{\mu\nu} = \frac{1}{2} b^2 \left(\phi^{/\mu} \phi^{*/\nu} + \phi^{*/\mu} \phi^{/\nu} \right) \tag{5b}$$

$V^{\mu V}$ can be defined as the potential energy part ofthis Lagrangian tensor.

$V^{\mu V}$ is Hermitian (observable), symmetric and with dimensions of energy.

$$L^{\mu\nu} = \frac{1}{2} \left(|\eta| m_o c^2 \right)^{\frac{1}{2}} \left(m_o c^2 \right)^{\frac{1}{2}} \left[\left(\phi^{/\mu} u^{\nu} - \phi^{/\nu} u^{\mu} \right) - \left(\phi^{*/\mu} u^{\nu} - \phi^{*/\nu} u^{\mu} \right) \right] \tag{5c}$$

$L^{\mu V}$ is Hermitian (observable), antisymmetric and with dimensions of energy.

We note that $L^{\mu\nu *} = -L^{\mu\nu} = L^{\nu\mu} = (L^{\nu\mu})^{T*}$ which is the definition of Hermitian or $L = L^{\dagger}$.

We will now try to find a simple meaning for $L^{\mu\nu}$ noting that it is anti-symmetric. Noting that

$$\phi^{/\mu} = -\frac{1}{2} R_{oc} \eta^{-\frac{1}{2}} \eta^{/\mu}$$

we obtain

$$L^{\mu\nu} = -\frac{1}{4} |\eta|^{\frac{1}{2}} m_o c^2 R_{oc} \left[\eta^{-\frac{1}{2}} \left(\eta^{/\mu} u^{\nu} - \eta^{/\nu} u^{\mu} \right) - \eta^{*-\frac{1}{2}} \left(\eta^{*/\mu} u^{\nu} - \eta^{*/\nu} u^{\mu} \right) \right] \tag{5d}$$

The dimensions of $L^{\mu\nu}$ are ergs.

$$\mathcal{L}^{\mu\nu} = T^{\mu\nu} - V^{\mu\nu} + iL^{\mu\nu}$$

We shall deal with these tensorial matters later.

3. A STRUCTURAL LAGRANGIAN

Thus, we see that the asymmetric complex tensor, which we call the Lagrangian tensor in (5) naturally breaks up into two parts, a symmetric part to the left of i and an antisymmetric part to the right of i.

The contraction of (5) with the metric tensor $g_{\mu V(L)}$ yields the inner product

$$\mathcal{L} = T - V + iL^{\alpha}{}_{\alpha} \tag{6}$$

where

$L^{\alpha}{}_{\alpha} = 0$ due to its antisymmetry

$T = |\eta| m_o c^2 g_{\mu\nu(L)} u^{\mu} u^{V}$

$V = m_o c^2 \phi_{/\alpha} \phi^{*/\alpha}$

We note that $\mathcal{L} = T - V$ is similar in mathematical structure to a Lagrangian, with T the kinetic energy and V the potential energy.

It therefore seems appropriate to utilize the Euler-Lagrange equations:

$$\mathrm{d}\left(\partial\mathcal{L}/\partial u^i\right)/\mathrm{d}s = \partial\mathcal{L}/\partial x^i \quad \text{for } i = 1,2,3,4$$

$$\partial\mathcal{L}/\partial u^i = \partial T/\partial u^i = 2|\eta| m_o c^2 g_{\alpha i(L)} u^\alpha$$

$$\mathrm{d}\left(\partial\mathcal{L}/\partial u^i\right)/\mathrm{d}s = 2m_o c^2 g_{\alpha i(L)}\left[|\eta|_{/\beta}\, u^\beta u^\alpha + |\eta|\,\mathrm{d}u^\alpha/\mathrm{d}s\right] \tag{6a}$$

$$\partial\mathcal{L}/\partial x^i = m_o c^2 g_{\mu\nu(L)} u^\mu u^\nu |\eta|_{/i} - V_{/i} \tag{6b}$$

Upon Equations 6(a) and 6(b), we obtain and upon multiplying both sides by $g^{i\lambda}{}_{(L)}$

$$2m_o c^2 |\eta|\,\mathrm{d}u^\lambda/\mathrm{d}s = m_o c^2 g_{\alpha\beta(L)} u^\alpha u^\beta |\eta|^{/\lambda} - 2m_o c^2 |\eta|_{/\beta}\, u^\beta u^\lambda - V^{/\lambda} \tag{7}$$

4. A CONSTANT OF THE MOTION

Contracting (7) withu_λ

$$\mathrm{d}[T+V]/\mathrm{d}s = 0$$

$$\mathrm{d}H/\mathrm{d}s = 0$$

$$H = T + V = \text{constant} \tag{8}$$

$$H = m_o c^2 |\eta| u_\alpha u^\alpha + V \tag{8a}$$

where $V = m_o c^2 \phi_{/\alpha}\phi^{*/\alpha}$

5. NECESSARY CONDITIONS FOR THE VIABILITY OF SPACE TRAVEL

This Equation 8(a) is what will be interpreted as the generalization of $g_{\alpha\beta(L)}u^\alpha u^\beta$ in the sense that $(\mathrm{d}s)^2$ is no longer required, in this general case, to be equal to $g_{\alpha\beta(L)}dx^\alpha dx^\beta$.

$$u^\alpha u_\alpha = g_{\alpha\beta(L)} u^\alpha u^\beta = \left(\mathrm{d}t/\mathrm{d}s\right)^2\left[g_{\alpha\beta(L)}\left(\mathrm{d}x^\alpha/\mathrm{d}t\right)\left(\mathrm{d}x^\beta/\mathrm{d}t\right)\right]$$

$$u_\alpha u^\alpha = \left(\mathrm{d}t/\mathrm{d}s\right)^2\left[-\left(\mathrm{d}x/\mathrm{d}t\right)^2 - \left(\mathrm{d}y/\mathrm{d}t\right)^2 - \left(\mathrm{d}z/\mathrm{d}t\right)^2 + c^2\left(\mathrm{d}t/\mathrm{d}t\right)^2\right]$$

$$u^\alpha u_\alpha = \left(\mathrm{d}t/\mathrm{d}s\right)^2 c^2\left[1 - \frac{v^2}{c^2}\right]$$

$$H = |\eta| m_o c^2 \left(\mathrm{d}t/\mathrm{d}\tau\right)^2\left[1 - \frac{v^2}{c^2}\right] + m_o c^2 \phi_{/\alpha}\phi^{*/\alpha}$$

Letting $\mathrm{d}s = c\mathrm{d}\tau$ where $\mathrm{d}\tau$ is the time aboard the spacecraft and $\mathrm{d}t$ is technically the time differential at the spacecraft's home planet, but can be considered as the background differential time coordinate discussed in the paragraph on galaxy rotation. Solving for $\mathrm{d}t/\mathrm{d}\tau$ we obtain

$$\mathrm{d}t/\mathrm{d}\tau = \frac{\sqrt{H}}{\sqrt{|\eta| m_o c^2}} \frac{\sqrt{1 - \dfrac{m_o c^2 \phi_{/\alpha}\phi^{*/\alpha}}{H}}}{\sqrt{1 - \dfrac{v^2}{c^2}}}$$

Space travel will not be practical or viable unless the crew of a spacecraft can be assured of returning to the same civilization that they left. This then imposes the two very important conditions, viz., 1)$\mathrm{d}t/\mathrm{d}\tau = 1$ and 2)velocities greater than the speed of light. We thus have the following conditions:

$$H = |\eta| m_o c^2$$

and

$$m_o c^2 \phi_{/\alpha} \phi^{*/\alpha} = H \frac{v^2}{c^2} = V$$

$$H = T + V = T + H \frac{v^2}{c^2}$$

$$T = H - H \frac{v^2}{c^2} = H\left(1 - \frac{v^2}{c^2}\right)$$

$$\begin{aligned} V = \hat{H} v^2/c^2 &< \hat{H} \text{ for } v < c \\ &= \hat{H} \text{ for } v = c \\ &> \hat{H} \text{ for } v > c \\ &< 0 \text{ for } v = 0 \end{aligned}$$

$$\begin{aligned} T = \hat{H}\left(1 - v^2/c^2\right) &> 0 \text{ for } v < c \\ &= 0 \text{ for } v = c \\ &< 0 \text{ for } v > c \\ &= \hat{H} \text{ for } v = 0 \end{aligned}$$

Let us look again at Equation 8(a)

$$H = m_o c^2 |\eta| u_\alpha u^\alpha + V$$

$$\lim_{G \to G_o} g_{\alpha\beta(L)} u^\alpha u^\beta = \frac{\lim_{G \to G_o} H - \lim_{G \to G_o} V}{m_o c^2 \lim_{G \to G_o} |\eta|} = \frac{m_o c^2 - 0}{m_o c^2} = 1$$

Therefore, when the spacecraft turns off its field, the usual space-time conditions, which we are familiar with on d*s*, once again apply.

6. ACCELERATION EQUATION

Let us look again at Equation (7):

$$2m_o c^2 |\eta| \mathrm{d}u^\lambda/\mathrm{d}s = m_o c^2 g_{\alpha\beta(L)} u^\alpha u^\beta |\eta|^{/\lambda} - 2m_o c^2 |\eta|_{/\beta} u^\beta u^\lambda - \left(m_o c^2 \varphi_{/\alpha} \varphi^{*/\alpha}\right)^{/\lambda}$$

From $\mathrm{d}H/\mathrm{d}s = 0$ we have $\mathrm{d}|\eta|/\mathrm{d}s = 0$

Thus, we can see that $m_o c^2$ cancels out ofthis acceleration equation giving

$$2|\eta|\,du^{\lambda}/ds = g_{\alpha\beta(L)}u^{\alpha}u^{\beta}|\eta|^{/\lambda} - \left(\phi_{/\alpha}\phi^{*/\alpha}\right)^{/\lambda} \tag{9}$$

Conclusion: An acceleration equation without mass implies inertia less acceleration.

7. A NEW TYPE OF 'ELECTROMAGNETIC' FIELD WITH A MAGNETIC MONOPOLE FEATURE

If we divide both sides of Equation (5d) by qR_{oc} then define a new tensor by $\mathcal{F}^{\mu V} = L^{\mu V}/qR_{OC}$ which has the dimensions of (esu/cm^2) or that of an electromagnetic field, bearing in mind the antisymmetry of $\mathcal{F}^{\mu V}$.

$$\mathcal{F}^{\mu\nu} = -\frac{1}{4}|\eta|^{\frac{1}{2}} m_o c^2 q^{-1}\left[\eta^{-\frac{1}{2}}\left(\eta^{/\mu}u^{\nu} - \eta^{/\nu}u^{\mu}\right) - \eta^{*-\frac{1}{2}}\left(\eta^{*/\mu}u^{\nu} - \eta^{*/\nu}u^{\mu}\right)\right] \tag{10}$$

$$\mathcal{L}^{\mu\nu} = T^{\mu\nu} - V^{\mu\nu} + i\left(qR_{oc}\right)\mathcal{F}^{\mu\nu}$$

Thus we come to the conclusion that Equation (10) may represent a new type of "electromagnetic field phenomena"associated with this new perspective on advanced space travel. In the equation

$$T^{\mu\nu} - V^{\mu\nu} + iL^{\mu\nu}$$

$L^{\mu\nu}$ is related to a new type of "electromagnetic" field process, while $V^{\mu\nu}$ is related to a symmetric tensor type process, since a type of "pressure gradient" seems to be derivable from $V^{\mu\nu}$, as noted from the acceleration Equation (9), this seems to provide the justification for viewing $V^{\mu\nu}$ as some type of space-time stress tensor. $T^{\mu\nu}$ represents a kinetic energy tensor ofmotion of the spacecraft.

$$qR_{oc}\mathcal{F}_{\mu\nu} = L_{\mu\nu} = \frac{1}{2}|\eta|^{\frac{1}{2}} m_o c^2\left[\left(\phi_{/\mu}u_{\nu} - \phi_{/\nu}u_{\mu}\right) - \left(\phi^{*}{}_{/\mu}u_{\nu} - \phi^{*}{}_{/\nu}u_{\mu}\right)\right]$$

Since $\mathcal{F}_{\mu\nu}$ is proportional to $L_{\mu\nu}$, it is easier to conceptualize some ideas by performing the following calculations using the φ's instead of the $\eta's$.

$$qR_{oc}\mathcal{F}_{\mu\nu} = L_{\mu\nu} = \frac{1}{2}|\eta|^{\frac{1}{2}} m_o c^2\left[f_{\mu\nu} - f^{*}{}_{\mu\nu}\right]$$

$f_{\mu\nu} = \phi_{/\mu}u_{\nu} - \phi_{/\nu}u_{\mu}$ and similarly, for its complex conjugate.

Now let us calculate the antisymmetrized sum of $\mathcal{F}_{\alpha\beta/\lambda}$ denoted by $\{\mathcal{F}_{\mu\nu/\lambda}\}_{(\mu\nu\lambda)}$.

$$qR_{oc}\left\{\mathcal{F}_{\mu\nu/\lambda}\right\}_{(\mu\nu\lambda)} = \frac{1}{2}|\eta|^{\frac{1}{2}} m_o c^2\left[\left\{\left(f_{\mu\nu/\lambda}\right)\right\}_{(\mu\nu\lambda)} - \left\{\left(f^{*}{}_{\mu\nu/\lambda}\right)\right\}_{(\mu\nu\lambda)}\right] + \frac{1}{2}m_o c^2\left\{\left[f_{\mu\nu} - f^{*}{}_{\mu\nu}\right]\left(|\eta|^{\frac{1}{2}}\right)_{/\lambda}\right\}_{(\mu\nu\lambda)} \tag{11}$$

$$\left\{f_{\mu\nu/\lambda}\right\}_{(\mu\nu\lambda)} = \frac{1}{3!}\left(f_{\mu\nu/\lambda} - f_{\mu\lambda/\nu} + f_{\nu\lambda/\mu} - f_{\nu\mu/\lambda} + f_{\lambda\mu/\nu} - f_{\lambda\nu/\mu}\right)$$

where $_{(\mu\nu\lambda)}$ indicates the variables that this sum is to be over, but since $f_{\mu\nu} = -f_{\nu\mu}$ this reduces to

$$\left\{f_{\mu\nu/\lambda}\right\}_{(\mu\nu\lambda)} = \frac{1}{3}\left(f_{\mu\nu/\lambda} + f_{\nu\lambda/\mu} + f_{\lambda\mu/\nu}\right)$$

$$\left\{f_{\mu\nu/\lambda}\right\}_{(\mu\nu\lambda)} = \left\{\left(\phi_{/\mu}u_{\nu} - \phi_{/\nu}u_{\mu}\right)_{/\lambda}\right\}_{(\mu\nu\lambda)}$$

$$\left\{f_{\mu\nu/\lambda}\right\}_{(\mu\nu\lambda)} = \frac{1}{3}\left[\phi_{/\mu}\left(u_{\nu/\lambda} - u_{\lambda/\nu}\right) + \phi_{/\nu}\left(u_{\lambda/\mu} - u_{\mu/\lambda}\right) + \phi_{/\lambda}\left(u_{\mu/\nu} - u_{\nu/\mu}\right)\right] \tag{11a}$$

$\{f^{*}{}_{\mu\nu/\lambda}\}_{(\mu\nu\lambda)}$ is just the complex conjugate of Equation (11).

$$\left\{f^{*}{}_{\mu\nu/\lambda}\right\}_{(\mu\nu\lambda)} = \frac{1}{3}\left[\phi^{*}{}_{/\mu}\left(u_{\nu/\lambda} - u_{\lambda/\nu}\right) + \phi^{*}{}_{/\nu}\left(u_{\lambda/\mu} - u_{\mu/\lambda}\right) + \phi^{*}{}_{/\lambda}\left(u_{\mu/\nu} - u_{\nu/\mu}\right)\right] \tag{11b}$$

$$\left[\left\{\left(f_{\mu\nu/\lambda}\right)\right\}_{(\mu\nu\lambda)} - \left\{\left(f^{*}{}_{\mu\nu/\lambda}\right)\right\}_{(\mu\nu\lambda)}\right] \tag{11c}$$

$$= \frac{1}{3}\left[\left(\phi_{/\mu} - \phi^{*}{}_{/\mu}\right)\left(u_{\nu/\lambda} - u_{\lambda/\nu}\right) + \left(\phi_{/\nu} - \phi^{*}{}_{/\nu}\right)\left(u_{\lambda/\mu} - u_{\mu/\lambda}\right) + \left(\phi_{/\lambda} - \varphi^{*}{}_{/\lambda}\right)\left(u_{\mu/\nu} - u_{\nu/\mu}\right)\right]$$

We also have

$$\left\{\left[f_{\mu\nu} - f^{*}{}_{\mu\nu}\right]\left(|\eta|^{\frac{1}{2}}\right)_{/\lambda}\right\}_{(\mu\nu\lambda)} = \frac{1}{3}\left[f_{\mu\nu}\left(|\eta|^{\frac{1}{2}}\right)_{/\lambda} + f_{\nu\lambda}\left(|\eta|^{\frac{1}{2}}\right)_{/\mu} + f_{\lambda\mu}\left(|\eta|^{\frac{1}{2}}\right)_{/\nu}\right.$$
$$\left. + f^{*}{}_{\mu\lambda}\left(|\eta|^{\frac{1}{2}}\right)_{/\nu} + f^{*}{}_{\nu\mu}\left(|\eta|^{\frac{1}{2}}\right)_{/\lambda} + f^{*}{}_{\lambda\nu}\left(|\eta|^{\frac{1}{2}}\right)_{/\mu}\right]$$

$$qR_{oc}\left\{\mathcal{F}_{\mu\nu/\lambda}\right\}_{(\mu\nu\lambda)} = \frac{1}{6}|\eta|^{\frac{1}{2}} m_o c^2\left[\left(\phi_{/\mu} - \phi^{*}{}_{/\mu}\right)\left(u_{\nu/\lambda} - u_{\lambda/\nu}\right) + \left(\phi_{/\nu} - \phi^{*}{}_{/\nu}\right)\left(u_{\lambda/\mu} - u_{\mu/\lambda}\right)\right.$$
$$\left. + \left(\phi_{/\lambda} - \phi^{*}{}_{/\lambda}\right)\left(u_{\mu/\nu} - u_{\nu/\mu}\right)\right] + \frac{1}{6}m_o c^2\left[f_{\mu\nu}\left(|\eta|^{\frac{1}{2}}\right)_{/\lambda} + f_{\nu\lambda}\left(|\eta|^{\frac{1}{2}}\right)_{/\mu}\right. \tag{11d}$$
$$\left. + f_{\lambda\mu}\left(|\eta|^{\frac{1}{2}}\right)_{/\nu} + f^{*}{}_{\mu\lambda}\left(|\eta|^{\frac{1}{2}}\right)_{/\nu} + f^{*}{}_{\nu\mu}\left(|\eta|^{\frac{1}{2}}\right)_{/\lambda} + f^{*}{}_{\lambda\nu}\left(|\eta|^{\frac{1}{2}}\right)_{/\mu}\right]$$

We know from Maxwellian electromagnetic theory that the usual Maxwell electromagnetic tensor $F^{\mu\nu}$ can be represented as

$$F^{\mu\nu} = A^{\mu/\nu} - A^{\nu/\mu}$$

where A^{μ} is the Maxwell four potential.

Further, $\{F_{\mu\nu/\beta}\}_{(\mu\nu\beta)} = 0$ means that the antisymmetrized sum is zero which means that there are no magnetic monopoles in Maxwellian electromagnetic theory, as is well known. In startling contrast, however, we immediately notice that $\{\mathcal{F}_{\mu\nu/\lambda}\}_{(\mu\nu\lambda)} \neq 0$ implying that there is a magnetic monopole type feature associated with this new electromagneticfield.

8. THE MAGNETIC MONOPOLE'S ROTATIONAL FEATURE

Another startling observation is that in the calculation of Equation 11(d), the tensor $u_{\lambda/\beta} - u_{\beta/\lambda}$ appears. The presence of the tensor $u_{\lambda/\beta} - u_{\beta/\lambda}$ means that the velocity field $u_{\alpha} = \mathrm{d}x^{\alpha}/\mathrm{d}s$ is not

entirely translational and that this tensor selects out those places in the velocity field u_α which have a vortex motion, *i.e*. a circulation or rotation. It is not proper to split u_α into a translational part and a rotational part since u_α is a true vector and rotational velocity is an axial or pseudo vector as its direction changes with the handedness of the coordinate system. The tensor $u_{\lambda/\beta} - u_{\beta/\lambda}$ is the only proper way to handle rotation in a true tensorial way. Thus, when the tensor $u_{\lambda/\beta} - u_{\beta/\lambda}$ is evaluated for , $\alpha = 1, 2, 3$, we obtain the components of the well-known three-dimensionalrot or curl or $\times \nabla$ operator in vector analysis. Further, we know from the theory of ordinary fluid flow that such a three-dimensional rotation can be expressed by the following equation

$$\omega/c = 1/2 \times \nabla u.$$

Therefore, the tensor $u_{\lambda/\beta} - u_{\beta/\lambda}$ indicates that this magnetic monopole feature has a rotational aspect associated with it.

9. IS THE WEAK INTERACTION HARBORING A POWERFUL ENERGY SOURCE? [2]

Just what is the plausible physical nature of the weak interaction? This endeavor starts out by noticing the similarityin values of two particular numbers. We begin by giving the following sets of values which will be used inthe calculation of those two numbers.

M_w =considered to be the average boson mass ofthe weak force $= 91 m_p$;
m_p =mass ofthe proton $= 1.673 \times 10^{-24}$g;
m_e =mass of the electron $= 9.109 \times 10^{-28}$g;
h =Planck's constant $= 6.626 \times 10^{-27}\text{erg} \cdot \text{sec}$;
G_o =gravitational constant $= 6.670 \times 10^{-8}\text{dyne} \cdot \text{cm}^2 \cdot \text{g}^{-2}$

$$r_{Go} = (G_o h/c^3)^{1/2} \text{ cm}$$

R_{oA} =avalue, which is assumed to be comparable to the range ofthe weak force $= \sim 10^{-17}$ cm;
c =speed oflight $= 3 \times 10^{10} \text{ cm} \cdot \text{sec}^{-1}$.

$$m_p/m_e = 1836.12$$

The first number N_1 to be calculated is

$$N_1 = r_{Go} M_w^{\ 3} \text{ cm} \cdot \text{g}^3$$

where $r_{Go} = (G_o h/c^3)^{1/2}$ cm

$$r_{Go} M_w^{\ 3} = \left[6.670 \times 10^{-8} \text{ dyne} \cdot \text{cm}^2 \cdot \text{g}^{-2} \times 6.626 \times 10^{-27} \text{ erg} \cdot \text{sec} \Big/ \left(3 \times 10^{10} \text{ cm} \cdot \text{sec}^{-1} \right)^3 \right]^{1/2} \left[91 \times 1.673 \times 10^{-24} \text{ g} \right]^3$$

$$r_{Go} M_w^{\ 3} = 1.428 \times 10^{-98} \text{ cm} \cdot \text{g}^3$$

The second number N_2 to be calculated is

$$N_2 = R_{oA} m_e^{\ 3} = \left(10^{-17} \text{ cm} \right) \left(9.109 \times 10^{-28} \text{ g} \right)^3$$

$$R_{oA} m_e^{\ 3} = 0.756 \times 10^{-98} \text{ cm} \cdot \text{g}^3$$

It is extremely coincidental that these two numbers are that close. The hypothesis of this paper is that these are, in reality, an equivalence, viz., $N_1 = N_2$ or

$$r_{Go} M_w^{\ 3} = R_{oC} m_e^{\ 3}$$

When this assumption is made, a calculated value R_{oC} from this postulated equivalence is

$$R_{oC} = r_{Go}\, M_w^{\,3} / m_e^{\,3} = 1.428\times10^{-98}\ \text{cm}\cdot\text{g}^3 \Big/ \left(9.109\times10^{-28}\ \text{g}\right)^3$$

or

$$R_{oC} = 1.889\times10^{-17}\ \text{cm}\,,$$

which is roughly ten times less than the value calculated from the uncertainty principle for the vector boson of $91m_p$.

Could this particular set of dimensions, cm$\cdot\,\text{g}^3$, be especially predisposed to a relationship between the weak interaction and the gravitational "constant"? We can explore this possibility further by attempting to create a simple non-quantum mechanical model ofthe weak interaction in order to determine its true nature.

To this end, let the model begin with a tiny variable electric dipole according to the following equation

$$p = q\left(R_{oC} - R\right)\text{esu}\cdot\text{cm}\,,$$

where $q = (2hc)^{1/2}$ esu, $R_{oC} = r_{Go}M_w^3/m_e^3, R = r_G M_w^3/m_e^3$, where $r_G = (Gh/c^3)^{1/2}, G$ now considered to be a real scalar variable for computational purposes.

We then form the square of$p$, $p^2 = q^2(R_{oC} - R)^2\text{esu}^2\cdot\text{cm}^2$, noting that $\text{esu}^2\cdot\text{cm}^2 = \text{erg}\cdot\text{cm}^3$.

We now posit that the weak interaction is activated by the variable $G \to 0$. Then we can take the limit

$$\underset{G\to0}{\text{LIMIT}}\ p^2 = q^2 R_{oC}^{\,2}$$

$$q^2 R_{oC}^{\,2} = (2hc)\left(1.889\times10^{-17}\ \text{cm}\right)^2$$

$$= \left(2\times6.626\times10^{-27}\ \text{erg}\cdot\text{sec}\times3\times10^{10}\ \text{cm}\cdot\text{sec}^{-1}\right)\left(3.568\times10^{-34}\ \text{cm}^2\right)$$

$$q^2 R_{oC}^{\,2} = 1.419\times10^{-49}\ \text{erg}\cdot\text{cm}^3\,.$$

We already know that the Fermi weak interaction constant is $1.41\times10^{-49}\text{erg}\cdot\text{cm}^3$ so that this simplisticmodel is somewhat instructive [3]. It is to be emphasized that this is a model and not a theory. If a successfultheory incorporating a variable gravitational 'constant' into the weak interaction is ever developed, then one of the expectations is that this model, or something close to it, would possibly be derived.

What the above hopefully shows is the possibility of a relationship between the gravitational 'constant' and the weak interaction. Assuming that this is the case, how could this posited assertion be verified experimentally?

One way is by calculating (using the uncertainty principle) the mass associated with the value $R_{oC} = 1.889\times10^{-17}$ cm. This value is $M_{oc} = 1118m_p$. If this theory is correct, then CERN should find a new particle at around 1118 times the mass of the proton.

We know that energy levels, whether nuclear or orbital, are properties of the atom as a whole. We also knowthat the wave amplitudes for some orbital electrons fall within the nucleus. Thus, it should come as no surprise that if a nucleus needs to change to a lower energy level, it has the option of

ejecting an orbital electron, calledan Auger electron (internal conversion process). This is a powerful concept! The nuclear energy levels can effecta change in the orbital energy levels. The question, which is now obvious, is whether or not this process is reversible.Can an orbital electron energy level effect a change in a nuclear energy level? In the case of this paper,can a change in the orbital energy levels effect a change in the weak interaction energy levels, through a manipulationof the entire atomic wave amplitude, thus manifesting a macroscopic variability in the gravitational"constant"? It is known that the process of beta decay emits electrons in a seeming continuous spectrum ofenergy levels ranging from a few kilovolts to the relativistic range of 15 Mev or more. A continuum of energylevels is a concept straight out of the pre-quantum mechanics period known as the classical period. This would seem to indicate a scalar activity of some sort and not a quantum activity.

Altering electronic energy levels could characterize the procedure involved in the combustion process. Whatis combustion? It is one or more molecular reactants (a fuel, an oxidant, and/or heat and/or a catalyst) producingone or more products of combustion plus heat through an intervening procedure consisting of a scrambling oforbital electron energy levels (via the probability amplitudes of the reactants and the products) until an equilibriumin such levels is attained for all the products involved. The question is whether or not there exists a singularset of combustion reactants, which, when ignited, will induce an excitational resonance, via the orbital probability amplitudes overlapping the nucleus in the weak interaction, and cause it to unleash a macroscopic variable gravitational 'constant'?

The many-body problem has never been solved, but most assuredly involves extremely complicated non-linearsolutions; however, such solutions, in the absence of combustion, must exist, otherwise clouds of electrons could not remain in a stable situation around atoms with atomic numbers $Z > 2$. To put another way, when applied to the atom, is it possible, in the absence of combustion, that there could exist many-body solutions of wave amplitudes of the atom which allow for a more or less direct exchange of information between orbital electrons and the neutrons in the nucleus? Usually, as in the case of the Auger electron, the information is sent one-way from the nucleus to the electron. Can this flow of information be reversed and tremendously amplified in the presence of combustion of the presumed singular set of combustion reactants so that information is sent from the orbitalelectrons to the nuclear weak interaction?

As mentioned earlier, a macroscopic field in this paper is seen to be the final effect, like a laser beam, ofmany many tiny effects added together.

If this reversibility can truly occur, then a powerful new energy source could be tapped, based upon a macroscopicvariable gravitational "constant", which would have tremendous upside potential in transportation, space exploration, and military applications. The only way to know for sure is to find that singular experimentumcrucis!

The charged W boson particle has a rest energy of 80.385 Mev and when divided by the energy of the proton 938.272 yields $85.673m_p$. Likewise, the neutral Z boson has a rest energy of 91.187 Mev and when divided by the energy of the proton 938.272 yields $97.186m_p$. Then the arithmetic average is $(85.673 + 97.186)/2 = 91.43m_p$.

However, the author questions whether the straight arithmetic average is the proper way to find the average between a charged particle and a neutral particle, simply, because of the possibility of there being three independent sources for the inertia of objects.

1) The Higgs particle/field is the source of inertia for all other particles: this is according to current particle theorist views.
2) Consider why a photon does not travel at infinite speed. Also consider why an Olympic runner on flat hard ground can run faster than a man slogging his way through a swamp wearing heavy boots in eight inches of mud. Something is slowing the photon down giving it the appearance of having inertia. That something from Maxwell theory is the product of the free space permeability and permittivity constants. The ability of space-time to store electromagnetic energy gives an inertia to the photon, which resists an acceleration to a higher velocity.

3) This paper also contributes to an apparent inertial/gravitational mass given by $m_{\text{apparent}} = (G/G_o)m_o$, which is another source of inertia or the lack thereof.

With three different sources of inertia, is it really valid to take a straight arithmetic average (especially between charged and uncharged particles) or is some type of weighted average really the proper course to take. The author believes that the proper weighted average, when found, will yield$91m_p$ and not the $91.43m_p$.

10. CONCLUSIONS

The author believes that this theory may provide a practical method for interstellar space travel if and when the generator for the fields talked about in this paper can be somehow pried from the nucleons associated with the weak interaction. These fields provide the means for inertia-less acceleration and for what looks like a new type of electromagnetic field, with its associated magnetic monopole. One obvious danger of a macroscopic magnetic monopole field is due to the fact that currents come to a halt near a magnetic monopole, per Ampere's law. Vehicles with electric ignition systems will be most affected; however, diesel engines probably will not be affected, since they depend solely upon compression of diesel fuel for ignition. Biological life forms also have currents running through their nerve fibers, and, as a result, there will be a very high danger of paralysis or even death near such a macroscopic field due to the cessation of these biologically generated currents.

As everyone knows, Faraday cages defeat Maxwellian electromagnetic fields. Examples of common Faradaycages or good approximations thereto are airplanes, school buses, cars and hoods on cars. The new type of electromagnetic field derived in this paper has greater penetrating power than Maxwellian fields and will be able to defeat the purpose of a Faraday cage and affect the flow of currents inside which is protected by the cage. This is due to this new type of electromagnetic field depending on the gradient in the supposed gravitational "constant", such gradient being unaffected by the presence of the Faraday cage, occurring both externally and internally to the cage.

Rotation is also associated with this magnetic monopole. It is unclear whether the rotation is generated automatically or whether the rotation is an independent variable which can be utilized by the crew of the spacecraft to further manipulate the fields.

Since the time interval in the frame of reference of this spacecraft and the coordinate time interval in the reference frame of the source planet remain the same, there is an implied certainty that significant space travel overinterstellar distances may occur during the lifetime of an explorer for sufficiently high velocities in excess of thespeed of light, with the added bonus being that the explorer will be able to return to the same civilization that he/she leaves on the source planet. Such extremely high velocities in excess of the speed of light may give pause for concern in deep space where interaction with particles of rock and dust will occur. It is to be noted that due to the equation$\varphi^{/\mu} = -1/2R_{oc}\eta^{-1/2}\eta^{/\mu} = A\eta^{-1/2}\eta^{/\mu}$, since $\eta = G/G_o$and as this supposed complex scalar approacheszero, this spacecraft is surrounded by a very sharp and powerful gradient in$\varphi^{/\mu}$due to the factor of$\eta^{-1/2}$. This powerful gradient will act as a deflector that protects the spacecraft against rock and dust at ultra-high speeds.

The presumption is that the spacecraft will be operating in the environment of outer space which provides an airless vacuum. However, there does not seem to be any reason why such a craft will not be able to operate within a gaseous or liquid medium, as well, taking note of the possibility that particles of the gaseous or liquidmedium near the crafts accelerating field will themselves be accelerated along with the craft. This may meanthat each time such a craft leaves the atmosphere of a planet, the accelerating field tears away a small amount of the atmosphere which is never to be replaced. Also, due to the factor of$|\eta|m_o$,the apparent mass of the spacecraft will be close to zero, indicating that there will probably be no sonic booms occurring at extreme velocities in aplanet's atmosphere.

COMPETING INTERESTS

Author has declared that no competing interests exist.

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A Note of Description on the Lie Algebra of the Invariants in the CBS Nonlinear Equation

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ABSTRACT

In this short note, a particular realization of the vector fields that form a Lie Algebra of symmetries for the Calogero-Bogoyavleskii-Schiff equation is found. The Lie Algebra is examined and the result is a **semidirect product** of two Lie Groups. The structure of the **semidirect product** is examined through the table of commutation rules. Two reductions are made with the help of two sets of generators and the final outcome for the solution is related to the elliptic Painlevé $\mathcal{P}(\xi)$ tion.

Keywords: Nonlinear integrability; group theory; Weierstrass P-Elliptic function.

1. INTRODUCTION

The Calogero-Bogoyavleskii-Schiff Nonlinear Partial can be written as [1]:

$$u_{xt}+u_x u_{xy}+\frac{1}{2}u_{xx}u_y+\frac{1}{4}u_{xxxy}=0$$

The study of the integrability of this equation has been the subject of a large body of literature concerning specially the solutions obtained by means of a wealth of methods. For instance the interested reader may wish to check the references [2,3,4] and [5]. To achieve this goal the method of the **Singular Manifold Expansion** has been extensively used. Starting with the encyclopedic work of P. J. Olver in his book of Symmetries in Differential Equations [6], J. Weiss, M. Tabor and G. Carnevale [7] and John Weiss himself [8] developed the theory of the **Singular Manifold Expansion** and its applications. An excellent modern account of the method as well as various examples can be found in the recent review of [9]. In this note we shall review known results with the aim of finding the **Lie Algebra** structure using the **Integrals of Motion** method andalternative modes of finding solutions that can be applied in the future to other Nonlinear Partial Differential Equations.

2. THE SYMMETRIES

The vector fields of the CBS equation take the following form in x, y, t and the field $u(x, y; t)$ coordinates:

$$\mathbf{X}_1=\frac{\partial}{\partial t}+f_1(t)\frac{\partial}{\partial x}+\left\{2yf_1'(t)+f_2(t)\right\}\frac{\partial}{\partial u}$$

$$\mathbf{X}_2=f_3(t)\frac{\partial}{\partial x}+\frac{\partial}{\partial y}+\left\{2yf_3'(t)+f_4(t)\right\}\frac{\partial}{\partial u}$$

$$\mathbf{X}_3=f_5(t)\frac{\partial}{\partial x}+t\frac{\partial}{\partial y}+\left\{2yf_5'(t)+f_6(t)+x\right\}\frac{\partial}{\partial u}$$

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$$\mathbf{X}_4 = t\frac{\partial}{\partial t} + \left\{ f_7(t) + \frac{x}{2} \right\} \frac{\partial}{\partial x} + \left\{ 2yf_7'(t) + f_8(t) - \frac{u}{2} \right\} \frac{\partial}{\partial u}$$

$$\mathbf{X}_5 = \left\{ f_9(t) - \frac{x}{2} \right\} \frac{\partial}{\partial x} + y\frac{\partial}{\partial y} + \left\{ 2yf_9'(t) + f_{10}(t) + \frac{u}{2} \right\} \frac{\partial}{\partial u}$$

$$\mathbf{X}_6 = \frac{t^2}{2}\frac{\partial}{\partial t} + \left\{ f_{11}(t) + \frac{xt}{4} \right\} \frac{\partial}{\partial x} + \frac{yt}{2}\frac{\partial}{\partial y} + \left\{ 2yf_{11}'(t) + f_{12}(t) - \frac{ut}{4} + \frac{xy}{2} \right\} \frac{\partial}{\partial u}$$

To find the form of the arbitrary functions $f_i(t)$ where $i = 1,2,3,\cdots,12$, we have to minimize the number ofvector fields by using the commutators of Table 1 which give rise to the following set of Ordinary Differential Equations:

$$f_4'(t) = 2f_1'(t); \quad f_5'(t) = f_3(t); \quad 2tf_1'(t) - f_1(t) = f_6'(t) - f_4(t)$$

$$tf_2'(t) + \frac{3}{2}f_2(t) = tf_8'(t)\, f_1'(t) + \frac{1}{2}f_1 = f_7'(t); \quad f_9'(t) = \frac{1}{2}f_1(t)$$

$$f_{10}'(t) + \frac{1}{2}f_2(t) = 0; \quad \frac{1}{2}\left\{ tf_2'(t) + \frac{1}{2}f_2(t) \right\} = f_{12}'(t) - f_8 - \frac{1}{2}f_{10}(t)$$

$$\frac{1}{2}t\left\{ tf_1'(t) - \frac{1}{2}f_1(t) \right\} = f_{11}'(t) - f_7 - \frac{1}{2}f_9(t); \quad tf_4'(t) + \frac{1}{2}f_4 = 2f_7'(t)$$

Table 1. Lie algebra *G*formed by G_1, G_2, G_3, D_1, D_2 and D_3

Lie Algebra	G_1	G_2	G_3	D_1	D_2	D_3
G_1	0	0	G_2	G_1	0	$\mathbf{D}_1 + \frac{1}{2}\mathbf{D}_2$
G_2	0	0	0	0	G_2	$\frac{1}{2}\mathbf{G}_3$
G_3	$-G_2$	0	0	$-G_3$	G_3	0
D_1	$-G_1$	0	G_3	0	0	D_3
D_2	0	$-G_2$	$-G_3$	0	0	0
D_3	$-\left(\mathbf{D}_1 + \frac{1}{2}\mathbf{D}_2\right)$	$-\frac{1}{2}\mathbf{G}_3$	0	$-D_3$	0	0

$$\left\{tf_4'(t)+\frac{1}{2}f_4(t)\right\}=2f_{11}'(t)-\frac{1}{2}f_6(t);\quad 2f_9'(t)-\frac{1}{2}f_4(t)=0$$

$$\left\{tf_6'(t)-\frac{1}{2}f_6(t)\right\}=2tf_7'(t)-f_7(t);\quad \left\{tf_6'(t)+\frac{1}{2}f_6(t)\right\}=4f_{11}''(t)$$

$$2tf_8'(t)-f_8(t)=\frac{1}{2}f_6(t);\quad 2tf_9'(t)-f_9(t)=f_7(t);\quad 2tf_{10}'(t)+f_{10}(t)+f_8(t)=0$$

$$tf_{11}'(t)-32f_{11}(t)=\frac{t}{4}\{2tf_7'(t)-f_7(t)\};\quad 2tf_{12}'(t)-f_{12}(t)=t\left\{tf_8'(t)+\frac{1}{2}f_8(t)\right\}$$

$$\frac{t}{2}\{2tf_9'(t)-f_9(t)\}=f_{11}(t);\quad \frac{t}{2}\{2tf_{10}'(t)+f_{10}(t)\}=-f_{12}(t)$$

The following functions form a non-unique solution of the above system of Ordinary Differential Equations:

$$f_1(t)=\frac{1}{2}f_4(t)=f_{10}(t)=t^{-\frac{1}{2}};\quad f_2(t)=t^{-\frac{3}{2}};\quad f_9(t)=t^{\frac{1}{2}}$$

$$f_3(t)=f_5(t)=f_6(t)=f_7(t)=f_8(t)=f_{11}(t)=f_{12}(t)=0$$

With these solutions the vector fields are easily shown to be:

$$\mathbf{G}_1=\frac{\partial}{\partial t}+t^{-\frac{1}{2}}\frac{\partial}{\partial x}+t^{-\frac{3}{2}}(1-y)\frac{\partial}{\partial u}$$

$$\mathbf{G}_2=\frac{\partial}{\partial y}+2t^{-\frac{1}{2}}\frac{\partial}{\partial u}$$

$$\mathbf{G}_3=t\frac{\partial}{\partial y}+x\frac{\partial}{\partial u}$$

$$\mathbf{D}_1=t\frac{\partial}{\partial t}+\frac{x}{2}\frac{\partial}{\partial x}-\frac{u}{2}\frac{\partial}{\partial u}$$

$$\mathbf{D}_2=\left\{t^{\frac{1}{2}}-\frac{x}{2}\right\}\frac{\partial}{\partial x}+y\frac{\partial}{\partial y}+\left\{t^{-\frac{1}{2}}(1+y)+\frac{u}{2}\right\}\frac{\partial}{\partial u}$$

$$\mathbf{D}_3=\frac{t^2}{2}\frac{\partial}{\partial t}+\frac{xt}{4}\frac{\partial}{\partial x}+\frac{yt}{2}\frac{\partial}{\partial y}+\frac{1}{4}\{2xy-ut\}\frac{\partial}{\partial u}$$

3. THE LIE ALGEBRA STRUCTURE

As can easily be seen the Invariants [10] can be divided into two different set of elements called $\mathcal{G}:\{\mathbf{G}_1,\mathbf{G}_2,\mathbf{G}_3\}$ and $\mathcal{D}:\{\mathbf{D}_1,\mathbf{D}_2,\mathbf{D}_3\}$ each of them possesing a Lie Algebra structure with commutation relations being of the form:

$$[\mathbf{G}_1,\mathbf{G}_2]=0;\quad [\mathbf{G}_2,\mathbf{G}_3]=0;\quad [\mathbf{G}_3,\mathbf{G}_1]=-\mathbf{G}_2$$

$$[\mathbf{D}_1,\mathbf{D}_2]=0;\quad [\mathbf{D}_2,\mathbf{D}_3]=0;\quad [\mathbf{D}_3,\mathbf{D}_1]=-\mathbf{D}_3$$

Although the form of the Lie Algebras seems at the first sight to be the same, this conclusion is wrong as the first one is isomorphic to a sort of *Non-Extended Galilei Lie Algebra* $\mathcal{G}$ [11] and the second one is isomorphic to a *Lie Algebra of Dilatations in one of the spatial coordinates* $\mathcal{D}$ [12]. Both Lie Algebras form the entire Lie Algebra of Symmetries G as a **Semi-Direct Product** which it is now written as:

$$G = \mathcal{G} \oslash \mathcal{D}$$

The rest of the entire Group of Symmetries has the following Lie Algebra that contains the rest of the information on the **Semi-Direct Product**:

$$[\mathbf{G}_1, \mathbf{D}_1] = \mathbf{G}_1; \quad [\mathbf{G}_1, \mathbf{D}_2] = 0; \quad [\mathbf{G}_1, \mathbf{D}_3] = \mathbf{D}_1 + \frac{1}{2}\mathbf{D}_2$$

$$[\mathbf{G}_2, \mathbf{D}_1] = 0; \quad [\mathbf{G}_2, \mathbf{D}_2] = \mathbf{G}_2; \quad [\mathbf{G}_2, \mathbf{D}_3] = \frac{1}{2}\mathbf{G}_3$$

$$[\mathbf{G}_3, \mathbf{D}_1] = -\mathbf{G}_3; \quad [\mathbf{G}_3, \mathbf{D}_2] = \mathbf{G}_3; \quad [\mathbf{G}_3, \mathbf{D}_3] = 0$$

4. THE SOLUTIONS

As is well known each symmetry and its correspondent differential invariant are related to a solution of the CBS Equation. Also any linear combination of the Invariants corresponds to a given change of variables (often called "reduction") which lowers the number of variables from three to one and/or from three to two, depending of the form of the generator.

1) An interesting and trivial combination of Invariants is to consider only $\mathbf{G}_1$ as the invariant that leads just to the reduction that we shall analyze below [3]. We then consider a reduction with the invariant:

$$\mathbf{G}_1 = \frac{\partial}{\partial t} + t^{-\frac{1}{2}}\frac{\partial}{\partial x} + t^{-\frac{3}{2}}(1-y)\frac{\partial}{\partial u}$$

that gives as a result the change of independent and dependent variables in the form: $\eta = x - 2y^{\frac{1}{2}} - 2t^{\frac{1}{2}}$ and $W(z,y) = u(x,y,t) + 2t^{\frac{1}{2}}(1-y)$ and the CBS equations is then reduced to the Ordinary Nonlinear Differential Equation written below with **one variable** which has been found through the **method of characteristics** [6]. The details can be found in [3] and the result is:

$$W'''' + 6W'W'' = 0$$

where the primes indicate the derivatives with respect to the η independent variable.

To solve this equation we first consider the following ODE:

$$\frac{1}{2}\psi'^2 + \psi^3 = c_1\psi + c_2$$

Deriving twice this new equation we easily find:

$$\psi''' + 6\psi\psi' = 0$$

The initial function $W(\eta)$ is related to $\psi(\eta)$ simply by $\psi = W'$ where the prime denotes derivative with respect to the independent variable η as can be trivially checked. Now let us look for a solution of the equation for ψ. In order to solve the equation for ψ we should consider the following identity involving the Weierstrass $\mathcal{P}$-Function:

$$\frac{1}{2}\mathcal{P}'^2 = 4\mathcal{P}^3 - g_2\mathcal{P} - g_3$$

that coincides with:

$$\frac{1}{2}\psi'^2 + \psi^3 = c_1\psi + c_2$$

if and only if:

$$\psi(\eta) = \mathcal{P}\left(\frac{i}{2}\eta\right)$$

and $g_2 = 4c_1$ and $g_3 = 4c_2$. The symbol η stands for the independent variable with respect to which we have performed all the derivatives. The last step is to find (η). Due to the fact that $W' = \psi$ we obtain trivially:

$$W(\eta) = \int_{-\infty}^{\eta}\mathcal{P}\left(\frac{i}{2}\eta\right)\mathrm{d}\eta = 2\mathrm{i}\int_{-\infty}^{\eta}\mathcal{P}(\xi)\mathrm{d}\xi$$

where $\xi = \frac{i}{2}\eta$. The integral of the Weierstrass $\mathcal{P}$-Function cannot be expressed as a closed function but rather as a series of powers in the independent variable ξ. The interest reader can learn about this integral in the book: In particular one can find there the expression of the integral of $\mathcal{P}(\xi)$ (see [13] and formula 1036.50 on it) as:

$$\int_{-\infty}^{\xi}\mathcal{P}(\xi, g_2, g_3)d\xi = -\frac{1}{\xi} + \frac{c_1}{15}\xi^3 + \frac{c_2}{35}\xi^5 + \frac{c_1^2}{525}\xi^7 + \frac{c_1c_2}{1155}\xi^9 + (\frac{c_2^3}{268125} + \frac{c_3^2}{7007})\xi^{11} + \ldots\,|_{-\infty}^{\xi}$$

where we have used the identification $g_2 = 4c_1$ and $g_3 = 4c_2$. Also we remember that:

$$\xi = \frac{i\eta}{2}$$

and with the factor $-2i$ in front of the expression one can write the final solution as:

$$W(\eta) = \frac{4}{\eta} - \frac{c_1}{60}\eta^3 + \frac{c_2}{560}\eta^5 - \frac{c_1^2}{33600}\eta^7 + \frac{c_1c_2}{295680}\eta^9 - (\frac{2c_2^3}{268125} + \frac{2c_3^2}{7007})(\frac{\eta}{2})^{11}\ldots\,|_{-\infty}^{\eta}$$

The solution becomes a pure real function for all $\eta \in \mathcal{R}$. One interesting property of the solution given as an expansion of the Weierstrass $\mathcal{P}(\xi)$-Function is that the initial conditions are inserted in the expansion. The set of the two arbitrary constants the any second order differential equation is included in the own definition of the function. One is still used to see the initial conditions as independent of the function in the realm of **linear** differential equations. In the **nonlinear** case this is not always the case and the first example is provided by the **nonlinear but integrable** of the Elliptic Functions. Beyond these functions we have to deal with **nonlinear but integrable** second order differential equations as the Painlevé Transcendents that also enjoy the same property of expansions containing the initial conditions. They are functions whose the movable singularities are only poles.

2) An apparent generalization of the invariant giving rise to the above *W*-equation (remember that $W' = \psi$) can be written as:

$$\frac{1}{2}\psi'^2 + \psi^3 = a_0\psi^2 + c_1\psi + c_2$$

After deriving twice the invariant this becomes:

$$\psi''' + 6\psi\psi' = 2a_0\psi$$

Indeed the case $a_0 = 0$ yields the case fully discussed in (1). For $a_0 = 2$ and $a_0 = 3$ we recover (26) and (31) of [3], which have also been solved using various algebraic and quite cumbersome and tedious procedures in this mentioned reference. However they are actually Weierstrass $\mathcal{P}(\xi)$-Functions if one remembers the well known property of the third order algebraic equations for which we can always eliminate the second degree term using a trivial translation of the dependent variable ψ (see [14]).

5. CONCLUSION

In this note, we have shown the power of the method of the symmetries for extracting all the information in a Non Linear Partial Differential equations; not only for finding the analytical solutions as it is usually used but also the algebraic structure: The Lie Algebra and the subgroups of the Invariants are explicitly shown as well as its relations to well known kinematical Lie Algebras. Also the connection with Elliptic Functions given in the last paragraph is interesting in its own. Other solutions can also be found with the help of Painlevé Transcendents, but this research which is now in progress will be postponed for a future publication.

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Author has declared that no competing interests exist.

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Chapter 5
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An Overview of the Hydrogen Atom Fundamental Resonance States

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ABSTRACT

In the 1920's, Louis de Broglie observed that the integer sequence that could be related to the interference patterns produced by the various electromagnetic energy quanta emitted by hydrogen atoms was identical to those of very well known classical resonance processes, which made him conclude that electrons have to be captive in related resonance states within atoms. This led Schrödinger to propose a wave equation to represent this sequence of resonance states that still has not been reconciled with the electromagnetic properties of electrons. This new approach is in complete agreement with the methods of QED and QFT and complements them by clarifying the function of the magnetic aspect of the energy of which electromagnetic elementary particles and their carrying energy is made, in a manner that allows describing their permanently localizable self-sustaining internal electromagnetic structure. This article is meant to identify and discuss the electromagnetic harmonic oscillation properties that the electron must possess as a resonator in order to explain the resonance volumes described by the wave function, as well as the electromagnetic interactions between the elementary charged particles making up atomic structures, that could explain electronic and nucleonic orbitals stability. An unexpected benefit of the expanded space geometry required to establish these properties and interactions is that the fundamental symmetry requirement is respected by structure for all aspects of the distribution of energy within electromagnetic quanta at the subatomic level.

Keywords: Wave function; electron resonance states; elementary electromagnetic particles; electromagnetism; hydrogen atom.

1. INTRODUCTION

This paper does not propose an alternate approach to quantum mechanics, but rather an addition to the already established descriptions of the orbital resonance states provided by Schrödinger's wave function, Heisenberg's statistical distribution method and Feynman's path integral, involving a clear description of the electromagnetic resonators responsible for the establishment of the related resonance volumes, meant to lay the groundwork for the eventual establishment of more elaborate wave functions that will for the first time completely account for the electromagnetic nature of these resonators.

The detailed mathematical proof of complete conformity with electromagnetism and with every aspect of all experimental data on record is provided in a series of articles previously published that are given in reference as required. This new approach is in complete agreement with the methods of QED and QFT and complements them by clarifying the function of the magnetic aspect of the energy of which electromagnetic elementary particles and their carrying energy is made, in a manner that allows describing their permanently localizable self-sustaining internal electromagnetic structure.

The key concept that triggered this particular research is an aspect of the wave function that seems to have escaped general attention almost from the moment that Quantum Mechanics (QM) was

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established to represent the hydrogen ground state from the correlation of Heisenberg's statistical representation and Schrödinger's wave equation. This concerns the very reason why Schrödinger came up with the idea of using a wave equation to describe the already well known stable ground state of the electron in the hydrogen atom. Strangely, it seems that the seminal paper which is at the origin of this major discovery never was translated to English [1].

This paper, written by Louis de Broglie, relates the interference patterns produced by the various electromagnetic energy frequencies emitted by hydrogen atoms to possible resonance states of the electron on what was then perceived as the various orbits that it could occupy in the hydrogen atom.

Here is de Broglie's description in his own words of the observation that led him in 1923 to this major conclusion, followed by its apparently first time ever translation to English:

> *"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."* ([2], 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 waves theory, where integers naturally occur".*

Shortly afterwards, he published a note in the *Comptes rendus de l'Académie des Sciences* in which he was proposing the first preliminary interpretation of the conditions that might explain the stability of the electron within atomic structures [1].

The critical conclusion of this note is the following. Original in French:

> *"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:"*

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

which is the stability condition determined by Bohr and Sommerfeld for a trajectory being run at constant velocity [1].

The following year, de Broglie published two more notes, 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 relating the frequency of the emitted wave to the initial electron stationary state and to its final stationary state [3,4] and ([2], p. 462). Two years later, Schrödinger introduced the wave function to account for this measurable condition.

The obvious starting point of his exploration was a complex-valued simple harmonic oscillation formula that then evolved into more elaborate spherical formulations to describe the ground state orbital of the hydrogen atom.

To this author's knowledge, no subsequent mention of the fact that Schrödinger's wave function is meant to describe a stable resonance state or volume into which the localized electron remains captive can be found in the historical formal literature, except in a book published in 1953 to which the actual discoverers of Wave Mechanics and Quantum Mechanics collaborated [2].

Moreover, although Einstein contributed the text of the introduction of this book in German, and that Schrödinger contributed in English the Chapter that he provided, both contributions being translated to French on the facing pages, the remainder of the book was in French only. It also appears that this particularly important book, to which Einstein, Schrödinger, Pauli, Rosenfeld, Heisenberg, Yukawa, Davisson and de Broglie, to name only the most famous, and many more, jointly collaborated to provide a general overview of the state of quantum physics as of 1952, highlighting in historical context the contribution of Louis de Broglie, was apparently never translated to English nor to any other language to be made available to the international scientific community.

Fortunately, this annoying issue of numerous major seminal documents produced by European scientists who were at the leading edge of research in fundamental physics in the first half of the 20th century, and who actually established Quantum Mechanics is in process of being addressed by organizations such as the *Minkowski Institute*.

From what can be learned from this book, soon after the wave function was introduced by Schrödinger, whose validity was confirmed within a few years as being incontrovertibly related to resonance states, according to interference patterns generated during experiments carried out by Davisson and Germer, and also by G.P. Thompson ([2], p.19), the adoption by the majority of researchers of Heisenberg's statistical representation, that replaces the volume of apparent isotropic energy density defined by Schrödinger's wave function by a distribution of the energy density of the electron according to a statistical arrangement reflecting an *amplitude probability* perceived as being a more precise representation than the initial wave function, giving a greater density of energy *presence* in the vicinity of the Bohr radius for example, caused the fact that the wave function was initially meant to represent a resonance state to be obscured and neglected practically from the onset.

The probabilistic interpretation also favored the idea of sudden jumps from one energy level to another, providing no mechanical explanation to these jumps, contrary to the wave equation that had the potential to allow descriptions of such changes as being mechanically progressive and mathematically describable processes, as re-emphasized by Schrödinger in 1953:

> *"To produce a coherent train of light waves of 100 cm length and more, as is observed in fine spectral lines, takes a time comparable with the average interval between transitions. The transition must be coupled with the production of the wave train... For the emitting system is busy all the time in producing the trains of light waves, it has no time left to tarry in the cherished "stationary states", except perhaps in the ground state."* ([2], p.18).

Even Einstein, who, like de Broglie and Schrödinger, was convinced that the electron remains constantly localized as it moves and always follows a precise trajectory, was unconvinced by the discovery by de Broglie's of the relation between discrete quantum states and resonance states, presumably because he did not associate the concept of "mass" to electromagnetism in the same manner as de Broglie and Schrödinger.

Here is Einstein's comment in this regard that appears at the beginning of the introduction of this book (Original text in German):

> *"Ich will dem zusammen mit Frau B. Kaufman verfassten Beitrag zu diesem Bande einige Worte vorausschicken in der einzigen Sprache, in der ich mich mit einige Leichtigkeit ausdrücken kann. Es sind Worte der Entschuldigung. Sie sollen zeigen, warum ich, trotzdem ich De Broglie visionäre Entdeckung des inneren Zusammenhanges zwischen discreten Quantenzuständen und Resonanzzuständen in relativ jungen Jahren bewundernd miterlebt habe, doch unablässig nach einem Wege gesucht habe, das Quantenrätsel auf anderem Wege zu lösen oder doch wenigstens eine Lösung vorbereiten zu helfen."* ([2], p.4).
>
> *"I will begin my contribution prepared for this book in collaboration with Mrs. Kaufman with a few words in the only language in which I can express myself with any ease. They are words to express regret. They are meant to show why - although I observed admiringly in my years of relative youth the genial discovery by Louis de Broglie of the intimate relation between the discrete quantum*

> *states and resonance states - I nevertheless ceaselessly searched for some manner to resolve the enigma of quanta by some other means, or at least help in preparing such a solution."*

It turns out that Schrödinger and de Broglie were initially analyzing these observed resonance states in view of establishing a progressive mechanical explanation to the transitions between the stationary states, that would explain the generation of the bremsstrahlung photons responsible for the fine spectral lines detected in relation with these transitions, but that the immediate popularity of Heisenberg's statistical method in the community caused all research in this direction to be stalled almost from the start. The issue of bremsstrahlung photons emission will be addressed further on.

Schrödinger clearly expressed his frustration for the neglect of any research in this direction in the chapter that he contributed:

> *"For it must have given to de Broglie the same shock and disappointment as it gave to me, when we learnt that a sort of transcendental, almost psychical interpretation of the wave phenomenon had been put forward, which was very soon hailed by the majority of leading theorists as the only one reconcilable with experiment, and which has now become the orthodox creed, accepted by almost everybody, with a few notable exceptions."* ([2], p.16).

Schrödinger and de Broglie were obviously convinced that the frequency of an emitted quantum could be produced only by means of a progressive mechanical process dependent on the resonance characteristics of an electron initial stationary state, and whose emission mechanically determined in a clearly describable manner the altered resonance characteristics of the final stationary states and that solving this problem would be useful not only in spectroscopy, but also in chemistry.

It seems that Schrödinger's frustration was well justified, considering that it took 55 more years after he so openly aired this protest in this book and also in a paper titled "*Are there quantum jumps*" published the same year in the "*British Journal for the Philosophy of Science*" [5], that is, 80 years after he introduced the wave function, for the first hints of renewed interest in resonance states in relation with the wave function to reappear in the community. This recent analysis can be found in a paper by V. A. Golovko [6] published in 2008.

The outcome of the adoption by the majority of theorists of the statistical method as representing fundamental reality then led to the establishment of the quantum field theory (QFT) grounded on an axiomatic fundamental concept of spontaneous quantum energy fluctuations on either side of a zero point energy level that would exist everywhere in space, that establishes virtual photons (bosons) as being the force carriers that would explain the energy levels and motion of real elementary electromagnetic particles in space.

These hypothetical spontaneous stochastic fluctuations of the underlying quantum field are also considered as explaining the apparently erratic transverse quivering motion observed in the behavior of moving electrons in certain circumstances that Schrödinger named *zitterbewegung*, which we will analyze further on [7].

It is quite obvious that QFT is correctly grounded on Maxwell's electromagnetic wave theory and equations, but it nevertheless obscures the fact that in electromagnetism, an electron, for example, which is electrically charged, can be made to move in a straight line when immersed in equal density ambient **E** and **B** fields; that if these intensities are made to simultaneously gradually vary, even if the variation is infinitesimally progressive, its velocity will vary just as gradually, and if their relative densities are made to gradually differ from each other, this will cause the electron to just as gradually curve its trajectory, which are processes all aspects of which can be calculated and controlled with the Lorentz equation ($\mathbf{F} = q(\mathbf{E} + \mathbf{v} \times \mathbf{B})$).

This behavior of electrons completely validates the possibility that if the QFT concept of virtual bosons being the force carrier was replaced by the infinitesimally progressive Coulomb interaction stemming from Maxwell's first equation, that is, Gauss's equation for the electric field, this would open up the possibility that electromagnetic bremsstrahlung photons could be defined as self-sustaining their own

motion in a localized manner without the need for any underlying ether, from the simple interaction of their own internal mutually inducing **E** and **B** fields in conformity with Maxwell's grounding hypothesis, and that they could be defined as default self-guiding in straight line from the default equal densities of there own internal **E** and **B** fields [8].

2. THE E AND B FIELDS OF THE MOVING ELECTRON

It can also be observed that the resonance states of the electron are not the only aspects of electrons that seem to have been the object of little research over the course of the past century.

Despite the known facts that the electron possesses and electric charge, that it can be guided by progressively varying ambient electric **E** and magnetic **B** fields and that the *wave* aspect of its established *wave-particle* nature confirm that it is an electromagnetic particle, it seems that the intrinsic **E** and **B** fields of the electron itself, that is the **E** and **B** fields that must be associated to its very charge and mass, have apparently not yet been investigated in the community.

Indeed, the only relations between the electron and **E** and **B** fields that can apparently be found in the literature of the past hundred years specifically refer to the motion of electrons in ambient electric or magnetic fields, without any mention of any sort of interaction between these external fields and those that have by structure to be related to their electric charge and rest mass.

The first breakthrough in this direction is fairly recent. In 2003, Paul Marmet succeeded in directly relating the increasing magnetic field of an accelerating electron to its increase in relativistic mass after quantizing the electron charge to its unit value in the Biot-Savart equation [9].

After he established the charge of the electron as remaining invariant at its unit value of 1.602176462E-19 C in the Biot-Savart equation, his equation 17 now provides us with an electromagnetic equation that allows directly calculating *the mass increment corresponding to the magnetic field increment* of the accelerating electron:

$$\Delta m_m = \frac{\mu_0 \left(e^-\right)^2}{8\pi r_e} \frac{v^2}{c^2} \tag{2}$$

This equation thus directly associates the concept of *classical mass* to the real electromagnetic energy that must by definition be associated with the *varying magnetic field increment* of the electron in motion, which implies by similarity that *the intrinsic magnetic field of the electron must also be associated to the real energy making up its invariant rest mass*, as we will shortly see.

He also observed that since the varying inertial mass of the moving electron is given by:

$$m = \gamma m_e \tag{3}$$

and that the Lorentz γ factor can be expanded into the following series:

$$\gamma = 1 + \left\{ \frac{1v^2}{2c^2} + \frac{3v^4}{8c^4} + \frac{5v^6}{16c^6} + \frac{35v^8}{128c^8} + \cdots \right\} \tag{4}$$

and that the term $(v/c)^4$ and other higher order terms are negligible with respect to the $(v/c)^2$ term, they can be ignored for low relativistic velocities, this allows establishing the following equality from Equation (4):

$$\gamma - 1 = \frac{1}{2} \frac{v^2}{c^2} \tag{5}$$

Knowing that the momentum related relativistic kinetic energy of a moving electron is obtained from the following standard equation, which makes use of the right term of Equation (5):

$$\Delta K = m_0 c^2 (\gamma - 1) \tag{6}$$

we can similarly calculate the relativistic mass increment from combining Equation (3) and Equation (5):

$$\Delta m = m - m_e = m_e(\gamma - 1) = \frac{m_e}{2}\frac{v^2}{c^2} \tag{7}$$

Comparing now Equation (2) with Equation (7), we observe that we now have two different equations representing the same mass increment of the moving electron, that is, Equation (2) providing this increment as the mass of the *magnetic field increment*, while Equation (7) provides this same increment as a *classical mass* increment. We can thus equate equations (2) and (7) in the following manner:

$$\Delta m_m = \Delta m = \frac{\mu_0 (e^-)^2}{8\pi r_e}\frac{v^2}{c^2} = \frac{m_e}{2}\frac{v^2}{c^2} \tag{8}$$

and finally, when the velocity becomes infinitesimal, both velocities ratios can be ignored to finally reveal the surprising fact that the mass of the intrinsic magnetic energy of the electron makes up exactly half of its invariant rest mass, which is the critically important conclusion reached by Marmet:

$$m_m = \frac{\mu_0 e^2}{8\pi r_e} = \frac{m_e}{2} \tag{9}$$

3. THE ELECTRON CARRYING ENERGY

Let us consider for a moment the meaning of Δm_m from Equation (2) and of ΔK from Equation (6). To really grasp what is involved here, let us use the well known concrete case of the well known theoretical electron relativistic velocity of 2187647.561 m/s on the theoretical classical Bohr ground state orbit. Using this velocity to resolve Equation (2), we obtain the following mass increment:

$$\Delta m_m = \frac{\mu_0 (e^-)^2}{8\pi r_e}\frac{v^2}{c^2} = 2.42533775E-35 kg \tag{10}$$

which is the magnetic field mass increment to be added to the rest mass of the electron to obtain the total effective electron mass that experimentalists have to deal with when transversely deflecting electrons moving freely at this corresponding relativistic velocity of 2187647.561 m/s.

Multiplying now this value by c^2, we obtained the energy in joules constituting this amount of mass (2.179784832E-18 j), and further dividing this value in joules by the unit charge of the electron (1.602176462E-19 C), we obtain its conversion to electronvolts (13.6 eV).

Let us now calculate with Equation (6) the momentum kinetic energy related to this same velocity of the electron:

$$\Delta K = m_0 c^2 (\gamma - 1) = 2.17978483E-18 j \tag{11}$$

If we now divide this value by the unit charge of the electron, we again obtain a value in electronvolts equal to (13.6 eV).

So, we observe that both ΔK and Δm_m resolve to the same 13.6 eV energy value, that we may be strongly tempted to consider as representing the same energy quantum calculated by different means.

But, it can hardly be disputed that on one hand, Δm_m measures the energy contained in a mass increment corresponding to an increase of the global magnetic field of the electron and that on the other hand, ΔK measures the well known kinetic energy that propels the effective mass of the electron at the stated velocity, an effective mass which is bound by structure to includes the quantity Δm_m calculated with Equation (2) on top of including the invariant rest mass of the electron.

Consequently, the only possible conclusion that can be drawn is that these two instances of 13.6 eV are different and are both induced simultaneously in the electron at this velocity, and consequently are in reality two *half-quanta* of energy whose sum constitutes a single quantum of *carrying-energy* that exists separately from the energy quantum of which the electron invariant rest mass is made, one of which converts to a mass increment while the other remains vectorially unidirectional, propelling the total effective mass of the electron at the stated velocity.

All calculations with equations (2) and (6) for any velocity will reveal that this even split between an amount going into an increase in magnetic field mass and a translational momentum related amount of kinetic energy is maintained for the whole range of all possible relativistic velocities.

Interestingly, this total amount of 27.2 eV that results from adding the energy of magnetic mass increment Δm_m obtained from Equation (2) and of momentum energy ΔK obtained from Equation (6), is exactly equal to the single amount of energy that can be calculated with the Coulomb equation as a function of the inverse of the mean axial distance separating the electron ground state orbital from the hydrogen nucleus, and that corresponds to relativistic velocity 2187647.561 m/s:

$$E = \int_{a_0}^{\infty} \frac{1}{4\pi\varepsilon_o}\frac{e^2}{a_0^{\,2}} \cdot da_0 = 0 - \frac{1}{4\pi\varepsilon_o}\frac{e^2}{a_0} = -4.359743805\ E\text{-}18\ J \tag{12}$$

When dividing this amount of energy by unit charge value 1.602176462E-19 C, we effectively obtain in electronvolts the exact amount of energy obtained by summing up the energies obtained from equations (2) and (6), that is, 27.2 eV, which confirms the validity of Equation (2) newly derived by Marmet, on top of confirming the fact that this total amount of energy induced for any relativistic velocity in a charged particle can be entirely obtained from an equation stemming from electromagnetism, that is, the Coulomb Equation (12), which now allows reuniting both ΔK and Δm_m obtained from equations (2) and (11) as belonging to a *single quantum* of energy now directly related to electromagnetism since they are simultaneously induced by the Coulomb force, which resolves for the electron when stabilized at mean resonance distance ground state from the proton in a hydrogen atom, to the following equation:

$$\text{Charged particle carrying energy} = \Delta K + \Delta m_m c^2 = 4.359743805E\text{-}18\ j \tag{13}$$

4. THE ISSUE OF MOMENTUM ENERGY BEING CONSIDERED CONSERVATIVE

Examining Equation (13) now reveals a major disconnect between the traditional classical/relativistic mechanics concept of *momentum*, that can be related only to the ΔK half of the energy adiabatically induced by the Coulomb force, which is deemed, from the traditional perspective, to reduce to zero when a body is not in motion, even if it remains adiabatically induced from the electromagnetic perspective, when the electron is captive in the hydrogen ground state orbital, in which it is now well understood that it is not moving on the theoretical Bohr orbit, as put in clear perspective in reference [10].

Moreover! There is no trace in traditional classical/relativistic mechanics nor in traditional quantum mechanics, of the second component of Equation (13), that is, $\Delta m_m c^2$, which is adiabatically induced by the Coulomb force simultaneously with the ΔK component.

In classical/relativistic mechanics, momentum is obviously viewed as the most fundamental principle, a concept that was carried over to traditional quantum physics under the forms of the Hamiltonian and the Lagrangian. But in electromagnetism, the energy that sustains momentum is even more fundamental than momentum, given that it still remains adiabatically present by definition even when this momentum is inhibited, that is, even when an electrically charged particle, such as the electron, is stopped in its motion when captured in a state of axial electromagnetic equilibrium in one of the possible stationary action orbitals in an atom [10].

This fundamental disconnect between electromagnetism on one hand, and traditional classical mechanic, traditional relativistic mechanics and traditional quantum mechanics on the other, makes it all the more difficult to conceptually overcome, because the value of ΔK as calculated with Equation (11) depends uniquely on the *velocity* parameter, which means that if this velocity falls to zero, then no momentum, that is, no motion inducing kinetic energy is conceptually deemed to exist from the non-electromagnetism traditional perspectives, which is in flagrant contradiction with the fact that according to Equation (13) stemming from electromagnetism, this energy is adiabatically induced uniquely as a function of the inverse of the *axial distance* between electrically charged particles by the Coulomb force, that forbids by very nature that any other level of energy be induced between two charges separated by this distance, which means that it can only remain induced even if the velocity of the particle is inhibited, as demonstrated in reference [10].

Even from the Quantum Mechanics perspective, the wave function accounts for the complete physical presence of this 13.6 eV ΔK momentum energy via the Hamiltonian even if it is experimentally established that the electron is unable to move toward the proton at any velocity despite the impossibility by structure that this momentum energy be vectorially oriented in any direction other than toward the proton.

This observation consequently brings to light the possibility that momentum kinetic energy can exist as a *material substance* irrespective of whether or not a forward velocity is involved, as analyzed in detail in references [8,10,11], and is at the heart of a new paradigm that now allows mechanically explaining a series of electromagnetic processes that find no explanation from the traditional conservative principles perspective [11,12].

Having now established this relation, the analysis that follows will be carried on strictly from the electromagnetism perspective.

5. SEPARATING THE ENERGY OF THE MAGNETIC FIELD INCREMENT FROM THAT OF THE MAGNETIC FIELD OF THE INVARIANT REST MASS OF THE ELECTRON

This new perspective now allows us to clearly separate the carrying energy of the electron from that of its rest mass and to calculate separately their electromagnetic frequencies and wavelengths by means of standard equations E=hν and c=λν. We thus obtain the following frequency and electromagnetic wavelength for the 4.359743805E-18 j reference carrying energy of the electron on the theoretical Bohr ground state orbit, which in fact corresponds to the mean carrying energy of the electron in the ground state orbital of the hydrogen atom:

$$\nu = \frac{E}{h} = 6.57968390\ 9E15\ \text{Hz} \qquad \lambda = \frac{c}{\nu} = 4.55633526\ 1E-08\,\text{m} \tag{14}$$

Similarly, we obtain the following frequency and electromagnetic wavelength for the energy of $E=m_oc^2$= 8.18710414E-14 j making up the electron invariant rest mass, which wavelength is also known as the electron Compton wavelength:

$$\nu = \frac{E}{h} = 1.23558997\ 6E20\,\text{Hz} \qquad \lambda_C = \frac{c}{\nu} = 2.426310215\ E-12\,\text{m} \tag{15}$$

We thus immediately observe that the energy related to the electron in motion involves the presence of not only one simple electromagnetic harmonic oscillation, as the Schrödinger wave function seems to currently assume, but of two distinct electromagnetic harmonic oscillations, whose mutual resonance beat interaction is not yet clearly defined.

These values will be quite useful later on when the zitterbewegung of the moving electron will be analyzed, as well as the complex electron resonance beat involving the interaction of these two harmonic oscillations with those of the proton inner electromagnetic elementary components when the electron becomes captive in the rest orbital of the hydrogen atom.

Let us also remark that although the concept of *wavelength* is sometimes assumed to represent a physical *length* to be associated to localized photons or even to the hypothetical electromagnetic waves of Maxwell's theory, such a wavelength can only be in reality a physical *distance* that such a localized photon or spread out theoretical electromagnetic wave needs to travel in space for one of the cycle of mutual transverse induction of their electric and magnetic aspects to be completed in reference to their frequency.

Speaking of Maxwell's continuous electromagnetic wave concept, the experiments carried out by Huygens, Fresnel and Young that demonstrate that at the macroscopic level, when a macroscopic electromagnetic wavefront is made to meet a surface into which a small aperture is made, however small it may be from our macroscopic perspective, this small aperture becomes the source of a secondary spherical electromagnetic wavefront, which is often flaunted as *the proof* of the physical existence of continuous electromagnetic waves such as Maxwell conceived them.

There is a habit in the community of thinking of an *electromagnetic wavefront*, but in reality there is an uninterrupted flow of electromagnetic energy in all of space, whether considered as a continuous wave phenomenon or as a crowd of countless separate point-like behaving electromagnetic photons that are constantly being individually emitted by de-exciting electrons being recaptured in allowed rest orbitals in atoms, after these electrons were excited either out of atoms or just pushed further away from their nuclei to some metastable orbital.

In reality, this behavior of electromagnetic energy as measurable at the macroscopic level does not demonstrate any disconnect with the idea that this macroscopic electromagnetic wavefront could be made in reality of countless elementary point-like behaving electromagnetic photons that would interact, while moving through the small apertures, with the countless other point-like behaving electromagnetic elementary particles captive in various least action electromagnetic equilibrium states in the atoms lining up the inner sides of the macroscopic apertures, and whose trajectories would consequently be deflected in such a way as to produce what seems to be, from our macroscopic perspective, the *secondary spherical electromagnetic wavefronts* that can be observed as they come out of the aperture.

There is absolutely nothing that rules out either the possibility that the countless individual photons that are constantly being emitted by de-exiting electrons in atoms all over the universe could continue behaving point-like after emission until they are subsequently absorbed by other charged particles, re-initiating in so doing the emission process, after having had their trajectories deflected numerous times before being absorbed by other charged particles at some other locations, as analyzed in reference [8].

Whether one concludes that electromagnetic energy really exists as a continuous wave phenomenon as perceived from our macroscopic level or that localized photons are the real deal at the subatomic level holds only to what a person has studied. Both schools of thought always had quite respectable advocates. The fact is that even if treating electromagnetic energy as localized quanta is consistent with the results of experiments carried out at the subatomic level, treating it as a continuous wave phenomenon remains consistent with the results of experiments carried out at our macroscopic level.

It seems however that the conclusion according to which this energy would physically exist as localized photons, as concluded by Planck, Einstein, de Broglie and Schrödinger, among others,

allows clearer mechanical explanations of the various processes that are known to occur at the subatomic level.

6. PARTICULARITIES OF ENERGY CALCULATION BY MEANS OF THE COULOMB EQUATION

Even though Equation (12) allows calculating the carrying energy of the electron at the hydrogen mean ground orbital distance from the central proton by mathematically accumulating this energy from *infinity* to this specific distance from r = 0, it can be observed that this amount of energy can only be systematically exactly equal to the actual amount of kinetic energy adiabatically induced by the Coulomb force as a function of the inverse of this distance separating both electrical charges, a distance which is equal by structure to the distance separating point d from point zero in the integration function (Fig. 1).

It can be observed also that point zero of the integration function can be relocalized to the middle of the distance between both charges processed by the Coulomb equation without affecting energy calculation in any way, a central point ⊗ that will be later correlated with the central junction point of an expanded spatial geometry.

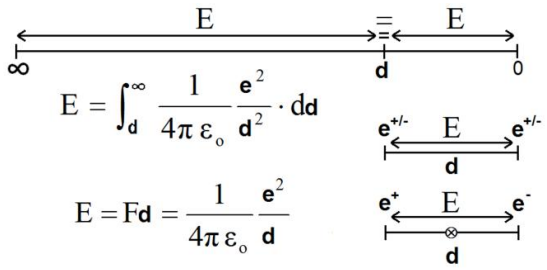

Fig. 1. Energy equality between integration from infinity to distance "d" and between "d" and zero

The method used by Marmet to derive Equation (9) from the Biot-Savart equation then allows deriving a new more general form of the Coulomb equation equivalent to traditional equation E=hv, that allows calculating the energy of any electromagnetic energy quantum without any need to use the Planck constant, and that also allows defining their intrinsic **E** and **B** fields strictly by means of a set of known electromagnetic constants.

Isolating the value of m_0 in Equation (9) established by Marmet and making use of the familiar equation $\mu_0 \varepsilon_0 c^2 = 1$ stemming from equivalent second partial derivatives of Maxwell's equations [13], that as far back as the 1860's allowed him to calculate the invariant speed of light from the two fundamental constants of vacuum ε_0 and μ_0, will allow introducing the electrostatic permittivity constant of vacuum ε_0 to link up with the Coulomb equation. Isolating μ_0 in this equation in the following manner $\mu_0 = 1/\varepsilon_0 c^2$ allows replacing it with its equivalent electromagnetic definition [14]:

$$m_0 = \frac{\mu_0 e^2}{4\pi r_e} = \frac{e^2}{4\pi\varepsilon_0 r_0 c^2} \tag{16}$$

Multiplying then both left and right terms of Equation (16) by c^2 will convert the equation from calculating mass to calculating energy, in this particular case, the energy quantum of which the invariant rest mass of the electron is made:

$$E = m_0 c^2 = \frac{e^2}{4\pi\varepsilon_0 r_0} = 8.18710414\,E-14\ j \tag{17}$$

Assuming that e^2 is likely to represent any pair of charges in such a general equation, let us replace the *classical electron radius* r_0 used by Marmet by the classical radius of the Bohr theoretical orbit in the Bohr atom a_0 to remain consistent with the hydrogen atom example. Considering that the Coulomb force between two such charges requires involving the distance between the charges, let us further divide both sides of the equation by a_0 to finally obtain the equation allowing calculation of the Coulomb force, and to identify in the resulting equation the long established electrostatic constant whose exact value is 8.987551733E-9 Nm^2/c^2, also know as the Coulomb constant:

$$F = \frac{E}{r_0} = \frac{e^2}{4\pi\varepsilon_0 r_0^2} \quad \text{where} \quad \frac{1}{4\pi\varepsilon_0} = k_e \text{ (Coulomb constant)} \tag{18}$$

As a final validity confirmation, let us calculate the well-known Coulomb force that applies at the theoretical Bohr orbit, using the Bohr radius a_0 = 5.291772083E-11 m:

$$F = \frac{e^2}{4\pi\varepsilon_0 a_0^2} = 8.238721807E-08\,N \tag{19}$$

Now going back to Equation (17) that allows calculating the energy making up the electron rest mass, we observe that the only *possibly variable* parameter that allows determining the amount of energy of the quantum making up this mass is r_0, which is considered a fundamental constant known under the name of *the classical electron radius* and that Marmet used to derive Equation (9).

It is well understood in physics circles that despite its name, this constant cannot really be an actual *radius* of the electron, given that it is now well established experimentally that the electron behaves *point-like* in all scattering experiments. *Point-like behavior* meaning here that during all such scattering experiments, however energetic, no unbreachable limit was ever detected at some distance from electrons' centers, however close two electrons came to each others' centers.

So despite this unfortunately misleading misnomer, r_0 is nevertheless considered useful to define a *length*, or *distance*, not yet fully understood, related to electromagnetic interactions involving electrons at the subatomic level.

But we may now have *telltales* as to what this *length* or *distance* may be, beginning with the observation that if we use it in Equation (12) instead of the classical Bohr radius a_0, we obtain the actual energy of the quantum of which the rest mass of the electron is made, as just calculated with standard Equation (17), as if r_0 was a really existing *distance* between a pair of still to be identified internal *would-be charges*, that would be involved in the still to be established electromagnetic inner oscillating structure of the electron, despite the fact that the *electric* charge of the electron is known to be unique and set at the fixed value of 1.602176462E-19 C. Maybe some sort of point-like *charges* of some nature different from *electric* but that would still be acted upon by the Coulomb force, despite the strangeness of the idea, at this point of the current analysis.

We will see further on that such an internal structure has effectively been established involving a harmonic oscillation of the inner magnetic energy of the electron cyclically converting to two such *non-electric charges* and back to magnetic energy state. See Equation (53) further on.

One more telltale concerns the relation between r_0 and λ_C that is, the electron Compton wavelength, that we just calculated with Equation (15). This further telltale is a relation that can be established between these two *constants* and fine structure constant α, first described in reference [15] in relation with the recall constant of Hooke's law as applied to the LC transverse oscillation of the magnetic energy of the rest mass of the electron, and that amounts to half the rest mass of the electron, as determined by Marmet with Equation (9).

From calculation carried out in reference [14], the maximum transverse separation amplitude between these *charges* during this transverse reciprocating LC oscillation would be exactly equal to $r_0=\alpha\lambda_C/2\pi$,

which would amount to the maximum distance that these two still to be identified *non-electric would-be charges* would reach in space as they oscillate between this double-component state and the magnetic single component constituting the magnetic half of the energy of the electron invariant rest mass. This conclusion was confirmed later when the transversely LC oscillating *neutrinic charges* of the electron were identified in reference [16]. This issue will be discussed further on.

This relation between r_0, λ_C and α led to consider the possibility that the same method could be applied to calculate the energy of any self-sustaining electromagnetic quantum, and subsequent verification confirmed this possibility. It turns out that $r = \alpha\lambda/2\pi$ coincides with the maximum distance that two charges – either electric or neutrinic – can reach transversely during the transverse LC oscillation of any self-sustaining electromagnetic quantum during the reciprocating oscillation that causes them to cyclically induce the magnetic field of the particle as they close in on each other, and its regression as they move away from each other [15,16,17,18] as we will see further on.

This means in fact that r_0 and a_0 are not really fundamental constants but only special cases of the whole range of possible electromagnetic energy transverse amplitudes coinciding with two stationary action quantized stable states of electromagnetic energy, that is, the invariant rest mass of the electron, and the stationary action electromagnetic equilibrium state of the electron in the hydrogen atom, and that they can be systematically replaced in the Coulomb equation by the more general variable expression $\alpha\lambda/2\pi$, λ being the electromagnetic longitudinal wavelength traditionally related to the electromagnetic energy quantum considered.

This allowed defining the following general equation in reference [14] by adapting Coulomb Equation (19) in the following manner (see also Fig. 1):

$$E = \int_{a_0}^{\infty} \frac{1}{4\pi\varepsilon_o} \frac{e^2}{(\alpha\lambda/2\pi)^2} \cdot dr = 0 - \frac{1}{4\pi\varepsilon_o} \frac{e^2 2\pi}{\alpha\lambda} = \frac{e^2}{2\varepsilon_o \alpha\lambda} \tag{20}$$

that defines an electromagnetic equation equivalent to E=hv, that does not require the use of Planck's constant to calculate electromagnetic energy levels, and whose complete derivation and justification was established in reference [14]:

$$E = h\nu = \frac{e^2}{2\varepsilon_o \alpha\lambda} \tag{21}$$

One surprising benefit brought about by the establishment of this form of the Coulomb equation was that it finally allowed unifying all classical force equations by allowing to reversibly derive the fundamental equation F=ma from all of them [19], beside observing that the Coulomb equation is an integral part of the Biot-Savart equation, since it is derived from Marmet's derivation from the Biot-Savart equation.

7. SEPARATELY CALCULATING THE E AND B FIELDS OF THE ELECTRON AND THOSE OF ITS CARRYING ENERGY

The development of Equation (21) then allowed separately defining in reference [14] the **E** and **B** fields equations accounting for the totality of the energy of which the invariant rest mass of the electron is made:

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

and with the same equation, using the electromagnetic wavelength of its carrying energy, to calculate the **E** and **B** fields of this carrying energy. To remain consistent with our example of hydrogen atom ground state orbital, here are the **E** and **B** fields calculated with the wavelength of the carrying energy obtained in Equation (14):

$$\mathbf{B} = \frac{\mu_0 \pi e c}{\alpha^3 \lambda^2} = 235051.7341\,\mathrm{T} \quad \text{and} \quad \mathbf{E} = \frac{\pi e}{\varepsilon_0 \alpha^3 \lambda^2} = 7.046673712\mathrm{E}13\,\mathrm{N/C} \tag{23}$$

Reference [14] then shows how magnetic and electric fields equations (22) and (23) can be added to establish the combined **E** and **B** fields of the electron in motion. To remain consistent with the hydrogen atom ground state parameters, the wavelengths obtained with equations (14) and (15) are used to calculate the corresponding fields:

$$\mathbf{B} = \frac{\pi \mu_0 e c \left(\lambda^2 + \lambda_C{}^2\right)}{\alpha^3 \quad \lambda^2 \lambda_C{}^2} = 8.289000246\mathrm{E}13\ \mathrm{T} \tag{24}$$

$$\mathbf{E} = \frac{\pi e}{\varepsilon_0 \alpha^3} \frac{\left(\lambda^2 + \lambda_C{}^2\right)\sqrt{\lambda_C\left(4\lambda + \lambda_C\right)}}{\lambda^2 \lambda_C{}^2 \quad \left(2\lambda + \lambda_C\right)} = 1.813341121\ \mathrm{E}13\ \mathrm{N/C} \tag{25}$$

It can now be confirmed that equations (24) and (25) are valid by calculating with the values obtained, the well known relativistic velocity of the electron when moving with the 4.359743805E-18 j reference energy of the hydrogen ground state (27.2 eV):

$$\mathrm{v} = \frac{\mathbf{E}}{\mathbf{B}} = \frac{1.813341121\mathrm{E}13}{8.289000246\mathrm{E}13} 10^{-7} = 2{,}187{,}647.566\,\mathrm{m/s} \tag{26}$$

The reason why the result must be multiplied by 10^{-7}, is that this factor, which was made part of the definitions of ε_o and μ_o for these constants to remain in harmony with the CGS system when the MKS units were adopted [13], and that are part of the parameters required to calculate the **E** and **B** fields of the moving electron with equations (24) and (25), ends up being squared in the denominator of the **E**/**B** fraction of Equation (26), which is something not obvious unless actual calculations are carried out, as in our example. This unwanted squaring is circumvented by simply multiplying the equation by 10^{-7} during its resolution. See reference [13] for an explanation of why this factor must not be squared.

So we observe that the magnetic mass increment provided by Marmet's Equation ([9], Equation 17), which was previously reproduced as Equation (2), can be matched with a corresponding **B** field provided by Equation (23) from the electromagnetic wavelength of 4.556335256E-8 m of the corresponding quantum of energy (4.359743805E-18 j), thus amending Equation (10) to obtain the mass increment using the velocity stemming from the **E** and **B** fields as calculated with Equation (26).

Given that Equation (26) provides the same relativistic velocity that Marmet established from the gamma factor [9] from equations (4) and (5), and that he used in establishing Equation (2), the velocity term of Marmet's equation can be replaced by the **E/B** relation that defines this velocity in Equation (26):

$$\Delta \mathrm{m}_\mathrm{m} = \frac{\mu_0 \left(\mathrm{e}^-\right)^2}{8\pi \mathrm{r_e}} \frac{\mathrm{v}^2}{\mathrm{c}^2} = \frac{\mu_0 \left(\mathrm{e}^-\right)^2}{8\pi \mathrm{r_e}} \frac{(\mathbf{E}/\mathbf{B})^2}{\mathrm{c}^2} = 2.425337726\mathrm{E} - 35\,\mathrm{kg} \tag{27}$$

thus allowing for the first time the calculation of a *classical mass* strictly from electromagnetic parameters.

The magnetic energy density involved can now be established for the energy of the composite **B** field calculated with Equation (24):

$$\mathrm{u_B} = \frac{\mathbf{B}^2}{2\mu_0} = \frac{1}{2\mu_0} \left(\frac{\pi \mu_0 e c}{\alpha^3 \lambda^2 \lambda_C{}^2} \right)^2 \left(\lambda^2 + \lambda_C{}^2\right)^2 = 2.73378555\ 9\mathrm{E}33\ \mathrm{j/m^3} \tag{28}$$

For comparison, here is the density of the magnetic field of the isolated invariant rest mass of the electron, making use of the invariant magnetic field of the electron calculated with Equation (22):

$$u_B = \frac{\mathbf{B}^2}{2\mu_0} = \frac{1}{2\mu_0}\left(\frac{\mu_0 \pi e c}{\alpha^3 \lambda_C{}^2}\right)^2 = 2.733785544\ \text{E33 j/m}^3 \tag{29}$$

and that of the isolated carrying energy of the electron in the hydrogen ground state calculated with Equation (23) is:

$$u_B = \frac{\mathbf{B}^2}{2\mu_0} = \frac{1}{2\mu_0}\left(\frac{\mu_0 \pi e c}{\alpha^3 \lambda^2}\right)^2 = 2.198300502\text{E16 j/m}^3 \tag{30}$$

The equation defining the volume within which such high energy densities make sense is derived in reference [14] and is also shown further on as Equation (50).

8. THE INTERNAL ELECTROMAGNETIC STRUCTURE OF THE ELECTRON CARRYING ENERGY

It was established long ago that the electron is an electromagnetic particle. However, the nature of its carrying energy could never be clarified until Marmet derived Equation (2) from the Biot-Savart equation, leading to Equation (13), that reveals that this carrying energy is made of 2 parts, that is, one half sustaining the momentum ΔK of the particle, and the other half identified by Marmet as an amount of magnetic energy that adds a relativistic mass increment Δm_m to the invariant rest mass of the particle in motion.

Since the electric charge of the electron has been systematically proven over the course of the past century to remain invariant, irrespective of its velocity, the related intrinsic electric **E** field that was established with the second Equation (22) can be expected to also remain invariant, and to remain Maxwell equations compliant, so does its intrinsic magnetic **B** field established with the first Equation (22).

As put in perspective with Equation (13), since the Δm_m magnetic mass increment identified by Marmet increases in the exact same proportion as the ΔK momentum energy of the electron, and that these two energy amounts can not be part of the energy quantum making up the invariant rest mass of the electron, this gives us a first conclusive clue that this carrying energy also is electromagnetic in nature, since its magnetic field cannot be dissociated from electromagnetism and consequently from Maxwell's equations.

This total amount of carrying energy represented by Equation (13) can thus be logically represented with the following relational equation:

$$E_{\left(\begin{smallmatrix}\text{Total electron}\\ \text{carrying energy}\end{smallmatrix}\right)} = E_{\left(\begin{smallmatrix}\text{Momentum}\\ \text{energy}\end{smallmatrix}\right)} + E_{\left(\begin{smallmatrix}\text{Magnetic mass}\\ \text{increment energy}\end{smallmatrix}\right)} \tag{31}$$

But to remain consistent with electromagnetism, it seems impossible that this magnetic energy component would not be involved in some cyclic process of transverse electromagnetic oscillation between this magnetic state and a yet to be identified *electric* state, that could potentially be represented as a reciprocating oscillation between both states, in conformity with the very foundation of Maxwell's theory, to the effect that for electromagnetic energy to even exist, both of these aspects must mutually induce each other [20]:

$$E_{\left(\begin{smallmatrix}\text{Total}\\ \text{carrying energy}\end{smallmatrix}\right)} = E_{\left(\begin{smallmatrix}\text{Momentum}\\ \text{energy}\end{smallmatrix}\right)} + \left[E_{\left(\begin{smallmatrix}\text{Electric}\\ \text{state}\end{smallmatrix}\right)}\cos^2(\omega t) + E_{\left(\begin{smallmatrix}\text{Magnetic}\\ \text{state}\end{smallmatrix}\right)}\sin^2(\omega t)\right] \tag{32}$$

It is at this point that a huge leap *out of the box* needs to be made, as the saying goes, because since this magnetic mass increment freshly identified by Marmet has been proven to physically exist by transverse interaction with relativistically moving electrons in experiments carried out by Walter Kaufman at the beginning of the 20th century [21], this means that the energy making up this *mass increment* can only physically exist just like the energy making up the invariant rest mass of the electron. And finally so must it also be for its momentum energy, despite the long held conclusion that it exists only inasmuch as its velocity can be expressed.

This conclusion leads to converting relational Equation (32) into the following electromagnetic form, representing this electromagnetic oscillation as a simple harmonic LC reciprocal transverse oscillation – in conformity with the fact that the **E** and **B** fields must be perpendicular to the direction of motion – between an electric state and a magnetic state of the energy making up the magnetic mass increment identified by Marmet:

$$E_{\left(\begin{smallmatrix}\text{Total Carrying}\\ \text{Energy}\end{smallmatrix}\right)} = \frac{hc}{2\lambda} + \left[\frac{e^2}{2C_\lambda}\cos^2(\omega t) + \frac{L_\lambda\, i_\lambda^{\,2}}{2}\sin^2(\omega t)\right] \tag{33}$$

where

$$E_{E(max)} = \frac{q^2}{2C} \qquad \text{and} \qquad E_{\mathbf{B}(max)} = \frac{L\, i^2}{2} \tag{34}$$

The definitions of the subcomponents C, L and i are provided further on with equations (45) and (47).

In this transitory form, Equation (33) may give the impression that the electromagnetic energy of the Δm_m half-quantum oscillates *longitudinally*, so to speak, moving in the same vectorial direction as its $\Delta K = hc/2\lambda$ momentum energy, but we will see further on that it can oscillate only transversely in conformity with Maxwell's equations, when the vectorial infrastructure will be put in place with Equation (48).

We will also see further on that the oscillation of the magnetic energy of this magnetic mass increment, between a state of maximum presence and one of zero presence as a function of its electromagnetic frequency is key to understanding the various resonance states of the electron, that is, its zitterbewegung on one hand, and also its axial resonance state when captive into a stationary action electromagnetic equilibrium state in an authorized atomic orbital.

Indeed, it can be established, as we will see further on, that even the magnetic energy of the invariant rest mass of the electron can only be involved separately in a similar harmonic oscillating motion between maximum presence and zero presence in space [17], and that the same oscillation characterizes the magnetic energy of the two types of elementary components making up all nucleons and of their respective carrying energies, that is, the up quark and the down quark [18].

9. CORRELATING CLASSICAL MECHANICS AND RELATIVISTIC MECHANICS VIA ELECTROMAGNETISM

The first benefit of representing the electron carrying energy with LC Equation (33), is the ease with which it allows visualizing its electromagnetically oscillating half as oscillating perpendicularly to the direction of motion of the energy sustaining its translational momentum ($\Delta K = hc/2\lambda$), which clearly matches, as previously mentioned, the well known perpendicular relation between the **E** and **B** fields of Maxwell's theory with respect to the direction of motion of any point on the wave front of his theoretical continuous electromagnetic wave in spherical expansion from its point of emission.

In turn, this clear separation between the unidirectionally oriented momentum energy and the transversely oscillating energy of the carrying energy quantum allowed directly upgrading Newton's non-relativistic kinetic energy equation $K=mv^2/2$ to a fully relativistic electromagnetic form [22]:

$$\frac{v^2}{c^2} = \frac{4\lambda\lambda_C + {\lambda_C}^2}{(2\lambda + \lambda_C)^2} \tag{35}$$

One unexpected outcome of the establishment of Equation (35) was that when using the wavelength of the carrying energy induced at mean ground state orbital distance from the nucleus of the hydrogen atom (4.556335261E-08 m), it directly provides the fine structure constant α [23]:

$$\alpha = \frac{v}{c} = \frac{\sqrt{\lambda_C(4\lambda + \lambda_C)}}{(2\lambda + \lambda_C)} = 7.297352533\mathrm{E}-03 \tag{36}$$

More surprising yet! Further dividing Equation (36) by 2π provides the exact fine structure constant α related electron "g" factor discovered by Julian Schwinger in 1948 [23,24]:

$$\begin{pmatrix} \text{electron} \\ \text{magnetic moment} \\ \text{magnetic drift} \end{pmatrix} = \frac{\sqrt{\lambda_C(4\lambda + \lambda_C)}}{2\pi(2\lambda + \lambda_C)} = \frac{\delta\mu}{\mu_B} = \frac{\alpha}{2} = 1.16138653\,5\mathrm{E}-3 \tag{37}$$

The fact that electromagnetic Equation (35) is relativistic by structure, also allows deriving the 4 standard relativistic equations. First in line is the relativistic momentum energy equation, now amended to also account for the presence of the magnetic mass increment Δm_m of elementary particles carrying energy [22]:

$$K = 2m_0c^2(\gamma - 1) \tag{38}$$

For the first time ever also, apparently, the Lorentz gamma factor equation was derived directly from an electromagnetic equation in reference [22], that is, from Equation (35), instead of from strictly mathematical geometric and trigonometric methods, as has been systematically done since Woldemar Voigt came up with the idea in 1887 [11,22,23,25,26]:

$$\gamma = \frac{1}{\sqrt{1 - v^2/c^2}} \tag{39}$$

The third relativistic equation derived was of course the relativistic mass equation of a moving elementary particle in motion [22]:

$$E = \gamma mc^2 \quad \text{where} \quad \gamma m = m_o + \Delta m_m \tag{40}$$

And finally, the relativistic energy-momentum relation equation [27]:

$$E^2 = (pc)^2 + (mc^2)^2 \tag{41}$$

Thus conclusively demonstrating that classical relativistic equations and electromagnetic equations can reversibly be derived from each other.

Besides Equation (35) making use of the wavelengths defined with equations (14) and (15) from which all classical relativistic equations can be derived, a second and even more fundamental electromagnetic equation was derived from upgrading Newton's kinetic energy equation to full electromagnetic status [22]. It is the following equation that directly makes use of the *quantities of energy* separately making up the invariant rest mass of the electron, its momentum, and finally its magnetic mass increment, the last two constituting its carrying energy. It is the following form:

$$\frac{\left(hc/\lambda + 2hc/\lambda_C\right)^2 - \left(2hc/\lambda_C\right)^2}{\left((2L_C\ i_C^{\,2}) + (L_\lambda\ i_\lambda^{\,2})\right)^2} = \frac{v^2}{c^2} \tag{42}$$

that resolves to

$$v = c\frac{\sqrt{4EK_{momentum} + \left(K_{momentum}\right)^2}}{2E + K_{magnetic}} \tag{43}$$

where E represents the energy of the invariant rest mass of the electron, $K_{momentum}$ is the ΔK momentum energy provided by the carrying energy, and $K_{magnetic}$ is the energy going into the Δm_m magnetic mass increment provided by the carrying energy of the electron.

What is so fundamental and important about this equation, is that when the energy of the electron rest mass is reduced to zero, leaving only its carrying energy in the equation, we end up with an equation that systematically provides the speed of light in an invariant manner, whatever the sum of the two half-quanta always equal by structure of the momentum energy and of the energy of the remaining magnetic mass; a velocity possible only for free moving electromagnetic energy:

$$v = c\frac{K_{momentum}}{K_{electromagnetic}} = \frac{\Delta K}{\Delta m_m c^2} = c\frac{\left(hc/2\lambda\right)}{(L_\lambda\ i_\lambda^{\,2})} = c\frac{1}{1} = 299{,}792{,}458\,m/s \tag{44}$$

where

$$L = \frac{\mu_0 \alpha \lambda}{8\pi^2} \quad \text{and} \quad i = \frac{2\pi\, ec}{\alpha\lambda} \tag{45}$$

Since Marmet's contribution allows conclusively establishing that Δm_m from Equation (2) and ΔK from Equation (6) will systematically be equal whatever total amount the sum of their energies will be, these two energy values will systematically simplify to 1 in Equation (44) whatever energy amount of electromagnetic energy is represented by its wavelength λ.

This means that for the first time, we have a conclusive clue regarding the possible internal electromagnetic structure of localized free moving electromagnetic photons, that is, electromagnetic photons that would not be slowed down by having to *carry and propel*, so to speak, the translationally inert electromagnetic mass of an electron on top of having to carry and propel their own electromagnetic mass complement. So LC Equation (33) could consequently be applied as well to free moving electromagnetic photons and to the electron's carrying energy, which would fully justify naming the latter a *carrier-photon*.

10. THE DE BROGLIE DOUBLE-PARTICLE ELECTROMAGNETIC PHOTON

So let us now consequently re-identify Equation (33) as describing the total energy of a free-moving electromagnetic photon and analyze further its structure:

$$E_{\left(\begin{smallmatrix}\text{Total Photon}\\ \text{Energy}\end{smallmatrix}\right)} = \frac{hc}{2\lambda} + \left[\frac{e^2}{2C_\lambda}\cos^2(\omega t) + \frac{L_\lambda\ i_\lambda^{\,2}}{2}\sin^2(\omega t)\right] \tag{46}$$

Of course, the L and i variables definitions of equations (45) still apply and the definition of C established in reference [8] is:

$$C = 2\varepsilon_0 \alpha \lambda \tag{47}$$

We first observe that the electric phase of the electromagnetic transverse oscillation between magnetic and electric states seems to involve a pair of charges, which is a possibility that has been a major stumbling block in electromagnetic theory ever since Maxwell established his theory of light propagation on the then axiomatic concept that the very existence of this energy mandated that both **E** and **B** fields mutually induce each other for the energy to even exist.

Even if the resulting theory has proven out of any doubt its absolute conformity with experience at the macroscopic level, the origin of the *displacement current* that would involve such a local motion of some postulated double electric charges that would induce the magnetic field, while they supposedly close in on each other, to then be re-induced themselves by the magnetic field as the latter regresses, could never be clarified either experimentally nor theoretically.

In a search to identify these still hypothetical charges at the subatomic level, de Broglie tried in the 1930's to establish a clear internal electromagnetic mechanics of the localized photon grounded on the characteristics of the wave function.

It turns out that he did correctly establish that such a permanently localized photon should satisfy the Bose-Einstein's statistic and Planck's Law, explain the photoelectric effect while obeying Maxwell's equations and remain in accordance with the properties of Dirac's theory of complementary corpuscles symmetry, if it involves two half-photons of spin 1/2,

> *"... qui doivent être complémentaires l'un de l'autre dans le même sens que l'électron positif* [le positon] *est complémentaire de l'électron négatif dans la théorie des trous de Dirac... Un tel couple de particules complémentaires est susceptible de s'annihiler au contact de la matière en cédant toute son énergie, ce qui rend compte parfaitement des caractéristiques de l'effet photoélectrique... le photon étant constitué de deux particules élémentaires de spin h/4π, il doit obéir à la statistique de Bose-Einstein comme l'exige l'exactitude de la loi de Planck pour le rayonnement noir... ce modèle du photon permet de définir un champ électromagnétique lié à la probabilité d'annihilation du photon, champ qui obéit aux équations de Maxwell et possède tous les caractères de l'onde électromagnétique lumineuse."* ([28], p. 277).
>
> *"... that must be complementary with respect to each other in the same manner that the positive electron* [the positron] *is complementary to the negative electron in the Dirac Hole Theory... Such a complementary couple of particles is likely to annihilate at the contact of matter by relinquishing all of its energy, which perfectly accounts for the characteristics of the photoelectric effect... The photon, being made up of two elementary particles of spin h/4π, will obey the Bose-Einstein statistic as required by the precision of Planck's law for the black body.…this model of the photon allows the definition of an electromagnetic field linked to the probability of annihilation of the photon, a field that obeys Maxwell's equations and has all the characteristics of electromagnetic light waves."*

His attempts to define the localized electromagnetic photon from the properties of the wave function were unsuccessful to the point that he finally concluded in 1936 that it was impossible to exactly represent elementary particles in the frame of 4D spacetime geometry, in his view too restrictive, hinting that if this frame could eventually be escaped from, such a description might become possible:

> *"... 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."* ([28], 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."

Retrospectively, it seems that in the restricted frame of the 4D space geometry, reverse engineering the description of the electromagnetic photon from the characteristics of wave function, that was not itself initially grounded on electromagnetism to start with, was an impossible task, since, let's remember, it was introduced by Schrödinger to represent a state of resonance in the classical resonance mechanics sense, stemming from de Broglie's comparison with well known classical mechanics resonance states [1]. See also Equation (1). We will discuss the issue of reverse engineering further on.

In reality, the only real relation that can exist between the Schrödinger wave function and the *electromagnetic* resonance state of the electron captive in the ground state orbital of the hydrogen atom can then only be a description of the spatial resonance volume within which all of the electron energy is expected to be contained, and can give no clue whatsoever as to the nature of the *electromagnetic resonator* whose resonance characteristics could explain this resonance volume.

Besides, the very idea that half the energy of the quantum could behave as 2 half-quantities displaying *electric* properties as they close in on each other while at the same time concentrically accumulating as a single quantity within the same volume of space while displaying *magnetic* properties goes directly against logic if this energy was a *physically existing substance* as the previous analysis leads to conclude.

This mechanical impossibility that comes to light when attempting to represent the mutual induction of the electric and magnetic aspects of localized electromagnetic quanta by reciprocating swing within the same volume of space effectively correlates with de Broglie's conclusion that 4D spacetime geometry is too restrictive to represent elementary particles.

11. EXPANDING THE SPACE GEOMETRY

It is generally assumed that in Maxwell's wave theory, the continuous wave concept imposes that both **E** and **B** fields must be *in phase* for the wave to exist and propagate. This is in fact the conception of Ludwig Lorenz that was widely adopted as he introduced the generalizing concept of the *Lorenz gauge*, that regroups both fields into a *single* electromagnetic field, an idea that Maxwell disagreed with because it distracts from continuous awareness that both fields have different vectorial orientations and other irreconcilable characteristics [29]. Contrariwise, the idea that the energy of localized electromagnetic quanta could exist, due to a self-sustaining reciprocating LC oscillation, imposes that both fields be 180^{o} "out of phase" for such an LC oscillation to be mechanically possible.

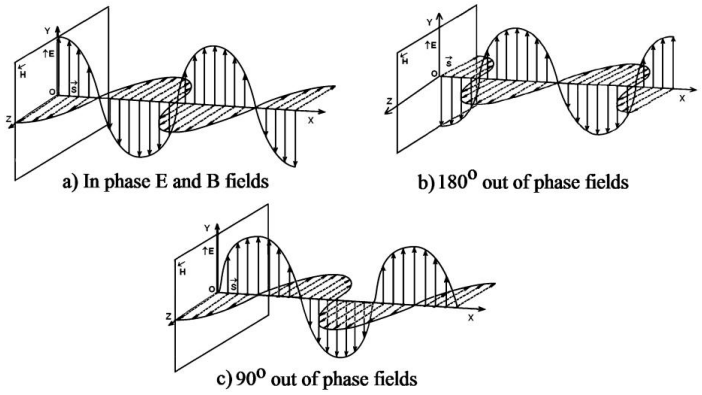

Fig. 2. Traditional representations of electromagnetic fields in phase, 180^{o} out of phase, and 90^{o} out of phase, in classical electromagnetism

A close examination of the graphic representations of electromagnetic theory phases as traditionally represented (Fig. 2) seems to reveals that both in phase alignment and 180° out of phase alignment result in the very same configuration. However, true 180° out of phase alignment (Fig. 3), although apparently incompatible with Maxwell's continuous electromagnetic wave theory, is perfectly allowed by his equations, with the electric phase reaching minimum while the magnetic phase reaches maximum and the reverse in a cyclic manner, which is effectively consistent with representing a self-sustaining electromagnetic quantum as a transverse reciprocating LC oscillating process in standing mode. Moreover, it is consistent with the very foundation of Maxwell's initial interpretation to the effect that both fields have to mutually induce each other for the energy to be correctly represented.

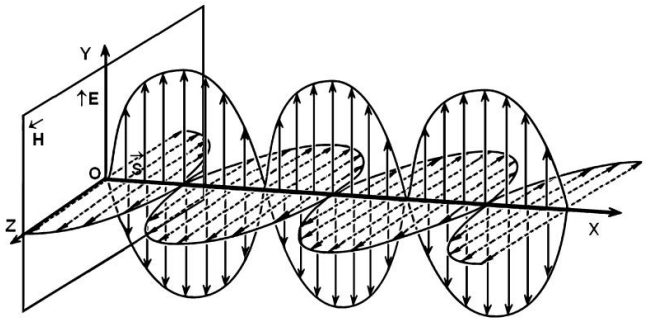

Fig. 3. 180° out of phase representation of E and B fields of Maxwell's theory for an LC oscillation

With regard to the mechanical impossibility that 2 half-quantities of a physically existing *substance* displaying *electric* properties as they close in on each other while at the same time concentrically accumulating as a single quantity that would display *magnetic* properties within the same volume of space, it is this very mechanical impossibility that gave rise to the idea that the solution could be for the magnetic quantity to *grow*, so to speak, into a different space while both charges were closing in towards each other within the first space, and inversely.

And without even going so far as to assume the real physical existence of such a second space, it so happens that from the vectorial perspective, it is rather easy to represent such a multi-spaces complex, and it is particularly easy to vectorially represent both **E** and **B** fields of the Δm_m magnetic mass half-quantum as transversely oscillating with respect to the direction of motion of the ΔK momentum half-quantum, in conformity with Maxwell's equations.

In this particular case, it so happens that the well known vectorial cross product of the magnetic **B** field vector and of the electric **E** field vector, both perpendicular to each other, resolving in a third vector perpendicular to the first two and representing the phase velocity (Fig. 4-a), which is the triple orthogonal relation that maps the direction of motion at the speed of light of any point of the wavefront of Maxwell's hypothetical spherically expanding continuous electromagnetic wave, gives us a solid footing to explore such a possibility.

The method consists in geometrically *exploding*, so to speak, each of the 3 standard electromagnetic vectors ***i***, ***j*** and ***k***, applicable to normal space into 3 full blown 3D vectorial spaces of their own (Fig. 4-b), each of the three X, Y and Z spaces (Fig. 4-c) remaining perpendicular to the other two, and all of them remaining connected via their common origin, previously identified as being midpoint ⊗ between a pair of charges in Fig. 1, and that can now be seen as a transit point for the energy, that would be located at the center of each electromagnetic elementary quantum, and through which the *substance* of the energy quantum would be free to travel as if between communicating vessels, according to their required transverse electromagnetic reciprocating motion, without the illogical interpenetration of the energy substance that would prevent such a reciprocating motion within the more limited frame of a single 3D space geometry.

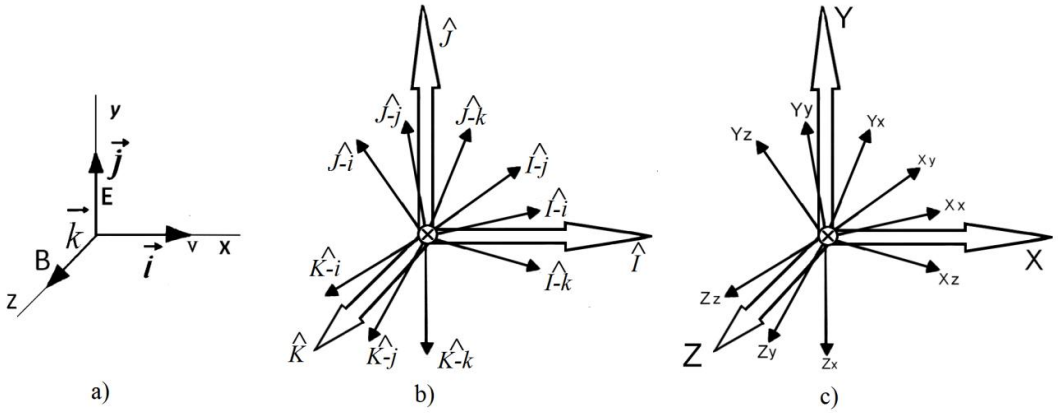

Fig. 4. Major and minor unit vectors sets applicable to the trispatial geometry

Contrary to expectation, it turns out to be relatively easy to mentally visualize such a trispatial mutually orthogonal 9-dimensional geometric complex. It suffices to imagine each of the 3 sets of minor vectors ***i***, ***j*** et ***k*** of Fig. 4-b as if they were folded metaphoric 3-rib umbrellas.

This allows us to mentally open at will any one of them, one at a time, to full 3-axes orthogonal extension to observe the behavior of the energy quantum substance in this fully deployed 3D space during each phase of the oscillating motion. Fig. 4-b and 4-c show the dimensions of the 3 spaces half deployed to allow clear unique identification of each of the 9 resulting orthogonal inner axes, which allows simple mathematical and vectorial identification of the inner motion of the energy within each space without changing nor invalidating in any way any of the traditional vectorial representations applied in the normal 4D space geometry to represent electromagnetic energy, in the traditional mechanics.

In this space geometry, the momentum energy that translationally propels elementary particles is unidirectional by definition, and is set by structure to be insensitive to any transverse interaction, which directly correlates with the lower transverse inertia of electrons moving at relativistic velocities in a bubble chamber observed by Walter Kaufman with respect to their longitudinal inertia [21]. From analysis of his data, he indeed measured that although the inertia of both half-quanta ΔK and Δm_m could be measured longitudinally in addition to the electron rest mass inertia, only the Δm_m half-quantum inertia could be measured transversely in addition to the electron rest mass inertia.

The same property will cause the pair of opposite signs *electric charges* of an electromagnetic quantum unidirectionally moving toward or away from each other on the Y-y/Y-z plane within Y-space to appear to be neutral with respect to the orthogonally oriented Y-x axis and to not even be detectable as perceived from normal X-space, which is the space from which we observe objective reality, which correlates with the observed fact that electromagnetic photons do not seem to possess electric charges [8,15], despite the physical incompatibility of such an absence with Maxwell's theory.

The same indetectability and apparent absence of opposite signs charges will characterize the pairs of *neutrinic charges* unidirectionally moving toward or away from each other on the X-y/X-z plane within X-space [16,17].

The fact that the pair of *electric charges* can only move in opposite directions on the Y-y/Y-z plane is what explains why photons can be polarized at any angle perpendicularly to their direction of motion along the X-x axis of normal X-space. Obviously, the same polarizability property will apply to the pair of *neutrinic charges* moving in opposite directions on the X-y/X-z plane.

Finally, any amount of energy now oscillating between Y and Z spaces finds itself oscillating transversely *by structure* with respect to normal X-space, and will thus appear to possess *omnidirectional inertia* as perceived from X-space, that is, will behave as if it was *massive* in the sense understood in classical/relativistic mechanics, as perceived from the X-space.

This expanded space geometry was first proposed at the Congress-2000 event held at the St Petersburg State University in July of 2000 [30]. It is introduced and put in perspective in reference [12] with respect to the traditional multidimensional geometries conceived of in previous historical attempts at resolving the remaining issues of fundamental physics, and is completely described in Reference [8].

12. FUNDAMENTAL SYMMETRY MAINTAINED BY STRUCTURE

One aspect of utmost interest of the trispatial geometry is that the fundamental principle of symmetry is respected by structure for all aspects of the distribution of the energy of an electromagnetic quantum.

The energy is systematically distributed between one half remaining unidirectional in one of the spaces while the other half cyclically oscillates in perpendicular orientation with respect to the first half by structure (half-half symmetry), which is what immediately reveals that in this space geometry, the speed of light can only be an invariant equilibrium velocity in vacuum in all cases of free moving electromagnetic photons, due to this half-half energy distribution mandated by structure between both half-quanta [8], as analyzed in the following section.

Within electrostatic Y-space where both electric charges – for free moving photons and carrier-photons – axially oscillate toward and away from each other [8,15], and within normal X-space where both neutrinic charges – for massive electron, positron, up quark and down quark (speaking only of the stable states) [16,17,18]) – also axially oscillate toward and away from each other in the same manner on the plane perpendicular to the space where their unidirectional complement resides, always symmetrically possessing equal amounts of energy and opposite directions, along which the varying distance between them, provide the corresponding varying intensity of the opposite signs of their charges (symmetry between the energy amounts and also between the intensities of the opposite signs of their charges within Y-space and X-space).

Within magnetostatic Z-space where a single quantity of the energy grows to maximum presence while leaving Y-space for photons and carrier-photons [8,15], or while leaving X-space for massive particles [16,17,18], this single quantity, after having reached maximum volume presence in Z-space, regresses toward zero presence in this space while the energy crosses over back into the Y-space – or X-space – it was in previously (symmetry between the increasing phase and the decreasing phase of the energy presence within magnetostatic Z-space).

In normal X-space, neutrino energy can be released only as identical pairs in opposite directions perpendicularly to the direction of motion of the unidirectional energy present in this space belonging to a newly created massive elementary particle – electron, muon or tau – that sheds in this manner an excess metastable initial excess amount of mass [16] (More on this issue later on).

Finally, global symmetry is also preserved since the time-varying space-wise moving electric dipole is permanently counterbalanced by a related time-varying growing and decreasing magnetic dipole oriented perpendicularly, both dipoles remaining perpendicular to the direction of motion of the photon in space, thus obeying the triple orthogonality required for plane wave treatment in Maxwell's theory's for straight line motion of electromagnetic energy [8].

13. THE SPEED OF LIGHT AS AN EQUILIBRIUM VELOCITY OF ELECTROMAGNETIC ENERGY

The hypothesis that the 3-spaces structure would be acting as a set of communicating vessels through the common central junction, defines this junction as offering zero resistance to the passage

of energy, which correlates with objective reality since it is well verified that no energy is lost during free moving energy electromagnetic oscillation when no external influence causes its frequency to vary, so this junction would always allow the energy of the photon to remain in some form of permanent equilibrium between the three spaces, an equilibrium that would constantly seek to keep the photon's energy split into two equal amounts between X-space and transverse YZ-spaces, even during energy losses or gains events related to red and blue shifting due to gravitational interaction.

When energy is lost by a photon as witnessed by a displacement towards the red of its frequency or gained as witnessed by a displacement towards the blue of its frequency, the half-half X vs YZ equilibrium would be maintained by the required amount of kinetic energy seeping through the X-YZ junction in the direction required to constantly restore this equilibrium. This would directly explain why all photons self-propel, so to speak, at the same constant *equilibrium* velocity, which is of course the speed of light [8].

14. RELATIVE REFERENCE FRAMES AND ABSOLUTE MOTION

Now, defining the speed of light as being an *equilibrium velocity* brings up the old issue of what this *equilibrium* constant velocity of photons in vacuum (free moving kinetic energy) would be relative to in reality. The century old line of research and development of concepts of motion *relative to observers* with all of its complexities has in fact its roots in the conclusion established at the beginning of the 20th century that it was impossible to demonstrate *absolute motion* in the universe [31]. The fundamental question that this method was meant to address is the following:

What is the motion of masses and energy relative to in physical reality?

Is it relative to some underlying medium? To the point of emission? To the point of absorption? To the observer? To this or that reference frame, or multiple reference frames, inertial, non inertial, Galilean, moving or not? etc.?

But the manner in which the present analysis reveals that kinetic energy is adiabatically induced in all charged particles leads to observe that they all can only be self-propelling according to the amount of ΔK momentum energy that they physically possess. So their motion, thus their velocity, can depend on only one criterion, which is the actual presence of their translational momentum ΔK kinetic energy component. As analyzed in Reference [8], if the local electromagnetic equilibrium state allows it, there will mandatorily be a velocity of the particle expressed in vacuum, irrespective of any hypothesized reference frame or frames.

Consequently, motion in the universe can be relative only to the constantly measurable amount of momentum energy that each charged particle locally possesses (in its own reference frame) at any given instant.

Traditionally, it is assumed that in its own reference frame an elementary particle such as an electron or a photon has no velocity, which implies, according to the classical concepts that its momentum would fall to zero. But the current analysis confirms that from the electromagnetic perspective, the ΔK and Δm_m *carrying energy* components of the particle have permanent existence as a *physically existing substance* [8], which means that from the very particle's structure and its continuously varying amount of its ΔK and Δm_m energy components, the state of *absolute motion* of the particle can be continuously determined within its own inertial reference frame for both a massive elementary particle such as the electron and electromagnetic photons.

Moreover, from within the particle's reference frame, the variations over time of the total amount of an electron's carrying energy at any given instant as can be continuously calculated with Equation (13) will reveal its state of *absolute motion* with respect to its environment, and therefore *its state of absolute motion in the universe*. For example, rapid increases and decreases of it total amount of carrying energy will reveal that it is stabilized in some axial stationary action resonance state such as an electronic orbital in an atom. Slow increases and decreases of its maximum amount of carrying

energy over longer periods of time will reveal that it belongs to an atom which is part of a macroscopic mass stabilized on an elliptic macroscopic orbit in some planetary system, and so on.

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

The absolute upper velocity limit involving electromagnetic oscillation is reached when a ΔK amount of translational kinetic energy propels an equal amount of Δm_m kinetic energy captive in transverse electromagnetic oscillation, that is, a free moving electromagnetic photon. Its well known velocity of *c* is the speed of light, that can be calculated with Equation (43), when *E*, the energy making up the invariant rest mass of the carried charged particle, is set to zero, as established with Equation (44).

The only other possible case between these two limits involving electromagnetic oscillation, applies to an amount of kinetic energy captive in transverse electromagnetic oscillation being propelled by a lesser amount of translational kinetic energy, such as the kinetic energy making up the m_0c^2 rest mass of an electron, plus the transversely oscillating $\Delta m_m c^2$ half of its carrier-photon's kinetic energy, both quantities being propelled by the ΔK unidirectional half of the carrier-photon's quantum of kinetic energy. The velocity of such a system will mandatorily lie between zero and asymptotically close to the speed of light, a process whose mechanics is described in Reference [22], and can be calculated with both Equation (35) and Equation (43).

Finally, the remaining case of kinetic energy whose motion seems not to involve any transverse electromagnetic oscillation and for which there consequently also seems not be any limiting factor on the velocity is the case of escaping neutrino energy, whose mechanics of liberation in the trispatial model is described in Reference [16].

15. THE TRISPATIAL PHOTON EQUATION

The first inner electromagnetic structure that the trispatial geometry allowed defining was that of the localized photon that de Broglie concluded could not be defined within the too restrictive confines of 3D space [8], and that graphically shows with Fig. 5 the transverse harmonic oscillation sequence of the energy of the photon as represented with Equation (46).

Fig. 5 indeed allows visually representing the complete time varying sequence of the transverse oscillation of the energy of the electromagnetic half-quantum within the trispatial complex. Fig. 5-a shows both inner opposite charges, measurable as generating the **E** field of the photon when reaching their maximum value, after having reached maximum transverse distance within electrostatic Y-space, followed by Fig. 5-b showing the energy of both charges transferring to magnetostatic Z-space.

Then comes Fig. 5-c showing the energy of both charges having completely entered Z-space in omnidirectional expansion, now measurable as generating the **B** field of the photon at its maximum value, followed by Fig. 5-d showing the energy of the single magnetic component transferring back into electrostatic Y-space. Finally, the final Fig. 5-a shows all of the magnetic energy having transferred back into Y-space as two opposite charges having reached again maximum transverse distance, and again measurable as the **E** field of the photon, ready for the next cycle to begin.

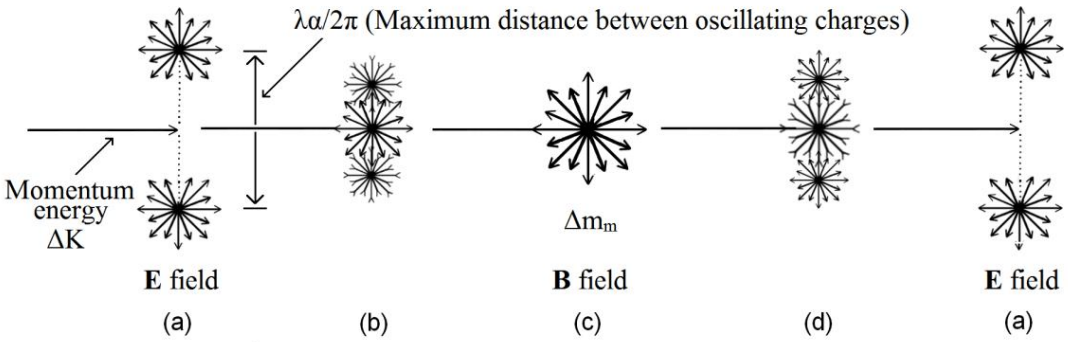

Fig. 5. Complete time varying cycle of the energy in transverse oscillation of the electromagnetic half-quantum of the double-particle photon while its momentum sustaining unidirectional half-quantum propels it translationally

As mentioned previously, the double-particle photon concept is an original idea of Louis de Broglie, and the complete analysis of its elaboration in the trispatial geometry is available in reference [8], where the complete development of its trispatial LC equation was elaborated from the inductance and capacitance representations of electromagnetic energy:

$$E\vec{I}\vec{i} = \left(\frac{hc}{2\lambda}\right)_X \vec{I}\vec{i} + \left[\begin{array}{l} 2\left(\frac{e^2}{4C}\right)_Y (\vec{J}\vec{j}, \vec{J}\overleftarrow{j})\cos^2(\omega t) \\ +\left(\frac{L\,i^2}{2}\right)_Z \overleftrightarrow{K}\sin^2(\omega t) \end{array}\right] \tag{48}$$

and also of the same LC formulation making use of the more familiar **E** and **B** fields defined with equations (23):

$$E\vec{I}\vec{i} = \left(\frac{hc}{2\lambda}\right)_X \vec{I}\vec{i} + \left[\begin{array}{l} 2\left(\frac{\varepsilon_0 \mathbf{E}^2}{4}\right)_Y (\vec{J}\vec{j}, \vec{J}\overleftarrow{j})\cos^2(\omega t) \\ +\left(\frac{\mathbf{B}^2}{2\mu_0}\right)_Z \overleftrightarrow{K}\sin^2(\omega t) \end{array}\right] V \tag{49}$$

in which volume V is the theoretical stationary isotropic volume that the incompressible oscillating kinetic energy of the photon would occupy if it was immobilized as a sphere of isotropic density, as derived in reference [14]:

$$V = \frac{\alpha^5}{2\pi^2}\lambda^3 \tag{50}$$

16. THE TRISPATIAL ELECTRON EQUATION

It is well established that electromagnetic photons of 1.022 MeV or more can be destabilized into converting to an electron-positron pair [17]. However, it so happens that all of the energy making up the two 0.511 MeV/c^2 rest masses of both the electron and the positron is electromagnetic in nature and thus reside within Y-space and Z-space in the new trispatial geometry, while the half-quantum of the whole initial quantum of a 1.022 MeV photon that resides in X-space before decoupling is vectorially unidirectional by definition and consequently displays only longitudinal inertia by structure in the trispatial geometry complex. This means that Nature has found some way to force this ΔK

unidirectional momentum energy to re-orient transversely for it to display omnidirectional inertia as it becomes part of the electromagnetic mass of both emergent massive particles.

One of the most interesting features of the trispatial geometry is that it effectively allows establishing a clear mechanical process by which this ΔK unidirectional energy of the half-quantum sustaining the momentum of a moving electromagnetic photon of 1.022 MeV can cross over into the orthogonal electrostatic Y-space and magnetostatic Z-space during the decoupling process, and so acquire the transverse orientation property that characterizes the complete mass energy of both electron and positron of the pair resulting from the separation process in the trispatial geometry [17].

By the same token, the very mechanics of transfer of this momentum energy into Y-space to end up defining the invariant unit charge of both electron and positron, also forces by structure the other half of the energy of each particle of the pair in process of separation to now start oscillating between Z-space and X-space for the symmetric energy distribution be maintained in the trispatial complex, resulting in the establishment of a double component state within X-space separating in a manner identical to the behavior of the pair of *electric charges* of the photon within Y-space, that are traditionally represented by e^2, but that now require to be identified with a new symbol since they cannot have the *electric* characteristic anymore, that belongs by definition only to energy present in Y-space, in this trispatial complex. Pending clear identification, the first-draft symbol that best fitted them was then $(e')^2$.

As we will see further on, deeper analysis succeeded in relating these double $(e')^2$ *non-electric charges* to the emission of neutrinos, which is what earned them the name of *neutrinic charges* in the subsequent descriptions [16,17].

The following trispatial LC equations were then defined to describe the corresponding inner trispatial energy structure of the invariant rest mass of the electron and positron:

$$\mathrm{E}\vec{\mathbf{0}} = \mathrm{m_e c^2}\,\vec{\mathbf{0}} = \left[\frac{\mathrm{H}}{2\lambda_C}\right]_Y \vec{\mathbf{J}}\,\vec{\mathbf{i}} + \left(\begin{array}{l} 2\left[\frac{(e')^2}{4C_C}\right]_X (\vec{\mathbf{I}}\,\vec{\mathbf{j}}, \vec{\mathbf{I}}\,\vec{\mathbf{j}})\cos^2(\omega t) \\ + \left[\frac{L_C i_C{}^2}{2}\right]_Z \overleftrightarrow{\mathbf{K}} \sin^2(\omega t) \end{array}\right) \tag{51}$$

and

$$\mathrm{E}\vec{\mathbf{0}} = \mathrm{m_e c^2}\,\vec{\mathbf{0}} = \left[\frac{\mathrm{H}}{2\lambda_C}\right]_Y \vec{\mathbf{J}}\,\vec{\mathbf{i}} + \left(\begin{array}{l} 2\left[\frac{(e')^2}{4C_C}\right]_X (\vec{\mathbf{I}}\,\vec{\mathbf{j}}, \vec{\mathbf{I}}\,\vec{\mathbf{j}})\cos^2(\omega t) \\ + \left[\frac{L_C i_C{}^2}{2}\right]_Z \overleftrightarrow{\mathbf{K}} \sin^2(\omega t) \end{array}\right) \tag{52}$$

Subsequent reformulation of the same LC equations making use of the more familiar **E** and **B** fields defined with equations (23) then forced the identification of the $(e')^2$ component pairs as being *neutrinic charges* ($\mathbf{v}^2$) in references [16,17] for reasons that will soon become obvious:

$$\mathrm{m_0}\,\vec{\mathbf{0}} = \frac{\mathrm{V_m}}{\mathrm{c^2}}\left\{\left[\frac{\varepsilon_0 \mathbf{E}^2}{2}\right]_Y \vec{\mathbf{J}}\,\vec{\mathbf{i}} + \left[\begin{array}{l} 2\left(\frac{\varepsilon_0 \boldsymbol{\nu}^2}{4}\right)_X (\vec{\mathbf{I}}\,\vec{\mathbf{j}}, \vec{\mathbf{I}}\,\vec{\mathbf{j}})\cos^2(\omega t) \\ + \left(\frac{\mathbf{B}^2}{2\mu_0}\right)_Z \overleftrightarrow{\mathbf{K}} \sin^2(\omega t) \end{array}\right]\right\} \tag{53}$$

where **v** (Greek letter **nu**) represents the *neutrinic* field equation [16,17] that now represents the double *neutrinic charges* whose energy calculation is identical to that of the electric **E** field equation, but that now oscillate in opposite directions on the X-y/X-z plane of X-space, within the trispatial

energy structure of elementary massive particles' masses in equations (51) and (52), just like the *electric charges* oscillate in opposite directions on the Y-y/Y-z plane of Y-space, within the photon or carrier-photon trispatial energy structure [8,15] in Equations (48) and (49). Here are the definitions of the required isotropic volume and of the neutrinic field:

$$V_m = \frac{\alpha^5 \lambda_C^{\,3}}{2\pi^2} \quad \text{and} \quad \nu = \frac{\pi(e')}{\varepsilon_0 \alpha^3 \lambda_C^{\,2}} \tag{54}$$

where $(e')^2$ is assigned the same numerical value grounded on the value of the unit electric charge e = 1.602176462E-19, since a pair of such components represents by structure the same maximum amount of energy in the trispatial electron structure, that is, half the rest mass of the electron when reaching maximum distance from each other within X-space when it splits into two equal quantities.

Modelled on Equation (49) for the free moving photon, the equation for the electron carrier-photon making use of **E** and **B** fields can now be formulated as follows, providing the same energy as the corrected classical relativistic kinetic Equation (13):

$$E_K \vec{\mathbf{I}}\,\vec{\mathbf{i}} = \left[\frac{hc}{2\lambda}\right]_X \vec{\mathbf{I}}\,\vec{\mathbf{i}} + \left[\begin{array}{l} 2\left(\frac{\varepsilon_0 \mathbf{E}_K^{\,2}}{4}\right)_Y (\vec{\mathbf{J}}\,\vec{\mathbf{j}}, \vec{\mathbf{J}}\,\overleftarrow{\mathbf{j}})\cos^2(\omega t) \\ + \left(\frac{B_K^{\,2}}{2\mu_0}\right)_Z \overleftrightarrow{\mathbf{K}} \sin^2(\omega t) \end{array}\right] V_K \tag{55}$$

which now allows representing the combined fields equations of the electron and its carrying energy as in Table 1.

Table 1. Combined fields equations of the moving electron and its carrier-photon

	Momentum kinetic energy in X-Space (normal space)	**Energy located in Y and Z spaces making up the translationally inert mass of the particle in motion**
Rest mass energy (m_oc^2)		$\left\{\left(\frac{\varepsilon_0 \mathbf{E}_e^{\,2}}{2}\right)_Y \vec{\mathbf{J}}\,\vec{\mathbf{i}} + \left(\frac{\mathbf{B}_e^{\,2}}{2\mu_0}\right)_Z \overleftrightarrow{\mathbf{K}}\right\} V_{me}$
Carrying energy $\Delta K + \Delta m_m c^2$	$\left(hc/2\lambda\right)_X \vec{\mathbf{I}}\,\vec{\mathbf{i}}$	$\left[\left(\frac{\mathbf{B}_K^{\,2}}{2\mu_0}\right)_Z \overleftrightarrow{\mathbf{K}}\right] V_K$
Total Relativistic mass energy (mc^2)		$\left[\begin{array}{l} \left\{\left(\frac{\varepsilon_0 \mathbf{E}_e^{\,2}}{2}\right)_Y \vec{\mathbf{J}}\,\vec{\mathbf{i}} + \left(\frac{\mathbf{B}_e^{\,2}}{2\mu_0}\right)_Z \overleftrightarrow{\mathbf{K}}\right\} V_{m_e} \\ + V_K \left(\frac{\mathbf{B}_K^{\,2}}{2\mu_0}\right)_Z \overleftrightarrow{\mathbf{K}} \end{array}\right]$

In fact, the carrier-photon provides the electron with the ambient **E** and **B** fields that permanently determine its velocity and direction of motion, when they can be expressed, in accordance with the Lorentz equation **F** = q(**E** + **v** x **B**) previously mentioned. More precisely, it constantly obeys the triple orthogonal relation **v=E/B** stemming from the Lorentz equation imposed to it by the **E** and **B** fields of its carrier-photon, whose intensity determines its velocity, and whose relative densities equilibrium determine its trajectory, default equal densities of both **E** and **B** fields resulting in straight line motion of the electron [14].

In turn, the **B** field of the electron carrier-photon constantly tends to align its relative magnetic polarity orientation, that is, its relative *magnetic spin* orientation, in least action antiparallel alignment with respect to the **B** field of the rest mass energy of the electron that it carries, and the combined resultant of which constantly tends to align in a least action antiparallel orientation with respect to the resultant of the **B** fields of the surrounding particles, thus with respect to the ambient macroscopic **B** field resulting from the addition of the surrounding **B** fields.

Given that the half-quantum ΔK momentum energy of the carrier-photon is immovably oriented perpendicularly to the **B** field of its own complementary electromagnetic mass increment Δm_m, the direction of motion of this unidirectional momentum energy is systematically determined by the orientation of its **B** field.

It is this immovable orthogonal relation that explains why unpaired electrons in ferromagnetic materials can be forced to align their spins parallel to each other against the default natural least action best fit antiparallel mutual orientation possible with respect to an ambient macroscopic magnetic **B** field, which is what can force their individual momentum ΔK energies to align in the same direction and add up to cause a macroscopic object such as the cylinder of the Einstein-de Haas experiment to rotate [32], or reciprocally, this is why when the unidirectional ΔK momentum energies of the carrier-photons of unpaired electrons in the ferromagnetic rod of the Barnett experiment are forced to align parallel to each other by mechanically forcing the rod to rotate, their individual **B** fields are also forced to align in parallel spin orientation, and add up to become measurable at our macroscopic level [32].

17. NEUTRINO EMISSION IN THE TRISPATIAL GEOMETRY

Interestingly, the trispatial geometry allows establishing for the first time a mechanical explanation to the emission of neutrinos. This particular solution emerges from the mandatory LC structure of elementary electromagnetic quanta in the trispatial geometry.

From this perspective, given that it is well verified that the electric charge of newly created particles *mu* and *tau* remains invariant at the same unit value as that of the electron, it can be concluded from the viewpoint provided by the trispatial geometry that the energy corresponding to the metastable excess mass that these two particles display cannot enter Y-space, because any energy increase in this space would cause by structure an increase in the value of their electric charge, which we know experimentally never to occur.

Given that they are massive just like the electron, meaning that their complete complement of invariant energy displays omnidirectional inertia like that of the electron, they can only have by structure the same LC inner structure as the electron in the trispatial geometry. This involves that this excess energy can exist only as a metastable increase of the energy quantum that oscillates between Z-space and X-space. In retrospect, the same conclusion can be hypothesized for an electron newly created by β- decay, which would modify the trispatial LC rest mass Equation (53) of the electron in the following manner. To simplify equations representations, we will do away from now on with the now well established unit vectors notation:

$$m_{0+} = \left\{ \left[\frac{\varepsilon_0 \mathbf{E}^2}{2} \right]_Y + \left[\begin{array}{l} 2\left(\frac{\varepsilon_0 \left(\nu_e + \nu' \right)^2}{4} \right)_X \cos^2(\omega t) \\ + \left(\frac{\left(\mathbf{B}_e + \mathbf{B}' \right)^2}{2\mu_0} \right)_Z \sin^2(\omega t) \end{array} \right] \right\} \frac{V_m}{c^2} \tag{56}$$

where $\mathbf{m_{0+}}$ represents a slightly increased rest mass of the electron, and **v'** and **B'** represent the slight energy increment that now momentarily oscillates between normal X-space and magnetostatic Z-space in momentary metastable excess energy with respect to the normal stable electron rest mass

energy. This solution allows the electron electric field **E** to remain unchanged in conformity with observation.

Since this β- decay electron possesses slightly more energy than the well known invariant rest mass the electron, it seems quite possible that as it is in the process of leaving the destabilized neutron structure, the extreme destabilizing tensions due this initial proximity could force the electron's two neutrinic energy quanta into a violent translational motion about the X-x axis on the X-y/X-z plane, that would free the two excess half-quantities momentarily in excess, causing them to escape into normal X-space in opposite directions on this X-y/X-z plane perpendicularly to the direction of motion of the electron, while the two rest energy neutrinic quantities of the oscillating half-quantum of the electron recover their usual to and fro oscillation inside the inner electron structure, that now has reached its lowest possible energy level an henceforth invariant rest mass as represented with Equation (53).

$$m_{0+} \rightarrow m_0 + \nu_e + \overline{\nu}_e \tag{57}$$

In the trispatial geometry, the muonic and tauic neutrinos emission would obviously follow the same pattern:

$$m_{0+} = \mu^- = \left\{ \left[\frac{\varepsilon_0 \mathbf{E}_e{}^2}{2} \right]_Y + \left[2\left(\frac{\varepsilon_0 (\nu_e + \nu_\mu)^2}{4} \right)_X \cos^2(\omega t) + \left(\frac{(\mathbf{B}_e + \mathbf{B}_\mu)^2}{2\mu_0} \right)_Z \sin^2(\omega t) \right] \right\} \frac{V_m}{c^2} \tag{58}$$

$$m_{0+} = \tau^- = \left\{ \left[\frac{\varepsilon_0 \mathbf{E}_e{}^2}{2} \right]_Y + \left[2\left(\frac{\varepsilon_0 (\nu_e + \nu_\tau)^2}{4} \right)_X \cos^2(\omega t) + \left(\frac{(\mathbf{B}_e + \mathbf{B}_\tau)^2}{2\mu_0} \right)_Z \sin^2(\omega t) \right] \right\} \frac{V_m}{c^2} \tag{59}$$

Resulting in similar mu and tau neutrinos emissions:

$$m_{0+} = \mu^- \rightarrow m_0 + \nu_\mu + \overline{\nu}_\mu \quad \text{and} \quad m_{0+} = \tau^- \rightarrow m_0 + \nu_\tau + \overline{\nu}_\tau \tag{60}$$

Of course, β+ decay, anti-muon and anti-tau will result in identical neutrino emissions, leaving behind a single positron instead of an electron.

The fact that both neutrinos produced during each emission can only be released as an identical pair moving in opposite directions perpendicularly to the direction of motion of the emitting particle, makes it impossible for neutrinos produced by decaying muons coming in direct line from the Sun's surface in the general direction of the detector to be detected since they escape and move on planes perpendicular to the Sun-detector axis.

So according to the trispatial characteristics of neutrino emission, the only neutrinos/antineutrinos that can possibly be detected originating from the Sun will be a small fraction of those released by decaying muons in motion on a plane perpendicular to the Sun-detector axis, that is, mainly neutrinos emitted at the outside limits of the visible disk of the Sun, which is a conclusion that would go a long way in explaining why their detection rate has consistently remained so far below what current theories predict.

This conclusion could easily be verified experimentally by focusing detection equipment directly to the circumference of the solar disk.

Finally, since they escape as simple momentum related unidirectional kinetic energy amounts in X-space, deprived of the complementary transverse electromagnetic component oscillating between Y-space and Z-space that explains omnidirectional inertia as perceived from normal X-space, that is *electromagnetic mass*, as well as *electric charge*, for all electromagnetic elementary particles in the trispatial geometry, this provides a clear explanation of why no mass nor charges were ever detected for them in all experiments in which they were involved.

18. UP AND DOWN QUARKS IN THE TRISPATIAL GEOMETRY

The last stable elementary particles that need to be examined before resonance states in atoms can be addressed are the up and the down quarks that have been confirmed to be the only scatterable point-like behaving electromagnetic charged massive elementary subcomponents that can be identified in protons and neutrons, during extensive non-destructive scattering experiments carried out from 1966 to 1968 at the SLAC facility [12,18,33].

The trispatial mechanics of creation of protons and neutrons from the only two possible combinations of triads of electrons and positrons interacting in close enough proximity without sufficient momentum energy to escape each others' mutual capture is described in reference [18].

Given that up and down quarks systematically display the same point-like behavior as electrons and positrons during all such scattering experiments with electrons or positrons, it has long been suspected in the community that these up and down quarks making up the inner scatterable structure of nucleons could possibly be positrons and electrons whose masses and charge characteristics would be warped into these potentially altered states by the stresses imposed on them by these most energetic least action equilibrium states that these particles can naturally reach in Nature [12,18,10].

This possibility immediately brings to light a possible explanation to the observed fact that no up or down quark could ever be observed moving separately in space after having been scattered out of a nucleon by sufficiently energetic scattering. Indeed, if they are electrons and positrons whose characteristics are warped into those observed for the up and down quarks, by their intensely stressed nucleonic electromagnetic environments, they would of course immediately recover their normal electron or positron characteristics as soon as they escape from these warping stresses.

The specific electron and positron characteristics that would be warped out of skew by these intense stresses are first of all their masses, which have been experimentally determined to lie between 1 and 5 MeV/c^2 for the up quark and between 3 and 9 MeV/c^2 for the down quark, and their electric charges that have been determined to be 2/3 of the charge of the positron for the up quark, and 1/3 the charge of the electron for the down quark ([34], p. 382).

It so happens that the trispatial geometry allows defining a clear mechanics of creation of nucleons from the only two possible combinations of triads of electrons and positrons, which provides a logical explanation to these stress induced changes in characteristics, and also on the nature of these electromagnetic stresses [18].

In the trispatial geometry, the mass and charge of stable elementary particles vary as an inverse function of each other as a function of their distance from the coplanar Y-z axis within electrostatic Y-space [12,18].

The distance from the Y-z axis within Y-space at which an electron-positron pair decouples from a destabilized 1.022 MeV photon is by structure 3.861592641E-13 m [17], which corresponds to the electron *classical radius* divided by the fine structure constant ($r'=r_e/\alpha$).

At this distance from the Y-z axis, its charge exactly corresponds to the well known unit charge of 1.602176462E019 C and its mass to 9.10938188E-31 kg. These values well established

experimentally allow determining the corresponding values for the up and down quarks masses as in Table 2 [18], which fall precisely within the experimentally estimated limits for these masses.

Table of the effective charges and masses of the electron, the up quark and the down quark, estimated on the assumption that the unit charge of the electron would be the amount of charge induced at the distance from the Y-z axis at which electron-positron pairs separate during the pair production process.

Table 2. Relation between up and down quarks charges and masses with respect to their distance from the Y-z axis within electrostatic Y-space

Particle	$r' = r_e/\alpha$	Charge	Mass
Electron	r'_e = 3.861592641E-13 m	1.602176462E-19 C	9.10938188E-31 kg
Up quark	r'_{eu} = 2.574395094E-13 m	1.068117641E-19 C	2.04961092E-30 kg
Down quark	r'_{ed} = 1.287197547E-13 m	5.340588207E-19 C	8.19844378E-30 kg

This allows establishing the following general equation to calculate the effective invariant masses of the only three stable massive and electrically charged elementary electromagnetic particles, which are behaving point-like in all scattering encounters, and are the only electromagnetic elementary sub-components of all atoms in existence in the universe, by means of *the electrostatic energy induction constant* K=1.220852596E-38 j·m^2 established from the Coulomb equation in references [12,17,18]. Of course, the positron can be considered as being identical to the electron except for the sign of its charge.

$$m_{i[d,u,e]} = K\left(\frac{3\alpha}{nr_0 c}\right)^2 \qquad (n = 1,2,3) \tag{61}$$

In the trispatial geometry, this lessening of the charges of the up and down quarks due to the electromagnetic stresses that they are subjected to inside nucleons cannot occur however without being compensated by an increase of the magnetic field of the particle and of its carrier-photon, as demonstrated for the magnetic drift suffered by the electron carrier-photon energy, even as far from the proton as the mean distance at which it stabilizes when in the ground state of the hydrogen atom [23].

Given that the up and down quarks stabilize at such precise relative distances from the Y-z axis in the trispatial geometry, it becomes possible to establish their magnetic drift constants from these distances:

$$S_U = \frac{r'_{eu}}{r'_e} = \frac{2}{3} \qquad \text{and} \qquad S_D = \frac{r'_{ed}}{r'_e} = \frac{1}{3} \tag{62}$$

Table of the energies and wavelengths of the effective masses of the up and down quarks, estimated on the assumption that the unit charge of the electron would be the amount of charge induced at the distance from the Y-z axis at which electron-positron pairs separate during the pair production process.

Table 3. Energies and wavelengths of the rest masses of the up and down quarks

Particle	$r' = r_e/\alpha$	$E = K / r^2$	$\lambda = hc/E$
Electron	r'_e = 3.861592641E-13 m	0.5109989027 MeV	2.426310215E-12 m
Up quark	r'_{eu} = 2.574395094E-13 m	1.149747531 MeV	1.078360096E-12m
Down quark	r'_{ed} = 1.287197547E-13 m	4.598990173 MeV	2.69590021E-13 m

These magnetic drift constants and wavelengths now allow establishing the trispatial LC equations of both up and down quarks:

$$m_U = \frac{E_U}{c^2} = \frac{1}{c^2}\left\{ \begin{array}{l} S_U\left[\frac{hc}{2\lambda_U}\right]_Y \\ +(2-S_U)\left[\begin{array}{l} 2\left(\frac{(e')^2}{4C_U}\right)_X \cos^2(\omega t) \\ +\left(\frac{L_U {i_U}^2}{2}\right)_Z \sin^2(\omega t) \end{array} \right] \end{array} \right\} \tag{63}$$

$$m_D = \frac{E_D}{c^2} = \frac{1}{c^2}\left\{ \begin{array}{l} S_D\left[\frac{hc}{2\lambda_D}\right]_Y \\ +(2-S_D)\left[\begin{array}{l} 2\left(\frac{(e')^2}{4C_D}\right)_X \cos^2(\omega t) \\ +\left(\frac{L_D {i_D}^2}{2}\right)_Z \sin^2(\omega t) \end{array} \right] \end{array} \right\} \tag{64}$$

The carrier-photon of each up and down quark within nucleons would of course have the same internal trispatial LC structure as that of the electron carrier-photon, that is, that shown with Equation (55), and would relate to its carried particle in the same manner, as described in Table 1 for the electron in motion, the only differences being the immensely higher energy levels that these nucleonic carrier-photons reach, and the amount of magnetic drift that they themselves suffer from the stress imposed by the nucleonic electromagnetic environment [18].

This relation between each up quark and each down quark with each its own carrier-photon makes them amenable to being represented by the wave function in a manner similar to that of the electron in the hydrogen ground state, as we will see further on.

19. PARALLEL AND ANTI-PARALLEL RELATIVE MAGNETIC SPIN ORIENTATIONS

In Quantum Mechanics (QM), the concept of *spin* is so weakly related to the magnetic field that although it is technically associated to the magnetic moment of charged particles, even this magnetic moment is seen by most in the community as a simple mechanical angular momentum (Sz=±½ħ) with no clear reminder that it very specifically concerns the relative magnetic polarities orientation, either parallel or anti-parallel of the magnetic fields of elementary electromagnetic quanta relative to each other. For all practical purposes, it is perceived as a mechanical "spinning motion" in two possible transverse directions perpendicularly to the direction of motion in the classical mechanics sense, with no real relation with electromagnetism.

However, the very idea of a *magnetic spin* of elementary particles being akin to the classical/relativistic mechanics concept of *angular momentum* directly clashes with the experimentally confirmed fact previously mentioned that no unbreachable limit was ever detected at any distance from electrons' centers, however close two electrons came to each others' centers during absolutely all scattering encounters, because the very idea of an *angular momentum* implies the existence of a volume that can rotate, which is meaningless in the case of an elementary electromagnetic quantum such as the electron, for which no volume can be measured since it systematically behaves point-like in all scattering encounters.

The disconnect between the QM concept of *spin* and the physical relative polar magnetic orientations of elementary electromagnetic quanta is so important that many remain convinced that *spin* would be an *intrinsic* angular momentum property of particles, instead of what it can only be, that is a *relative*

property that remains meaningless unless at least two electromagnetic quanta are involved, which is the uncircumventable condition for the very ideas of *magnetic parallel orientation* and *magnetic antiparallel orientation* to even make any sense.

The fact that two electrons succeed so easily in associating in a very strong and intimate least action antiparallel magnetic spin covalent bound to unite two hydrogen atoms into an H_2 molecule despite their electric repulsion function of the inverse square of the distance, reveals that an interaction law of a higher order than the inverse square Coulomb force is simultaneously at play to so easily initiate and maintain such a powerful least action magnetic covalent bound between two electrons.

Interestingly, experiments carried out as recently as 2014 by Kotler et al. [35] experimentally demonstrated that the interaction law involved, when 2 electrons are forced to interact in parallel magnetic spin alignment, is the inverse cube interaction law function of the distance, which is the interaction that overcomes the inverse square repulsion Coulomb law when two electrons are forced to come sufficiently close to each other in antiparallel magnetic spin alignment. The relation between these two interaction laws is described in Fig. 6.

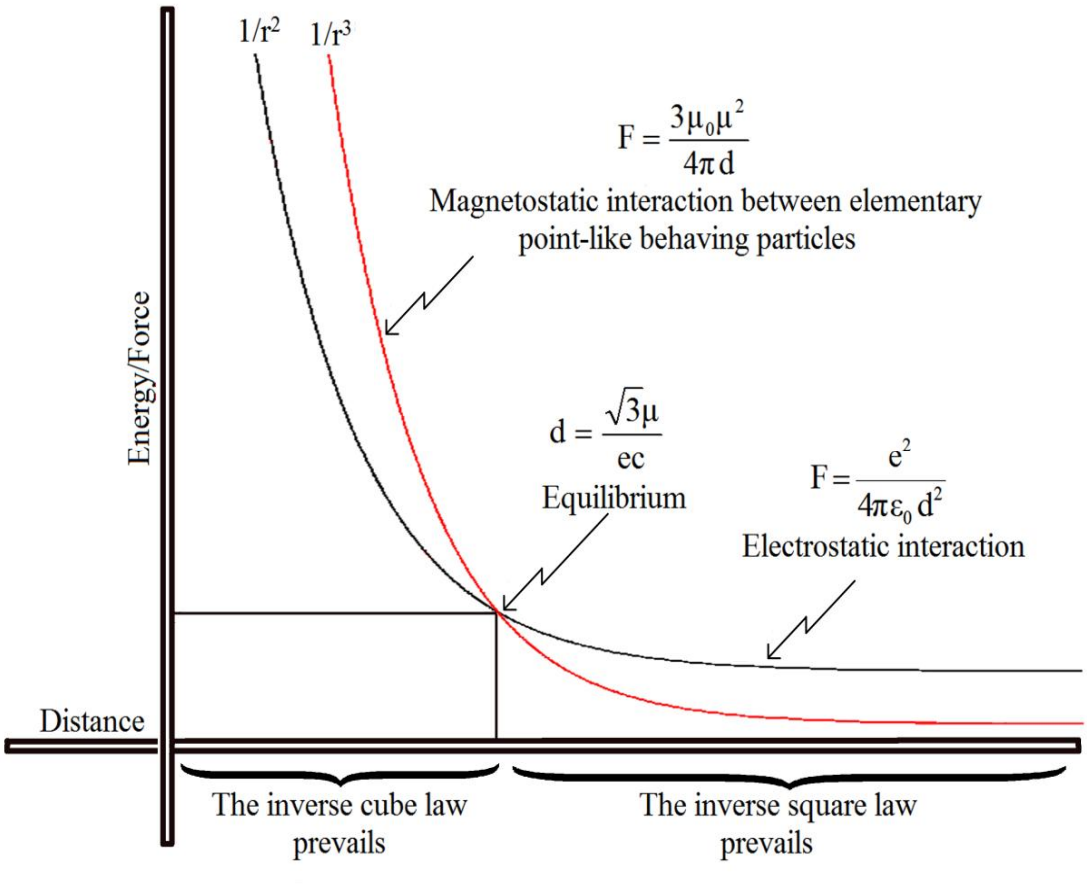

Fig. 6. Intersecting inverse square and inverse cube interaction curves

Also, an experiment carried out in 1998 already confirmed this magnetic interaction function of the inverse cube law between magnets having the same magnetic field configuration as that of elementary electromagnetic quanta, which is the experiment that allowed analyzing the oscillating nature of the magnetic energy when forced into this configuration that was revealed by the experiment, and which is applicable by similarity to localized electromagnetic quanta in the trispatial geometry [36], and finally, that brought to light the fact that the magnetic fields of elementary

electromagnetic quanta can only behave at any given moment as magnetic monopoles that constantly reverse their polarity as a function of time according to their energy frequency [11].

This conclusion finally brings to attention the key function of the relative frequency ratios existing between elementary electromagnetic quanta in explaining why two electrons can so easily magnetically stabilize in covalent bound despite their repelling same electric charges signs, due the ratio 1:1 of the synchronous frequencies of the spherical expansion and regression of their respective magnetic energies presence; also why an electron and a positron captive in metastable positronium configuration can combine to convert to electromagnetic photon states precisely due to the ratio 1:1 of their synchronous magnetic reversal frequencies combined with their attracting opposite electric charges signs [11]; and finally why an electron and a proton can so systematically magnetically repel each other to end up stabilizing at the known electron ground state orbital mean distance despite their attracting opposite electric charges signs [11,36], due to the asynchronous frequencies ratio of the spherical expansion and regression of their magnetic energy presence, whose mechanics was summarily analyzed in references [10,11,36], and that will be analyzed in more details further on in relation with the resulting resonance states.

But let us first analyze how the asynchronous magnetic interaction between the invariant frequency of the energy of the electron rest mass and the variable frequency of the energy of its carrier-photon allow both quanta to define the irregular resonance state known under the name of zitterbewegung of the electron in motion.

20. ZITTERBEWEGUNG

Considering Table 1 again that puts in perspective the fact that the electron in motion involves two different energy quanta, that not only electromagnetically oscillate at different frequencies, but whose harmonic oscillation centers ⊗ can only be physically separated by structure on a plane transverse to the direction of motion of the system in space (See Fig. 7).

Comparing electron rest mass Equation (53) with its carrier-photon Equation (55) indeed shows that each quantum possesses its own trispatial junction ⊗, which are separated by structure from the simple fact that their energy oscillates between different pairs of spaces in the trispatial complex, that of the electron oscillating between Z-space and X-space, while that of its carrier-photon oscillates between Z-space and Y-space, besides oscillating at different frequencies. This means that except for the case when the carrier-photon would possess exactly 0.511 MeV of energy, both components of the electron in motion are physically unable to associate in exactly synchronized attractive relative anti-parallel magnetic spin alignment, which highlights the contrast between these predictable and measurable asynchronous resonance interactions, and the unpredictable spontaneous stochastic fluctuations of the zero point energy level of QFT currently assumed to be responsible for zitterbewegung.

In reality, any difference in frequency between both components can only force both trispatial junctions to follow oscillating trajectories that may appear erratic transversely with respect to the direction of motion of the twin component system, due to the uninterrupted asynchronous sequence of cyclic alternance between attractive anti-parallel spin alignment states and repulsive parallel spin alignment states, which can only generate the resonance state that came to be identified as the zitterbewegung of the moving electron.

We will see further on that a third oscillation process, axial within atomic structures this time, will become involved when the electron is captured in least action electromagnetic equilibrium in atomic orbitals, which generates the actual three-components complex resonance volume within which de Broglie concluded the electron has to be captive into in the hydrogen atom and that Schrödinger meant to describe with the wave function, even if they then assumed it to involve a single harmonic oscillation.

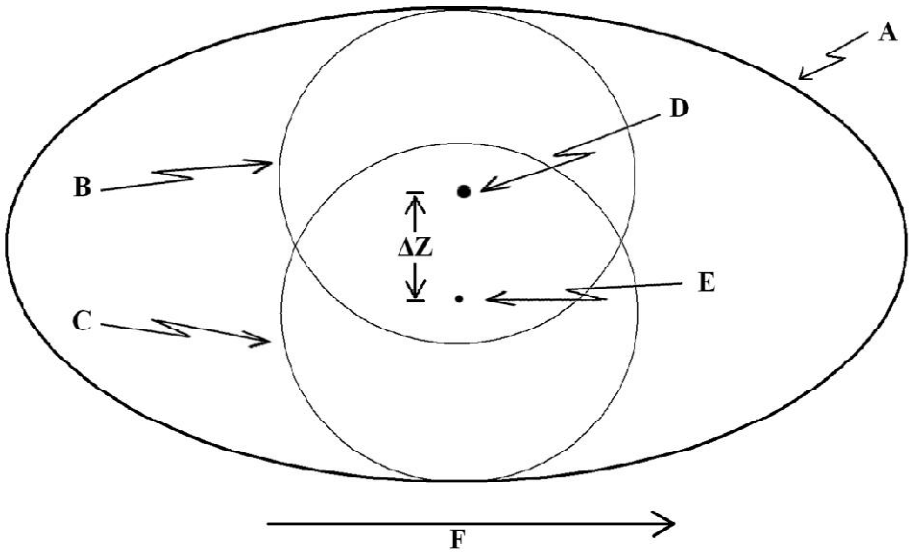

Fig. 7. Free moving electron

Legends for Fig. 7:

A - Symbolic representation of the resonance volume of the electron energy in free motion as definable by a wave function, involving the cyclic magnetic spin reversals interaction within Z-space of both electromagnetic quanta of the electron in motion "B" and "C", to be correlated with the resonance mechanics symbolically represented in Fig. 8 and Table 1.

B – Symbolic representation of the spherical volume of the oscillating magnetic energy of the electron in Z-space. Ref. Fig. 5-c as applied to the electron inner oscillating structure and Equation (53). This volume corresponds to its magnetic energy varying from zero presence to maximum presence calculated with Equation (22), and to half its invariant mass as determined in reference [14].

C – Symbolic representation of the spherical volume of the oscillating magnetic energy of the electron carrier-photon in Z-space. Ref. Fig. 5-c as applied to the carrier-photon inner oscillating structure and Equation (55). This volume corresponds to its magnetic energy varying from zero presence to a maximum presence calculated with Equation (23), and to the velocity related electron magnetic mass increment Δm_m as calculated with Equation (10). This volume also corresponds to the energy contained in the volume defined by the Schrödinger wave function.

D - Central resonance anchoring point ⊗ of the magnetic energy of the electron within resonance volume "A", that is, its trispatial junction point, where the origin of the trispatial complex is located for the electron energy quantum (Fig. 4).

E - Central resonance anchoring point ⊗ of the magnetic energy of the electron carrier-photon within resonance volume "A", that is, its trispatial junction point, where the origin of the trispatial complex is located for the carrier-photon energy quantum (Fig. 4).
Note that more realistically, the combined magnetic volume of both magnetic quanta should amount to a single spheroid whose dimensions would vary as a function of the constantly varying sum of the magnetic energies present in Z-space at any given instant due to their constant alternance between maximum presence and zero presence at different frequencies, and within which both anchoring points "D" and "E" would physically remain at some varying distance ΔZ from each other by structure as they oscillate toward and away from each other as will be analyzed with Fig. 8. This exploded representation is only meant to help visualize that both quanta oscillate separately at their respective frequencies.

F - Unidirectional orientation in X-space of the ΔK electron momentum motion energy.

ΔZ - Zitterbewegung distance between both trispatial junctions "D" and "E".

Fig. 7 should be correlated with Fig. 8 that represents the transverse interplay determining the actual zitterbewegung resonance state.

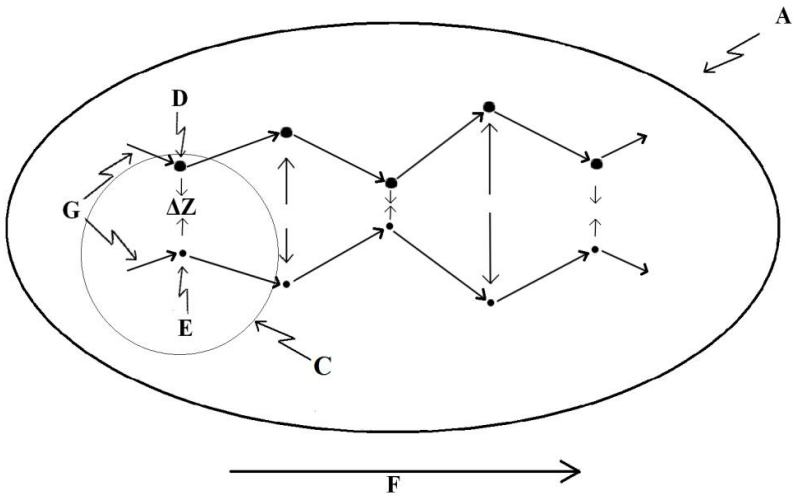

Fig. 8. Zitterbewegung

Additional legend for Fig. 8, completing those defined for Fig. 7:

G - The transverse zitterbewegung resonance oscillation resulting from the cyclic relative spin reversals of the magnetic energy spheres "B" and "C" according to their respective frequencies (see Fig. 7) result in an uninterrupted sequence of successive closing in toward each other and moving away from each other of both central resonators anchoring points "D" and "E". The irregularity of the successive cyclic reversed distances is only meant to highlight that both magnetic spheres of Fig. 7 cycle from maximum presence to zero presence at different frequencies, resulting in an irregularity of resonance cycles that generate the observed zitterbewegung.

As a matter of fact, the relative motion freedom of both tri-spatial junctions with respect to each other can only be perpendicular to the direction of motion of the system, since the stability by structure of the amount of translational energy of the carrier-photon at any given moment depends uniquely on the Coulomb interaction between the carried electron and other charged particles. This constraint thus prevents any longitudinal deceleration or acceleration relative to each other from being involved in their motion.

The only remaining possible direction of motion available for the two trispatial junctions with respect to each other is thus transverse with respect to the direction of motion of the system, which implies that at any given moment, both trispatial junctions will be at distance ΔZ (zitterbewegung distance) from each other (see Fig. 7), computable as a function of the state of the electromagnetic harmonic oscillations parameters of both quanta at this moment.

Haven't we just identified here the cause of the *zitterbewegung* that Schrödinger was discussing in his analysis of the Dirac wave equation [7] and that he found amounted to an irregular circular fluctuating motion of the electron, which is superimposed to its translational motion? The difference with Schrödinger's description is that while QM asserts that the magnetic spin moment is caused by the zitterbewegung motion (observed, but unexplained), the trispatial geometry approach predicts and mechanically explains that it would be the zitterbewegung which would be due to the forced interaction between the pre-existing cycling magnetic energy of the electron and the pre-existing cycling magnetic energy of its carrier-photon, due to their frequencies differences.

So, on top of revealing that the actual resonance volume *visited* by the two interacting oscillating electromagnetic quanta of the electron in motion will vary with the varying frequency of the increasing or decreasing energy of the carrier-photon due to the varying proximity of the carried electron with other charged particles in its environment, this analysis reveals that when the energy of the carrier-photon becomes exactly equal to that of the invariant rest mass of the electron, that is 0.511 MeV, the amplitude ΔZ of the zitterbewegung oscillation should fall to zero due to perfectly coinciding anti-parallel magnetic spin alignment while the resonance volume synchronizes in simple harmonic oscillation, which could be verified experimentally.

21. THE WAVE FUNCTION AND THE RESONANCE STATE OF THE MOVING ELECTRON

This brings us to put in perspective the resonance volume defined as the moving electron's fixed amount of harmonically oscillating energy interacts with the varying amount of its harmonically oscillating carrier-photon energy, as the electron moves freely in space, with respect to the traditional form of the wave function being used to represent it.

Let's recall that the wave function was initially introduced to represent the resonance volume that de Broglie had concluded that the electron had to be captive into when stabilized in the hydrogen ground state [1]. The method was then extended to represent electrons and electromagnetic photons in free motion.

As it currently stands, the Schrödinger wave function involves the complex harmonic oscillation of an unclearly defined single resonator mathematically combining a real and an imaginary part [37], whereas from the trispatial geometry perspective, we observe that the electron in motion involves two very clearly defined electromagnetic resonators in separate simple harmonic oscillation.

Even if as it stands, although the Schrödinger wave function allows accounting for the complete complement of momentum energy ΔK of the electron in motion or captive in atomic orbitals, it is unable to account for the electron zitterbewegung as stemming from the electromagnetic properties of the electron and of its carrying energy.

Indeed, its classical mechanics origin incompletely related to electromagnetism does not allow reverse engineering any of the electromagnetic characteristics of the resonating electron from this wave function characteristics, which is the disconnect that Feynman observed in 1964 that prevented Quantum Mechanics from being completely synchronized with electromagnetism [38]:

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

Let us note here that reverse-engineering the manner in which observed phenomena can be explained is a quite usual method of exploration in scientific circles. Indeed, it possibly is the only effective method, but its minimal condition of success hinges on considering as few arbitrary axiomatic grounding premises as possible, while taking into consideration as many related confirmed experimental observations as can be gathered, and finally no unrelated elements.

Faced with this dead end when starting from the wave function characteristics, it appeared logical to attempt reverse-engineering the electromagnetic resonating structure of the electron and of its carrier-photon, not from the characteristics of the wave function as de Broglie attempted to do, but from the well established and well known characteristics of electromagnetic energy, which led to the present solution elaborated from the trispatial geometry perspective.

To get an idea of the challenge that de Broglie was confronted with, let's examine how the nature of the resonator generating a well understood resonance volume in classical mechanics can rather easily be understood by means of reverse-engineering.

Who has not observed with a modicum of curiosity how a guitar string that was just picked practically *disappears* from sight, particularly in the middle of its length as it vibrates, while transversely *visiting*, so to speak, a very characteristic volume of space, which is its actual *resonance volume*, which can be represented by a wave function?

In this case, we obviously know in advance that the resonator is a continuous elastic string tied at both ends, because we can actually see the string when at rest, and even though it seems to disappear when vibrating, we also know that the string still physically exists even if we don't see it as it momentarily oscillates transversely too fast for us to see.

We can also imagine that someone having never seen a guitar nor any other string instrument, but expert in mathematics, being shown the very characteristic wave function describing completely the stationary resonance volume of the string, after carefully observing the symmetrically diminishing toward zero of the amplitude of the resonance volume on either side of its maximum value, may well be able to deduce that this resonance volume could only have been produced by a continuous elastic string anchored in fixed positions at both end, thus discovering and understanding the nature of a resonator that he knew nothing about previously.

But no such luck with the Schrödinger's wave function because, as we saw in the previous section, the electromagnetic resonance anchoring points of the wave function that would allow understanding how its resonance mechanics can be established, are not conveniently located outside the resonance volume as in the case of the guitar string, but inside this volume, which provides no clue whatsoever that could help even recognizing their very existence and consequently their relation to electromagnetism. This is why the only possible reverse engineering direction that could reveal the relations between Schrödinger's wave function and electromagnetism was from the confirmed characteristics of electromagnetic energy.

In fact, the identification of the electromagnetic localizations parameters allowed by the trispatial mechanics show that the Schrödinger wave function has been mapping the resonance volume of the ΔK momentum related half-quantum the electron carrier-photon, which means that when the wave function is made to theoretically collapse, it is the momentary location in space of the electron carrier-photon trispatial junction "E" which is physically located [37], and its momentary ΔK momentum energy which is revealed. See Figs. 7, 8 and 9.

The relative position of the electron trispatial junction "D" can then established to lie at distance ΔZ (momentary zitterbewegung distance between both trispatial junctions) from the carrier-photon trispatial junction "E" at the same perpendicular distance from the atomic nucleus when the electron is captive in an atomic orbital (see Fig. 9).

With the help of Fig. 7 to establish a mental representation of the related "B"/"C" magnetic interactions, we thus observe that both electromagnetic components are kept together by the sequence of cyclic transverse magnetic attraction/repulsion reversals due to the fact that their separate magnetic energy "B" and "C" are constantly switching between mutual relative parallel and anti-parallel alignments of their magnetic spins at different frequencies [10,11,14,27]; the spherical magnetic orientation of the electron energy "B" cyclically reversing at the invariant frequency calculated with Equation (15), while that of its carrier-photons "C" that varies with the amount of kinetic energy of which it is made at any given moment, cyclically reverses at the frequency that can be calculated with Equation (14).

Each closing in sequence between the "D" and "E" trispatial junctions corresponds to the duration of a phase of magnetic antiparallel alignment of the spins both magnetic spheres "B" and "C", corresponding to the fact that the sum of their energies present in Z-space progressively diminishes toward some momentary minimum presence value, while each moving away sequence corresponds to a phase of magnetic parallel alignment of their spins, corresponding to the fact that the sum of their energies present in Z-space progressively increasing toward some momentary maximum presence value.

Given that both magnetic spheres oscillate at different frequencies, these minima and maxima will vary according to the extended resonance sequence specific to their combination as a function of the variation of the adiabatic energy making up the carrier-photon as it moves in space with reference to varying distances between this electron in motion and surrounding other charged particles, thus completely accounting for the apparently random observed zitterbewegung.

22. THE RESONANCE STATES OF THE ELECTRON IN ATOMIC ORBITALS

As analyzed in references [10,11], the only way for an electron to be stopped in its motion when moving freely in Nature, is for it to be captured into some stationary action axial electromagnetic equilibrium states in one of the authorized orbitals in an atom.

During its just analyzed free motion already, both separate electromagnetic quanta making up the electron in motion, that is, that of the invariant energy of its rest mass "D" and that of the energy of its carrier-photon "E", can only be maintained together because the interaction in high frequency cyclic inversion of their magnetic energy "B" and "C", whose attractive presence phases, despite being intermittent and asynchronous as a function of the inverse cube of the distance, is sufficiently strong at so short distances, to insure a cohesion that can only be a state of least action by definition.

But as powerful this interaction can be at so short distances between the magnetic energy spheres "B" and "C", it is dwarfed out of all proportions with respect to the power of the interaction between these magnetic energy spheres and the magnetic energy spheres "N" of the carrier-photons of the up and down quarks making up the proton constituting the nucleus of a hydrogen atom (See Figs. 9 and 10).

So powerful in fact, that even at the *relatively astronomical* approximate distance of 5.29E-11 m from the proton, the complex resultant of their combined cyclic repulsive parallel magnetic interaction is sufficient to literally stop the electron in its tracks as it is in the final leg of its acceleration motion toward the proton at the moment of capture, the latter due to the Coulomb force attraction between its negative charge and the positive combined charges of the three quarks, and that the complex resultant of their combined cyclic attractive antiparallel magnetic interaction is sufficient to keep it from escaping and keep it captive in a stabilized stationary action axial electromagnetic equilibrium state.

The parameters of Tables 2 and 3, and equations (61) to (64) indeed allowed calculating in references [10,11,18,36] that the magnetic energy component "N" of the energy of each of the quarks' carrier-photons is more than 600 times more powerful than that of the invariant magnetic energy of the rest mass of the electron "B", which mutually build up their combined strength to about 2000 times that of the electron and its carrier photon.

During the actual stopping process, the forward moving ΔK momentum related energy half-quantum "F" of the electron carrier-photon had no option, due to its forward inertia, but to escape as a well known bremsstrahlung electromagnetic photon, whose energy amounts is 13.6 eV in the case of the establishment of the electron in the hydrogen ground state orbital "H". See Section 24 further on.

As this momentum energy escapes, the exact same amount of replacement ΔK momentum energy "F" is simultaneously adiabatically re-induced by the Coulomb force as described in reference [10] according to the mechanics analyzed in Section 24, because it is well verified that Coulomb interaction between charges forbids that an amount of energy different from 27.2 eV be induced as a carrier-photon in elementary charged particles separated by this distance of 5.29E-11 m.

This new ΔK half-quantum of momentum energy "F" now directly and unswervingly oriented by structure toward the proton will continue applying a continuous vectorial *pressure* tending to keep the negatively charged electron moving toward the oppositely signed resultant of the charges of the nuclear subcomponents, even if its forward motion is impeded by the magnetic counter pressure existing between its magnetic energy "B" and that of the inner proton carrier-photons "N".

And it is the *pressure/counter-pressure* interplay between the electron carrier-photon ΔK momentum energy "F" and the complex interaction between the oscillating magnetic spheres "B" and "N" involved that determine the resonance volume described by the Schrödinger wave function, as we will see.

It must be said that the capture of an electron by a proton to form a hydrogen atom is possibly the best-understood process involving elementary particles stabilized into least action axial electromagnetic equilibrium. It has however been studied and understood for the past century only by means of two traditional distinctly different filtering paradigms that cannot be directly reconciled, that of classical/relativistic mechanics physics and that of quantum mechanics physics.

From the classical/relativistic mechanics paradigm, inherited from Newton's mechanics, stabilization of the electron at the calculated distance of 5.291772083E-11 m can be related only to the idea that the electron would be a localized mass without internal structure orbiting the proton at this distance at the velocity corresponding to its ΔK momentum energy, a velocity that can be calculated either from the classical or the relativistic viewpoint depending on whether or not the gamma factor is taken account of in its calculation.

From this perspective, it is not conceivable that the electron could conserve its ΔK momentum kinetic energy as calculated with Equation (11) if it were to slow down and become immobile at this axial distance from the proton, because the very existence of kinetic energy, from the classical/relativistic mechanics perspective, depends on the velocity of a massive body [11]. From this perspective, if a massive body were to slow down in this manner, its kinetic energy is deemed to convert to an equivalent amount of *potential* energy, which would be tantamount to depriving the electron of any possibility of remaining *in orbit*, so to speak, and it is considered that this would lead to the electron theoretically *falling* onto the proton.

But of course, since we know with certainty that this never happens in physical reality, from countless experiments carried out over the course of the past century, we also know that this conclusion, drawn with reference to macroscopic massive bodies apparent behavior before the existence of electric charges and of the Coulomb force were discovered, is somehow at least partly misleading when applied to the behavior of electric charges, even if it appears satisfactory when applied to massive bodies at our macroscopic level.

From the quantum mechanics perspective, inherited from the establishment of the Schrödinger wave function and Heisenberg's statistical distribution in the 1920's, the electron stabilized in the hydrogen ground state is seen with 100% probability as being present within a clearly defined resonance volume of space about the proton, within which the energy of the electron, without any internal structure just like in classical/relativistic mechanics, is estimated to statistically be more concentrated (or more often present) about this mean distance of 5.29E-11 m from the proton, a volume within which the electron cannot be seen as moving on a clear trajectory contrary to classical/relativistic mechanics, even though it is clearly established that it can be axially located anywhere within this volume when any theoretical wave function *collapse* is calculated, and that its most probable location tends to coincide with the classical Bohr orbit representation, which is expressed as a probability of increased density of the energy of the electron within the volume described by Heisenberg's statistical method.

Its total energy is defined in more general terms with the Hamiltonian inherited from the classical mechanics paradigm as combining in a single conservative concept the sum of the kinetic energy and the potential energy that accounts for is momentum in classical/relativistic mechanics, intriguingly still internally grounded on the same p=mv Newtonian conservative momentum concept (p=γmv from the relativistic perspective), that causes the ΔK amount of related kinetic energy to still depend on velocity, even if no velocity can be associated with the spread out energy of the electron as currently represented by the wave function resonance volume.

Although both traditional paradigms take into account the ΔK momentum kinetic energy amount from Equation (11), neither of them takes into account the energy corresponding to mass increment Δm_m from Equation (2), despite its proven existence experimentally confirmed by the Kaufman experiments

[21] as measured by means of transverse interaction, and consequently, this is why neither paradigm assigns any function to the magnetic fields of charged particles nor to their magnetic mass increments in subatomic interactions.

This pinpoints exactly where the disconnect resides between classical/relativistic mechanics and quantum mechanics on one hand, and electromagnetic mechanics on the other hand, and reveals the importance of the adiabatic nature of energy induction [10] by means of the Coulomb interaction as shown with Fig. 1 and Equation (20), that combines as Equation (13) the total amount of energy adiabatically induced in charged particles as calculated with Equation (11) for the translational momentum component, and with Equation (2) for the magnetic mass increment.

The critical disconnect resides precisely in the fact that the ΔK momentum kinetic energy half of the total energy quantum induced is adiabatically induced by the Coulomb interaction (Equation (12)) in such a way that it can only remain physically present and vectorially active in the axial direction of the proton, even if it is experimentally proven not to be able to cause the electron to move forward according to its vectorial direction of application toward the proton, nor along the trajectory mandated by classical mechanics since its vectorial orientation is immutably set by structure perpendicularly to this classical trajectory.

This brings to attention the fact that the relativistic momentum energy ΔK of Equation (6) and the Δm_m relativistic mass increment from Equation (2) as combined in Equation (13), that completely account for the relativistic velocity and relativistic mass increase confirmed by the Kaufmann experiment [21], remain entirely adiabatically induced even when the related relativistic velocity is prevented by *something* from being expressed when the electron is stabilized in the hydrogen atom ground state.

This in turn leads to the conclusion that terms such as *electromagnetic momentum* and *magnetic mass increment* would be more appropriate than the current terms *relativistic momentum* and *relativistic mass increments* to describe these adiabatically induced energy half-quanta since it can be demonstrated that electromagnetic energy is adiabatically induced strictly as a function of the *distance* between charges, according to the induction growth curve dependent on the gamma factor and the Coulomb force [11,21,22], and that contrary to the very foundation of all traditional theories about energy and matter exclusively elaborated from macroscopic level experiments, according to which kinetic energy can exist only if translational motion is possible, kinetic energy is found, from all experiments involving subatomic charged elementary particles, to be a *physically existing substance* whose existence does not depend on velocity as currently axiomatically assumed, but that it is velocity that depends on the prior existence of kinetic energy, a velocity that can be expressed only if charged particles' translational motion is not impeded by local magnetic translational *counter-pressure* [10].

The ultimate question then turns out to be: How could this *something* operate to so effectively and so systematically hinder the natural motion of the ΔK momentum kinetic energy of the electron in such a way that it makes it impossible for it to go crashing onto the proton in accordance with its natural vectorial orientation?

Neither classical/relativistic mechanics nor quantum mechanics offer any mechanical clue to resolve this issue. But the from the electromagnetic perspective, the trispatial geometry allows observing that this hindrance can only be provided by a predominantly repulsive magnetic interaction, that is, a magnetic counter-pressure, resulting from of the constant parallel/anti-parallel magnetic spins orientation switching interaction between the magnetic energy "B" of the electron invariant rest mass and those of the 3 quarks carrier-photons "N" of the proton [10,11,36], as symbolically represented with Figs. 9 and 10 that we will now analyze.

It must be clearly understood that it is the spherical increase/decrease motion of the physical presence of the actual *magnetic energy substance* of the electron and of the 3 quarks carrier-photons that must be visualized during this analysis, and not that of their **E** and **B** fields mathematical representations of Maxwell's equations, as we would be intuitively tempted to do.

To really understand the axial resonance trajectory that the electron is forced to move into, that determines the volume defined by the Schrödinger wave function, the relative powers of the oscillating magnetic spheres involved must be put in perspective.

In this process, the magnetic half-quantum Δm_m of the electron carrier-photon "C" will be ignored to simplify the current analysis, because it is infinitesimal in the definition of the ground state resonance volume when compared to the role played by the magnetic mass "B" of the electron as revealed by its value calculated with Equation (27) and the following ratio established with the magnetic mass of the electron stabilized in the hydrogen ground state, and is significant only with respect to the transverse zitterbewegung of the electron previously analyzed:

$$\frac{\Delta m_m}{m_e/2} = \frac{2.42533772\ \ 6E\ -\ 35}{4.55469094\ \ E\ -\ 31} = \frac{1}{1.87796152\ \ 7E4} \tag{65}$$

The ΔK momentum half-quantum "F" of the electron carrier-photon does have a role to play however, because each time that the magnetic sphere "B" of the electron rest mass reduces to zero presence within Z-space, all magnetic counter-pressure disappears by structure between the electron and the magnetic energy making up the magnetic spheres "N" centered on the proton, which causes the ΔK momentum energy "F" of the electron to be free again to propel the electron toward the proton, until the magnetic energy substance "B" of the electron rest mass begins to increase again in Z-space as the following cycle of its frequency initiates.

On the side of the proton, it is the magnetic masses "O" of the up and down quarks that will be ignored, because contrary to the insignificance of the magnetic Δm_m half-quantum "C" of the electron carrier-photon with respect to the magnetic mass of the electron as shown with Equation (65), it is the magnetic masses "O" of the up and down quarks that are insignificant when compared to the immensely larger values of the Δm_m magnetic half-quanta of their carrier-photons. Indeed, as calculated in reference [18] each quark carrier-photon "N" would have a mean total energy of about 310.457837 MeV:

$$\text{Quark carrier - photon energy} = \Delta K + \Delta m_m = 4.974082389E-11\,\text{j} \tag{66}$$

which sets their frequency and wavelength to the following values:

$$\nu = \frac{E}{h} = 7.506837869\,E22\,\text{Hz} \qquad \lambda_C = \frac{c}{\nu} = 3.993591722E-15\text{m} \tag{67}$$

and even without taking into account the magnetic drift caused by the so close mutual proximity of the 6 inner electromagnetic quanta of the proton (Ref: Equation (62) and references [18,36]), that considerably increases their magnetic energy, to simplify this analysis, each of their Δm_m magnetic half-quanta will minimally have the following value:

$$\Delta m_m = \frac{E/2}{c^2} = 2.767206524\ E-20\,\text{kg} \tag{68}$$

In relation with the up quark mass available in Table 2, the following ratio can be established:

$$\frac{\Delta m_m}{m_U/2} = \frac{2.76720652\ \ 4E\ -\ 20}{1.02480546\ \ 2E\ -\ 30} = \frac{2.700226166\ \ E10}{1} \tag{69}$$

and for the down quark:

$$\frac{\Delta m_m}{m_D/2} = \frac{2.76720652\ 4E\ -\ 20}{4.09922189\ E\ -\ 30} = \frac{0.6750565347\ E10}{1} \tag{70}$$

So, comparing these last two ratios with the electron magnetic masses ratio calculated with Equation (65), not only do we observe that these two ratios are reversed with respect to the relation between the electron magnetic mass and that of its carrier-photon, but we also observe that the quarks carrier-photons are 10 orders of magnitude more energetic than the quarks that they carry, which justifies taking only the magnetic spheres "N" of these 3 carrier-photons into account to summarily explain the electron resonance volume in the hydrogen atom.

Finally, the ratio of the magnetic mass "B" of the electron $m_e/2$ with respect to the minimal Δm_m magnetic mass "N" of even only one of the quarks' carrier-photons, will give a glimpse of how easily and strongly the electron can be set in resonance like a feather in hurricane winds as it is shoved about axially by even the minimal eleven-fold greater magnitude magnetic energy of the even only one quark carrier-photon centered on the proton location:

$$\frac{m_e/2}{\Delta m_m} = \frac{4.55469094E-31}{2.767206524E-20} = \frac{1.64595266E11}{1} \tag{71}$$

Facing the single electron oscillating magnetic energy sphere "B", the combined magnetic energy of the inner proton components materialize as two relatively concentric antiparallel energy spheres of unequal spherical volumes (see Fig. 10). The largest is made of the cyclically varying sum of the magnetic energy of two quarks carrier-photons (2 x "N") in permanent mutual parallel spins alignment as it cyclically increases and decreases between zero energy presence and maximum energy presence in Z-space, while the smallest magnetic sphere is made of the magnetic energy "N" of the remaining third carrier-photon, which can only be by structure in antiparallel spin alignment with the first two, and whose energy is in constant oscillation in opposition with the sum of the spherical motion of the magnetic energy of the first two, that is, in increasing energy presence phase while the energy presence of the first two is decreasing, and in decreasing energy presence while the energy of the first two is increasing.

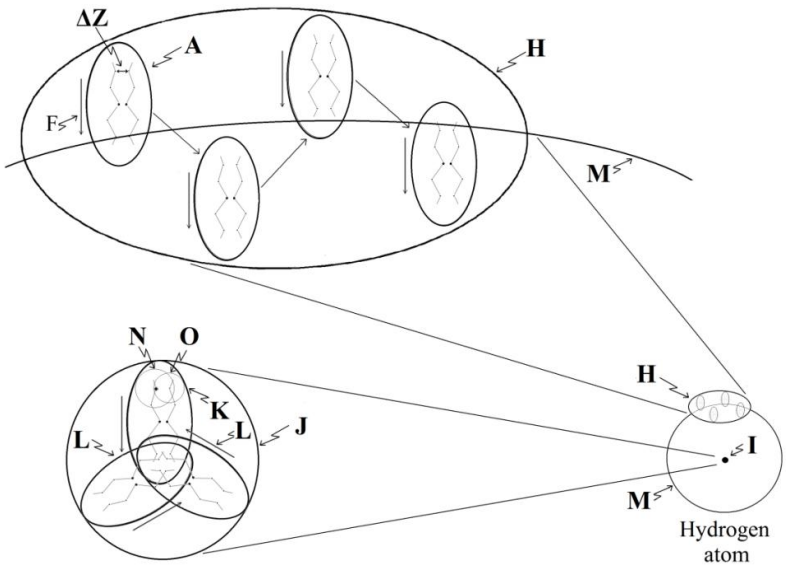

Fig. 9. The hydrogen atom resonance states

Additional legends for Fig. 9, completing those defined for Figs. 7 and 8:

H - Symbolic representation of the resonance volume within which the electron point-like behaving trispatial junction and that of its carrier-photon remain captive in the hydrogen ground state orbital.

I - Proton.

J - Symbolic representation of the proton energy resonance volume, resulting from the cyclic spins reversal interaction between all 6 inner components of the proton structure, which are 2 up quarks, 1 down quark and their 3 carrier-photons.

K - Symbolic representation of the zitterbewegung resonance volume within which the point-like behaving down quark trispatial junction and that of its carrier-photon involved in mutual cyclic magnetic spin reversal interaction within Z-space remain captive, as represented with Figs. 7 and 8, but involving much higher frequencies than the zitterbewegung resonance volume of the electron.

L - Symbolic representation of the zitterbewegung resonance volume within which the point-like behaving up quark trispatial junction and that of its carrier-photon remain captive according to the same mechanics described for the down quark with previous representation K.

M - Hydrogen ground state mean orbital distance between the electron and the proton, corresponding to the theoretical Bohr radius at which the electron momentum energy is set at precisely ΔK, outside of which distance this momentum energy diminishes to ΔK -Δ(ΔK) when the electron is pushed further away, and increases to ΔK +Δ(ΔK) when it is pulled closer to the proton, during its cyclic axial resonance motions sequences.

N - Symbolic representation of the spherical volume of the oscillating magnetic energy of a quark's carrier-photon in Z-space. Ref. Fig. 5-c, as applied to the carrier-photon inner oscillating structure and Equation (55). This volume corresponds to its magnetic field varying from zero presence to a maximum presence that can be calculated with Equation (23), using the carrier-photon wavelength obtained with Equation (67), and to the velocity related quark magnetic mass increment Δm_m obtained with Equation (68).

O - Symbolic maximum extent of the spherical volume of the oscillating magnetic energy of one quark up or down in Z-space. Ref. Fig. 5-c, as applied to the quark inner oscillating structure and Equations (63) and (64).
Since all three quarks carrier-photons have the same frequency, they remain permanently synchronized in one of the only two possible configurations, which are "U || U ≠ D" or "U || D ≠ U". See Fig. 10.

The outcome is that irrespective of which increasing or decreasing presence phase of its magnetic oscillation "B" the electron may be in, either the larger or the smaller magnetic sphere centered on the proton location will be in parallel spin alignment with it and will repel it, which is what permanently interdicts that the electron could naturally reach the proton, unless having been accidentally or artificially induced from outside sources with a carrier-photon sufficiently energetic to do so, as is routinely done in high energy accelerators.

In the symbolic representation of Fig. 9, the electron zitterbewegung resonance volume "A" is oriented as if it was going to move toward the proton, to reflect the fact that the 13.6 eV half-quantum of momentum energy ΔK re-induced in the electron carrier-photon as the electron was captured (see Section 24) remains permanently oriented toward the proton, even if its forward motion is constantly inhibited by the fact that whatever increasing or decreasing presence phase its magnetic oscillating sphere may be in (Characteristic "B" in Figs. 7 and 10), the latter will be repelled since either one or the other of the two mutually antiparallel magnetic spheres centered on the proton location (See Fig. 10) will always be in repulsive parallel spin alignment with respect to the electron magnetic energy sphere "B".

This constant relative parallel repulsive spin orientation of the electron magnetic sphere with respect to at least one of the two proton concentric magnetic spheres is not however what explains the ground state orbital axial resonance state of the electron defined by the Schrödinger wave function. We will get into this in a moment, but let's first analyze the proton electromagnetic structure.

There may appear to be a disconnect between the idea that the energy of the magnetic oscillating spheres of the quarks carrier-photons could reach as far in space as the ground state orbital located at 5.29E-11 m from the proton, and with sufficient strength at that to establish a least action electromagnetic equilibrium state keeping the electron captive at this relatively great distance from the

relatively minuscule volume of radius 1.2E-15 m within which we know that the 6 inner electromagnetic quanta making up the proton are captive into.

This is more easily put in perspective when considering that the magnetic field of the Sun reaches out as far as the outer limits of the Solar System, presumably as far as the Oort cloud, even if the matter of which the Sun is made is contained within a sphere whose radius is well shorter than the radius of Mercury's orbit, its innermost planet. Indeed, the huge magnetic field of the Sun can only be made of the sum of the individual magnetic fields of the innumerable elementary particles and carrier-photons making up the matter of which the Sun is made. The same conclusion can obviously be drawn for all existing celestial bodies, as put in perspective in reference [39].

So there is no disconnect between this conclusion drawn at the submicroscopic level and what can be observed even at the astronomic scale, because if a hydrogen atom was theoretically upsized sufficiently for its proton diameter to reach in dimension that of the Sun, then the electron would stabilize as far as Neptune's orbit, which relatively speaking, would give the magnetic field of the proton the same order of magnitude as that of the Sun.

Let us also recall that in the trispatial geometry, it is not within normal X-space that this magnetic energy expands and contracts, but within magnetostatic Z-space, and that only the ΔK momentum energy half-quanta and the point-like trispatial junctions ⊗ of each elementary particle, free moving photon and carrier-photon that actually really "live", so to speak, in normal X-space, that is, the only two aspects of elementary particle's electromagnetic energy that are physically detectable by means of frontal longitudinal collisions, which are the total sum of the electromagnetic energy that resides in the other two orthogonal spaces Y and Z, and whose physical presence we can detect only through these trispatial junctions ⊗ that behave point-like in X-space, and their ΔK translational momentum energy; and the only aspect of electromagnetic energy that can be detected by transverse collision or interaction, which is only the electromagnetic energy that resides in the other two orthogonal spaces and that we detect through these trispatial junctions ⊗ always behaving point-like in X-space, that is, the energy of the rest masses "m" of the electron, the positron, the up quark and the down quark, and the energy of the magnetic mass increments "Δm_m" of the carrier-photons, and finally the electromagnetic energy half-quanta "Δm_m" of freely moving photons.

Indeed, it is not the magnetic fields of the proton 6 inner components that are captive within its physically measured volume, but the 6 point-like behaving trispatial junctions ⊗ that are the individual anchoring locations of this magnetic energy within normal X-space, and through which their electromagnetic energy cyclically oscillates, that are captive by pairs in zitterbewegung transverse resonance states, and also collectively in the common least action resonance volume resulting from their mutual trispatial electromagnetic interaction resulting in the establishment of the stable proton structure.

The neutron, which is not illustrated in this document, has an inner electromagnetic structure involving the same up and down quarks and their carrier-photons of slightly higher energy, with the difference that instead of involving 2 up quarks and 1 down quark (uud), it involves 2 down quarks and 1 up quark (udd). The details of the trispatial structures of both nucleons are available in reference [18].

With regard to the ground state orbital resonance volume, Fig. 10 puts in perspective the fact that this resonance volume is due to the hugely higher oscillating frequency of the quarks carrying-photons energy with respect to the much slower oscillating frequency of the electron rest mass magnetic energy.

Relating these frequencies of the electron from Equation (15) and of a quark carrier-photon from Equation (67) allows determining that minimally, the magnetic polarity reversal of each quark carrier-photon occurs in excess of 600 times during each occurrence of magnetic polarity reversal of the electron magnetic energy, that is, during each magnetic presence cycle of the electron magnetic energy in Z-space:

$$\frac{\nu_{\text{quark carrier-photon}}}{\nu_{\text{electron}}} = \frac{7.506837869\ \text{E22}}{1.23558997\ 6\text{E20}} = \frac{607.5508878}{1} \tag{72}$$

The constant interplay due to the frequencies difference of the various magnetic spheres involving the inverse cube interaction law with distance, that opposes the ΔK unidirectional momentum energy "F" that constantly tends to propel the electron toward the proton, to an uninterrupted sequence of magnetic attraction-repulsion phases, can then only result in the establishment of the stable axial resonance state that de Broglie identified [1].

In Fig. 10, the central sequence "B" symbolically represents an arbitrary sample of 6 occurrences of the intensity variation of the spherical presence of the electron magnetic energy as a function of its frequency. In a simplified manner, each of these 6 occurrences is confronted in the lower sequence by the more than 600 occurrences of the intensity variation of the spherical presence of the magnetic energy of the 3 carrier-photons of the up or down quarks of the proton as a function of their own frequencies.

The least action orbital equilibrium state is consequently established by the fact that the ΔK momentum energy "F" half-quantum of the electron carrier-photon, is alternately hindered in its forward motion, when the magnetic interaction function of the inverse cube law becomes repulsive – parallel magnetic spin alignment between the magnetic energy spheres of the electron and one of the proton magnetic energy spheres – and is then freed from this counter-pressure while the magnetic interaction becomes attractive – antiparallel magnetic spin alignment between the magnetic spheres involved.

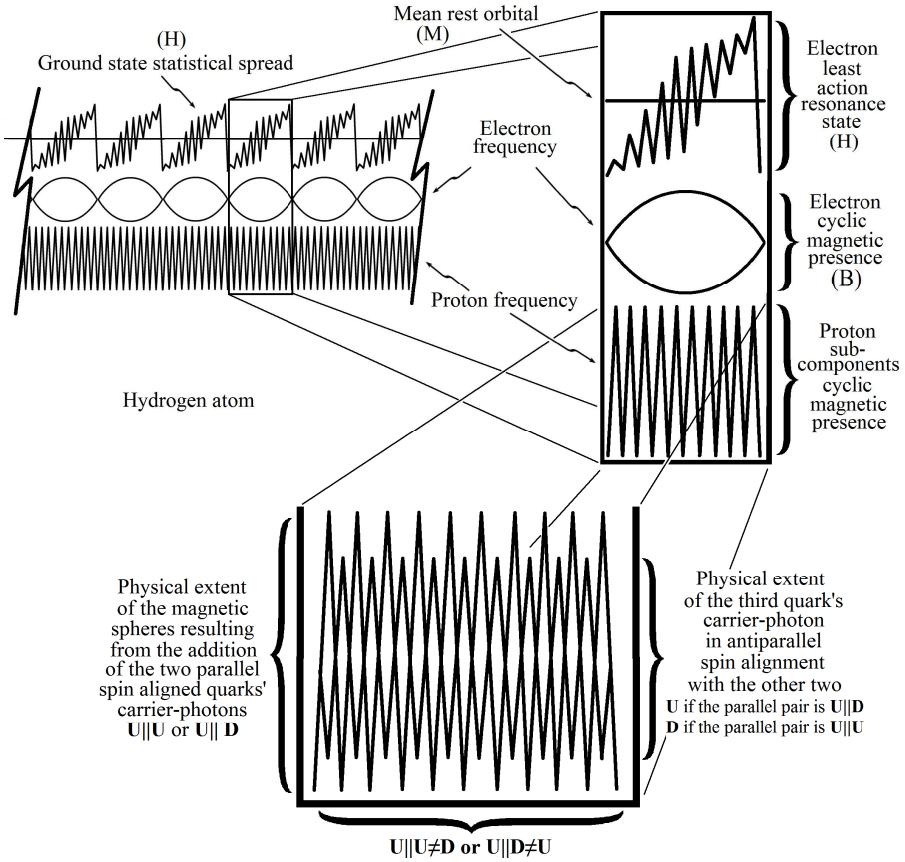

Fig. 10. Establishment of the least action resonance state of the electron in the hydrogen atom

As represented with Fig. 10, during each of the 600 magnetic cycles of a quark's carrier-photon "N", the electron magnetic sphere "B" will be axially repelled away from the proton by distance "Δd" during half of the carrier-photon "N" magnetic presence cycle, during which their spin alignment is parallel – thus repulsive, and since the electron will be farther away from the proton as the relation becomes antiparallel for the same duration, there will be a physical impossibility for it to be axially brought back all the way to distance "-Δd", given that the inverse cube force will be weaker at this farther location from the proton at the beginning of the antiparallel phase than it was at the beginning of the previous parallel phase.

Therefore, and by structure, given the more weakly acting inverse cube attraction at the beginning of attractive phase, the electron can be axially brought back only to distance "-(Δd-Δ(Δd))", which will cause it to progressively move away from the proton at each "B"/"N" relative magnetic spins polarity reversal sequence until its own magnetic energy presence "B" falls to zero, moment during which only the electron carrier-photon "ΔK" half-quantum momentum energy will be active, now causing the electron to freely move as close to the proton as the Coulomb force inverse square law will bring it, until its next magnetic presence cycle "B" initiates and that the whole predominantly repulsive magnetic sequence "B"/"N" is initiated again, as represented with Fig. 10.

Of course the actual resonance state of the electron in the least action orbital of the hydrogen atom or in any other atom will be much more complex than hinted at with this limited example, which is only meant to describe the fundamental mechanics of the magnetic interaction between the electron magnetic energy "B" and its "ΔK" momentum energy on one hand, and the magnetic energy of the quarks carrier-photons of the proton, on the other hand. Obviously, the exact resonance volume within which each elementary electromagnetic massive particle in the hydrogen atom will be circumscribed, which are one electron, one down quark and two up quarks, can eventually be determined only by a careful study of all electromagnetic interactions between them and their carrier-photons.

Given that the mean equilibrium distance that this process forces the electron in motion to stabilize at in the hydrogen atom coincides with the densest area of probability distribution of Heisenberg's statistical method, it would seem that the axial trajectory of the electron about this mean distance within the volume that the electron can thus visit as a function of its varying relativistic mass and related inertia at any given instant, it should directly correspond with Heisenberg's probability distribution of all of the possible instantaneous locations that the electron can be stochastically calculated to be localized at when repeatedly theoretically collapsing the wave function in its current form [5,21], and whose quantized axial beat can no doubt be related to the regularities of the fine structure of the hydrogen spectrum, that Sommerfeld first associated to a hypothetical elliptical orbit that the electron would follow, in his attempt to explain the fine splitting of the main spectral lines ([37], p.114).

So the very limited resonance volume in X-space within which the ΔK momentum and the trispatial junctions ⊗ of a moving electron will be localized within can be represented as:

$$\int_{-d}^{+d} |\psi|^2 \, dxdydz = 1 \tag{73}$$

while the theoretical resonance volume in Z-space within which the magnetic energy of the same moving electron can still theoretically be represented would be:

$$\int_{-\infty}^{+\infty} |\psi|^2 \, dxdydz = 1 \tag{74}$$

It seems also entirely reasonable to conclude that the elementary charged up and down quarks making up the scatterable inner structure of protons and neutrons and their carrier-photons, which are known to be the only existing elementary electromagnetic subcomponents of all atomic nuclei, as analyzed in reference [21], should be subject to similar resonance states within their own local least

action electromagnetic equilibrium states, that could then also potentially be described by the various methods of quantum mechanics in a manner more satisfactory than Quantum Chromodynamics (QCD) has achieved.

23. INTERACTING ATOMIC AND MOLECULAR RESONANCE VOLUMES WITHIN MAGNETOSTATIC Z-SPACE

It is assumed that it is the electronic orbitals that define the real spherical volume occupied by atoms in normal X-space, but from the viewpoint of the magnetostatic Z-space, it would rather seem that it is the intense elastic magnetic field in resonance of the atomic nuclei that really defines the atomic volumes in this space, as can be gathered from the stabilization mechanics of the electron in its rest orbital in the hydrogen atom just analyzed, while the elastic magnetic double spheres of the electron enter into a stable resonance state with respect to the six elastic magnetic spheres of the proton, in the allowed orbitals located at specific mean distances from the centre of the nuclear magnetic fields, in the same way that the planets in the solar system are stabilized in the various stable orbits allowed within the magnetic field of the Sun whose size encompasses the entire solar system.

According to this perspective, the entire universe would thus be populated, from the subatomic to the astronomical level, by innumerable magnetic spheres of elementary particles oscillating electromagnetically, interacting elastically in antiparallel magnetic alignment to capture each other, or combining in forced parallel magnetic alignment to merge into macroscopic static magnetic fields, whose interactions establish the full hierarchy of stable axial stationary equilibrium resonance states that can be observed, in conjunction with the counterpressure exerted by the momentum energy of these particles' carrier-photons, which is always oriented vectorially so as to counteract the default mutual repulsion resulting from the parallel spin orientations due to their different oscillation frequencies. See Reference [11].

For example, the electrons of two hydrogen atoms naturally combine in a state of antiparallel magnetic spin, since this is their least action state to form, thanks to this very strong covalent bond, a H_2 hydrogen molecule. The result obtained is the association of the two composite magnetic spheres of the two protons repelling each other on either side of the covalent electronic bound due to both their same sign mutually repelling electric charges, and their presumably dominating default permanent mutually repelling parallel spin states.

The resonance frequencies of a hydrogen gas volume – composed of numerous H_2 molecules in mutual interactions, or of helium gas – composed of helium atoms in mutual interaction, in which the nuclear magnetic fields are completely exposed to interact with other atoms or molecules, remains to be analyzed according to this perspective.

The same also for all molecules comprising hydrogen atoms, whose proton is also exposed to other atoms or molecules, contrary to higher atomic weight atomic atoms and molecules whose surrounding electronic escorts is predominantly what interacts with other atoms or molecules, like for example, the water molecule, that combines both two exposed protons and an exposed predominantly electronic sphere.

24. THE BREMSSTRAHLUNG PHOTON EMISSION MECHANICS

As previously analyzed in Reference [29], Let us now examine the possible progressive mechanical explanation to the processes of emission and absorption of electromagnetic photons by electrons in atoms that are related to the transitions between the stationary states that de Broglie and Schrödinger were initially working to resolve. Indeed, the trispatial geometry perspective analyzed in this paper seems to allow such a development, that is, an emission mechanics that they were looking forward to establish in the 1920s, but that elicited little interest in the community at the time, for lack of a potential avenue of resolution to be explored at that time.

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

Immediately prior to its capture and stabilization at mean rest orbital distance from the proton (a_0=5.291772083E-11 m), the electron will have reached the relativistic velocity of 2187647.561 m/s, driven by the precise amount of ΔK momentum energy that its carrier-photon will have accumulated at this distance as it accelerated towards the proton [16]:

$$E_K = \Delta K = m_o c^2 (\gamma - 1) = 2.179784832E\text{-}18\,j \tag{75}$$

This velocity generates the *forward inertia* of the amount of momentum energy (13.6 eV) that will cause its own evacuation as an electromagnetic bremsstrahlung photon as the forward motion of the electron is suddenly brought to a dead stop as a first step in the establishment of its stable axial stationary action orbital state. In addition to the forward inertia provided by this momentum energy, the total inertia of the incoming electron will also involve the inertia of the total amount of energy making up its carrier-photon transversely oriented half-quantum and that of its transversely oriented invariant rest mass ($E=m_oc^2$=8.18710414E-14 j), both of which will not be evacuated during the stabilization process:

$$E_e = \Delta K + \Delta m_m c^2 + m_0 c^2 = 8.187540114E-14\,j \tag{76}$$

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

$$E_p = m_p c^2 = 1.503277307E\text{-}10\,j \tag{77}$$

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

$$\frac{E_e}{E_p} = \frac{1}{1836.054891} \tag{78}$$

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

$$\frac{E_K}{E_p} = \frac{1}{6896448l.49} \tag{79}$$

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

However, contrary to the momentum energy of a moving object hitting a wall at our macroscopic level, for example, that we know experimentally will be communicated to the wall as the object hits it, we

also know experimentally that the momentum energy of the incoming electron is not communicated to the proton, but will be ejected right out of the electron-proton system as a detectable and measurable outgoing electromagnetic photon of energy 2.179784832E-18 j, wavelength 9.113034513E-8 m and frequency 3.289710552E15 Hz, moving at the speed of light.

The issue of how the separation and ejection of this bremsstrahlung photon mechanically proceeds has been pending ever since Louis de Broglie and Erwin Schrödinger began studying this process in the 1920's, but it was not really possible to resolve it before the expanded Maxwell compliant trispatial geometry previously described was elaborated and presented in 2000 at the event Congress-2000 [30].

This new space geometry now allows understanding that although the electron and its carrier-photon are suddenly stopped in their forward motion towards the proton while being abruptly captured at mean ground state orbital distance from the proton in a hydrogen atom, the forward motion of its ΔK momentum energy component calculated with equation (75) is not stopped in its forward motion *within* the internal trispatial structure of the electron carrier-photon (Fig. 4-a and 4-b), whose three separate spaces of its inner configuration act as communicating vessels [8], a forward inertia of moving electromagnetic photons that was confirmed by Einstein's photoelectric proof.

The key to understanding why the motion of the ΔK momentum energy half-quantum of the electron carrier-photon is not stopped inside the carrier-photon as the latter is itself stopped in its forward motion, relates to step (c) of its trispatial electromagnetic cycle, as represented with Fig. 5, which is the step, during its transverse oscillating cycle, during which all of its transverse energy reaches its maximum volume within magnetostatic Z-space (Fig. 4).

The manner in which the forward moving momentum energy ΔK of the electron being captured by the proton first crosses over to Z-space, as it own forward inertia forces it across the central point-like junction area interconnecting the three spaces through which the particle's energy freely transits within its own trispatial complex; and is then ejected backwards as a magnetic pulse during the electric phase of the carrier-photon's transverse oscillation cycle (Fig. 5-e), as the two separated charges behave in Y-space, during the electron stopping process, as a fixed-length dipole antenna [40], can be summarized in a four steps sequence illustrated with Fig. 11.

Fig. 11-a represents the electron accompanied by its carrier-photon internally reaching step 7-c (Fig. 5-c) of its transverse oscillating cycle, as both of their magnetic fields begin colliding with the relatively huge magnetic field of the proton, as they repel each other by momentarily all being in parallel magnetic spin alignment, as previously analyzed.

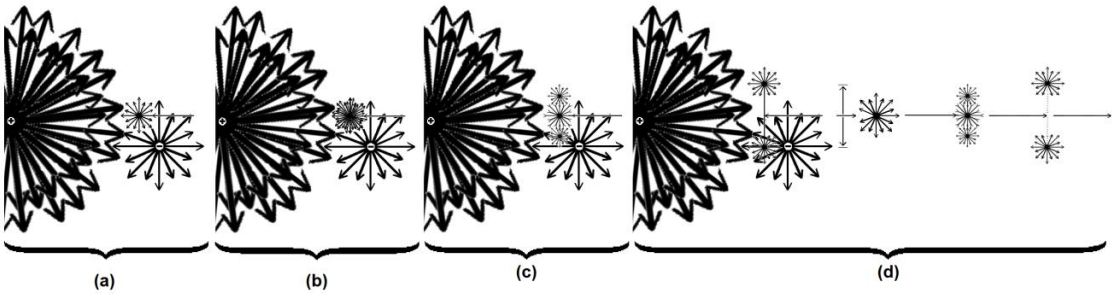

Fig. 11. Representation of a bremsstrahlung emission mechanics

Fig. 11-b represents the second step of the ejection process, and illustrates the actual stopping sequence, as the complete complement of the ΔK=2.179784832E-18 J momentum energy has just been forced into Z-space by its own forward inertia, which actually momentarily doubles the amount of energy making up the magnetic field of the incoming carrier-photon, a doubling which is graphically represented by an increased visual density of the carrier-photon magnetic sphere:

$$2 \cdot \Delta \mathbf{B} = 2 \frac{\mu_0 \pi e c}{\alpha^3 \lambda^2} = 470103.4692 \text{ T} \tag{80}$$

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

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

Something else might already have drawn the reader's attention in Fig. 11-b. Although the momentum energy initially belonging to X-space, and represented by the left-pointing arrow leading to the carrier-photon magnetic sphere in Fig. 11-a, was just mentioned as having been forced into Z-space by its own forward inertia to add up with the already residing magnetic energy as calculated with equation (54-80), an identical arrow still is present in Fig. 11-b. This requires an additional explanation, because this is no misrepresentation, because given that both the electron and the proton are electrically charged in opposition, the Coulomb interaction does not allow by structure that no momentum energy be induced in the electron carrier-photon at this distance from the proton, as put in perspective in reference [10].

Moreover, reference [32] clearly puts in perspective that a clear distinction must be made between an *uncompensated mechanically induced rotation or translation motion* and a *permanently compensated electrostatically or gravitationally induced rotation or translation*. Such uncompensated motion characterizes the state of a satellite launched into a metastable inertial orbit about the earth for example, or any object artificially rotated at our macroscopic level by means of a single initial impulse. The orbit of such an artificial satellite always degrades causing the satellite to crash, and the rotation of such an artificially rotated object always stops, unlike the natural permanently compensated orbit of the Earth for example, and its natural permanently compensated rotation. Considering the clear correlation previously established between translational, rotational motions and the states of stationary action resonance, the capture and stabilization of an electron in the stationary action resonance orbital of a hydrogen atom clearly belongs to the *permanently compensated* category, as put into perspective in reference [10].

Since the amount of ΔK momentum energy induced by the Coulomb interaction at this distance from the proton can in no way be different from 13.6 eV, it can be concluded that as the initial amount of forward moving ΔK momentum energy is evacuated from X-space, a replacement 13.6 eV amount of ΔK momentum kinetic energy has to synchronously be adiabatically induced by the permanently acting Coulomb interaction, an energy whose vectorial direction of application will now be expressed as a *stationary pressure* exerted towards the proton, increasing, so to speak, the permanent counter-pressure established between the parallel-aligned magnetic fields involved. This means that momentarily, the carrier-photon will involve 40.8 eV, including now the momentary double intensity magnetic field, until the 13.6 eV temporarily transferred to Z-space is subsequently evacuated as a separate out-going electromagnetic photon.

Fig. 11-c represents the setting up of the metaphorical dipole antenna that will emit the excess 13.6 eV energy as an electromagnetic photon. As the carrier-photon magnetic field reached maximum *presence* in Z-space as represented in Fig. 11-b, the related dipole electric field was down to zero *presence* in Y-space, which corresponds to the two rods of a fixed length dipole antenna being neutral when no alternating current is provided to the antenna [40].

As the magnetic energy represented in Fig. 11-c starts moving back into electrostatic Y-space, the energy builds up in Y-space as two opposite charges moving in opposite directions on the Y-y/Y-z plane [8,12], causing the two opposite charges to eventually peak at their maximum allowed value, which cannot exceed the maximum transverse **E**-field energy authorized mean value of 2.179784832E-18 J (13.6 eV) at this distance between the positively charged proton and the negatively charged electron, which combined with the newly induced equal authorized momentum

energy value which is now *stationarily pressuring* the electron against the magnetic field of the proton, and is adiabatically maintained by the Coulomb interaction at this mean distance.

It is this maximum **E**-field energy limit enforced by the Coulomb interaction that causes the sudden maximizing of the distance between both charges in Y-space causing it to act similarly the two fixed length dipole antenna rods, which allows the extra energy that was forced into Z-space, initially coming from X-space, to now move on into Y-space and overload the now fixed maximized length of the Y-space dipole, causing it to emit the excess 13.6 eV energy as a magnetic pulse in magnetostatic Z-space, in the same manner as electromagnetic energy pulses are emitted from a very normal dipole antenna at our macroscopic level, which is represented with Fig. 11-d.

The question comes up here as to why does the electron not simply fly away from the proton since it is universally known to do so when precisely this amount of ΔK=2.179784832E-18 j energy that it now already possesses is provided to it from an incoming electromagnetic photon, which is the case that will be addressed in the next and last section of this paper. The answer is really simple in this specific case, and is provided by simply becoming aware that the whole practically instantaneous sequence represented by Fig. 11 occurs while the *forward inertia* of the total amount of energy making up the electron invariant rest mass and its carrier-photon is applying its maximum pressure against the magnetic field of the proton, momentarily defeating any possibility for the electron to be ejected at this precise moment, and also defeating any possibility for the distance between the electron and the proton to vary during this so brief stopping sequence process.

Right after having been chased into Z-space by the Y-space electric dipole, the first thing that will happen to the freed energy will be the transfer from Z-space to X-space of half its energy to build the momentum energy half-quantum that will then start propelling it at the speed of light away from the proton, in the first step of the re-establishment of its natural trispatial electromagnetic equilibrium. Once both energy half-quanta have reached their default equal longitudinal and transverse energy levels as could be determined according to de Broglie's hypothesis and from Marmet's derivation, the energy of its transverse magnetic **B**-field will naturally start transversely oscillating by crossing over to Y-space to induce the corresponding **E**-field, thus initiating the stable transverse electromagnetic oscillation of the new Bremsstrahlung photon, now moving freely at the speed of light, as represented with Fig. 11-d [8].

Note that although the complete process took a noticeable amount of time to describe, the actual sequence of events causing the electron to come to a momentary dead stop as it is being captured by a proton, has to be practically instantaneous, due to the velocity of the incoming electron, combined with the fact that the whole sequence definitely has to be completed during the fleeting half-cycle of the carrier-photon transverse electromagnetic oscillation, beginning with its parallel magnetic spin alignment (Fig. 5-c) with respect to the spin orientation of the magnetic field of the proton and ending with the maximum **E**-field charges separation (final Fig. 5-a) as represented at the beginning of Fig. 11-d; the whole sequence occurring, as previously mentioned, while the inertia of the total amount of energy making up the electron invariant rest mass and the momentarily invariant mass of its carrier-photon are applying maximum pressure against the magnetic field of the proton.

25. THE ELECTROMAGNETIC PHOTON ABSORPTION MECHANICS

As soon as the bremsstrahlung photon has been emitted, the *forward inertia* of the electron invariant mass/electromagnetic-fields and of its carrier-photon variable mass/electromagnetic-fields half-quantum, due to their incoming velocity, will be replaced by their default *stationary inertia*, to which must be added the *adiabatically variable forward pressure* provided by the newly induced ΔK carrier-photon momentum energy half-quantum, which is permanently oriented towards the proton, that jointly interact in counter-pressure with respect to the *oscillating*, but nevertheless *stationary inertia* of the much larger mass/electromagnetic-fields of the proton, which interaction establishes and maintains the electron on its axial least action resonance trajectory within the stationary action volume of space that Schrödinger meant to describe with the wave equation [37], as previously described.

Now that only the permanent *forward pressure* of the recently and adiabatically induced ΔK momentum is preventing the electron from escaping, and that the *momentary pressure* that was initially exerted towards the proton due to the *forward inertia* of the electromagnetic fields of the electron and carrier-photon, which initially prevented the electron carrier-photon transverse **E** field energy from exceeding its incoming initial value of 2.179784832E-18 j, is no more in action, but which is what caused the bremsstrahlung photon to be emitted, as described in the previous section; any energy coming from outside the electron-proton system will be captured by the Y-space electric dipole of the carrier-photon, presumably still acting as a dipole antenna, but whose length can now vary, and will be equally distributed between both carrier-photon half-quanta, to the extent that the electron's magnetic gyroradius in the hydrogen atom will allow [23].

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

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

26. CONCLUSION

Unexpectedly, this mechanics also brings to light the possibility of using the various methods of quantum mechanics to establish wave functions to describe the resonance states of the elementary particles making up the inner scatterable structure of protons and neutrons.

This mechanics of establishment of the resonance volume representable by a wave function is grounded on the identification of the anchoring points ⊗ inside this volume of both quanta of electromagnetic energy constituting an elementary electromagnetic particle, that is, the trispatial junctions through which the quanta of kinetic energy involved oscillate harmonically to establish this volume.

The trispatial geometry reveals that each stable elementary electromagnetic particle involves in fact a pair of separate electromagnetic quanta, that is, a massive stable elementary electromagnetic quantum which is intrinsically translationally inert in X-space – electron, positron, up quark and down quark – possessing a measurable electric charge and a measurable magnetic field, accompanied by a carrier-photon, possessing a pair of electric charges whose opposite signs mutually cancel each other and a measurable magnetic field, and which contributes the momentum ΔK of the inert quantum that it accompanies in space, as well as its electromagnetic mass increment Δm_m.

This geometry reveals furthermore that the spin of elementary particles is a property of relative alignment of magnetic polarity between the electromagnetic particles and not an intrinsic property of angular moment of these particles, and that the half-quantum of magnetic energy of any electromagnetic quantum oscillates between a state of maximum presence and a state of zero presence in Z-space at the frequency of its energy.

Finally, the trispatial geometry reveals that it is the differences in oscillation frequencies of the half-quanta of magnetic energy of elementary quanta that explain the stability of all stationary action orbitals in atoms, as well as all of their resonance states.

COMPETING INTERESTS

Author has declared that no competing interests exist.

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Chapter 6
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A Brief Description of the Relationship between the Fundamental Constants of Physics Obtained from the Uncertainty Principle for Energy and Time

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ABSTRACT

An attempt is done to calculate the value of the elementary electron charge from its relation to the Planck constant and the speed of light. The aim of the present paper is to demonstrate that, in fact, a reference between *e*, *h* and *c* can be supplied in effect of i) an elementary analysis of the forces entering the emission process of the electron energy, ii) an application of the uncertainty principle for energy and time which couples the parameters considered in i). This relation is obtained, in the first step, from the Pauli analysis of the strength of the electric field associated with an elementary emission process of energy. In the next step, the uncertainty principle is applied to both the emission time and energy. The theoretical result for *e* is roughly close to the experimental value of the electron charge.

Keywords: Fundamental constants of physics; uncertainty principle for energy and time; quantum theory.

1. INTRODUCTION

As soon as the atomic theory of matter occured to be a right idea, there arose a tendency to describe the physical properties of matter with the aid of a possibly low number of the elementary notions concerning the atoms and their structure. A further step in this direction has been provided by the quantum theory. Quantum theory is without any doubt one of the greatest scientific achievements of the 20th century. It provides a uniform framework for the construction of various modern physical theories [1]. In effect numerous properties of the atomic world could be represented in terms of the so-called fundamental constants of physics which are evidently few in their number. It is clear that the number of such constants depends on the theoretical model at hand and hence depends on personal preferences and it changes of course with the evolution of physics [2]. Perhaps the most widely used constants became *e*, *m*, *h* and *c* , which are respectively the electron charge and electron mass, the elementary action called the Planck constant and the speed of light.

Simultaneously a mutual reference between the constants mentioned above seemed to be not so much evident. The aim of the present paper is to demonstrate that, in fact, a reference between *e*, *h* and *c* can be supplied in effect of i) an elementary analysis of the forces entering the emission process of the electron energy, ii) an application of the uncertainty principle for energy and time which couples the parameters considered in i).

The energy-time aspect of the uncertainty principle has been presented originally by Heisenberg [3] (see also e.g. [4]) in the formula

$$\Delta E \Delta t > \hbar \tag{1}$$

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Where ΔE is the energy change in a quantum process the duration of which is Δt. But (1) has been objected on many occasions [5-7] and in fact numerous textbooks on quantum mechanics neglect (1) at all; see e.g. [8].

However, a modified approach to the coupling between ΔE and Δt is also possible [9-11]. This gives instead of (1) a relation

$$2mc^2 \Delta E \left(\Delta t\right)^2 > \hbar^2 \tag{2}$$

which on many occasions can be replaced by an approximate equation

$$2mc^2 \Delta E \left(\Delta t\right)^2 \approx \hbar^2 \tag{2a}$$

The formula (2a) allowed us to approach several problems of the elementary quantum theory, for example the spectrum of the Bohr hydrogen atom [12] and the spin mechanism [13,14]. A check of (2) has been done in [15]. It gives the formula

$$2mc^2 \Delta E \left(\Delta t\right)^2 > \frac{8}{n}\hbar^2 \tag{2b}$$

where ΔE is the energy of transitions between the Bohr quantum levels n and n+ 1 and Δt is the time of transition estimated in [15]. Evidently for n close to 10 the formula (2b) approaches (2a) and for n = 8 there is satisfied the relation (2). In the present paper the aim of (2a) is to put a bridge between *e*, *h* and *c*.

One of the notions useful to this purpose is a minimal distance between two particles having the same mass *m*.

This is

$$\Delta x = \frac{\hbar}{mc}. \tag{3}$$

Equation (3) has been derived also on the basis of the formula (2a); see [12]. Before (2a) and (3) are applied, we refer to the Pauli analysis of the radiation emission process.

2. PAULI ANALYSIS OF THE ELECTRIC FIELD INVOLVED IN THE RADIATION EMISSION PROCESS [16]

Pauli's idea was to consider the strength of the electric field *E* connected with an oscillator having a definite frequency *v*. The change of the number of quanta of the oscillator connected with the emission process is un-known. The average frequency *v* of the emitted light let be referred to the interval of time Δt by the relation

$$v \sim \frac{1}{\Delta t}. \tag{4}$$

In effect the intensity square of the electric field *E* is coupled with Δt by the formula

$$E^2 \sim \frac{v^3}{c^3}\frac{hv}{2} \sim \frac{hc}{\left(c\Delta t\right)^4}. \tag{4a}$$

In order to derive (4a) two formulae for the momentum change Δp within the time interval Δt can be considered. These are

$$\Delta p \Delta t > \frac{h}{v - v'} \tag{5}$$

where Δp is the momentum change of an arbitrary body, and

$$\Delta p \Delta t > \frac{e^2}{c^3}(v' - v) \tag{6}$$

where Δp is the momentum change due to the radiation process. An effect of multiplication of (5) and (6) is

$$(\Delta p \Delta t)^2 \sim \frac{e^2 h}{c^3} \tag{7}$$

or

$$\Delta p \Delta t \sim \frac{e h^{1/2}}{c^{3/2}}. \tag{7a}$$

On the other hand the change Δp in effect of a change of the electric field ΔE in time Δt leads to relation

$$e\left|\Delta \boldsymbol{E}\right| \Delta t > \Delta p \tag{8}$$

so

$$e\left|\Delta \boldsymbol{E}\right| (\Delta t)^2 > \Delta p \Delta t \sim \frac{e h^{1/2}}{c^{3/2}} \tag{8a}$$

Therefore a final formula gives

$$\left|\Delta \boldsymbol{E}\right|^2 > \frac{h}{c^3 (\Delta t)^4} = \frac{hc}{(c \Delta t)^4}. \tag{9}$$

According to Pauli the square root of ΔE^2 exceeds the square root of the expression presented on the right of (9); see also (4a).

However, for simplicity, let us assume that this excess is small and the change of the field intensity in the emission is

$$\left|\Delta \boldsymbol{E}\right| \sim \frac{(hc)^{1/2}}{(c \Delta t)^2}. \tag{10}$$

In result the force acting on the electron particle becomes

$$e\left|\Delta \boldsymbol{E}\right| \sim e \frac{(hc)^{1/2}}{(c \Delta t)^2} \tag{11}$$

We assume that the force given in (11) is acting along an elementary (minimal) space interval Δx presented in (3). In effect the change ΔE of the electron energy obtained along the distance Δx amounts to

$$\Delta E = \Delta x e\left|\Delta E\right| \sim \frac{\hbar}{mc} e\frac{(hc)^{1/2}}{(c\Delta t)^2}. \tag{12}$$

3. ENERGY *E* OF (12) APPLIED IN THE UNCERTAINTY FORMULA (2a) GIVES AN EQUATION FOR *e*

As a final step we substitute the energy change (12) to the uncertainty formula (2a). This gives an approximate equation

$$2mc^2\,\Delta E\,(\Delta t)^2 \approx 2mc^2\,\frac{\hbar}{mc}\,e\frac{(hc)^{1/2}}{(c\Delta t)^2}(\Delta t)^2 \approx \hbar^2 \tag{13}$$

which can be simplified to the relation

$$\frac{h}{\pi}\left(\frac{h}{c}\right)^{1/2} e \approx \frac{h^2}{4\pi^2} \tag{14}$$

or

$$e \approx \frac{(hc)^{1/2}}{4\pi} \tag{15}$$

coupling the constants *h*, *c*, and *e*. A substitution of

$$h = 6.62\times10^{-27}\ \text{erg}\cdot\text{sec} \tag{16}$$

and

$$c = 3\times10^{10}\ \text{cm}\cdot\text{sec}^{-1} \tag{17}$$

into (15) gives

$$e = 1.12\times10^{-9}\ \text{esu.} \tag{18}$$

The well-known value of the measured *e* is

$$e = 0.48\times10^{-9}\ \text{esu.} \tag{18a}$$

The difference between (18) and (18a) is about 50 percent of (18). In some earlier papers (see [17-19] and also [20] instead of (3) the Compton length

$$\Delta x^{\text{Compton}} = \frac{h}{mc} \tag{3a}$$

is proposed which is larger than Δx in (3) by the factor of 2π . This would imply that *e* in (18) should be smaller by the factor of 2π, so

$$e^{\text{Compton}} = \frac{1.12}{2\pi} \times 10^{-9} \text{ esu} = 0.18 \times 10^{-9} \text{ esu.} \tag{18b}$$

An approximate character of the formalism applied in the present paper is evident.

Discussion on the interdependence of the fundamental physical constants e, h, and c describing the quantum matter has been given [21]. A reference of quantum parameters entering the hydrogen atom to the classical radius of the electron particle is done in [22]. Microstructure properties of the electron particle considered in the Maxwell equation for the magnetic field are examined in [23]. Finally, the assumption of an equivalence of the Joule-Lenz and quantum-mechanical energy emission intensity done in the case of an oscillator provides us with a rather accurate inter-relation between the constants e, h and c; see [24].

4. SUMMARY

The electron charge *e* has been calculated from the Planck constant *h* and the speed of light *c*. This has been done on the basis of i) the Pauli expression for the emission strength of the electric field, ii) the uncertainty principle for energy and time. The emitted energy is obtained as a product of the force of the electric field and the elementary distance Δx [see (3)] derived from the principle mentioned in ii); see [12].

In case the factor of 1/2 introduced by Pauli as a multiplier of $h\nu$ [see (4a)] is taken explicitly into account, the result for *e* in (18) is transformed into

$$e = \frac{1.12}{2^{1/2}} \times 10^{-9} \text{ esu} = 0.79 \times 10^{-9} \text{ esu.} \tag{19}$$

This number is different by less than 40 percent of its value from the experimental *e* represented in (18a). The particle mass does not interfere in the equations of the paper. This implies that the absolute value of *e* can be the same for electrons and protons.

COMPETING INTERESTS

Author has declared that no competing interests exist.

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Chapter 7
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Simulated Scientific Experiments for Teaching CAD Techniques Using Analytic and Finite Element Solutions of Electromagnetic Two-dimensional Problems with Longitudinal Symmetry

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ABSTRACT

The paper describes an approach to teaching low-frequency electromagnetic CAD techniques to undergraduate students pursuing a degree course in electrical engineering. At the laboratory meetings, the problems are initially solved analytically. Upon this, students learn how to create the numeric model and how to define the sequence of field problems that lead to the required solution. Simulation tasks based on a force-producing electromagnet are used to introduce numeric techniques to determine magnetic field distribution, evaluation of energy storage and generation of magnetic forces. Magnetic forces are calculated by the classical and weighted versions of the method of Maxwell stress tensor. The paper provides all the basic elements required for further exploration of devices with longitudinal symmetry.

Keywords: Actuators; electromagnetic engineering education; energy storage; finite element method; magnetic forces.

1. INTRODUCTION

The present work aims to encourage higher education teachers to use finite element programs as a complementary tool in the teaching of electromagnetics. The enhanced capability of the finite element method in the analysis of problems involving non-homogeneous, non-linear and time-dependent problems has been determinant in the choice of this numerical method. The use of simulation in education does make a difference. Wenglinsky [1] found that classroom simulation use was associated with academic achievement in math and also with many types of social improvements (e.g., motivation, class attendance, and lowered vandalism of school property) [2]. The manuscript takes the reader to a step-by-step simulation journey that provides all the basic elements required for the analysis of electromagnetic devices with longitudinal symmetry. It is worth noting that many practical electrical devices like motors, transformers and actuators possess longitudinal symmetry. The work will certainly benefit higher education teachers who intend to create new virtual laboratories or to introduce changes in the existing ones. A similar work for the exploration of axisymmetric problems has been recently published and appears in [3]. Both papers contain a section devoted to the numeric modeling of the test problem that can serve as a template for future simulation practices on new topics.

Following the high impact of the first applications of the finite element method in electrical engineering in 1969, industrial researchers and academic groups soon realized the need for training courses offered to designers and postgraduate students in order to overcome the difficulties in using such a versatile tool in industrial design and education.

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There have appeared many papers describing experiences on the use of the finite element method in the teaching of electromagnetics. Some papers describe the experience of academic groups in the development of electromagnetic field simulators, and explain how these programs have been used as teaching tools [4]. Commercial finite element packages have also been successfully used as an aid in teaching electromagnetics around the world. The main disadvantage of commercial packages is the expensive licensing. In their work, Lowther and Freeman describe how laboratory courses on field simulation based on a commercial software have been devised and implemented in three different universities, and discuss the advantages and disadvantages of finite-element CAD tools in the teaching environment [5]. Steady-state, transient, linear and nonlinear problems in electromagnetics, structural analysis, and fluid dynamics may be analyzed and solved with it, [6,7,8]. At the turn of the century, open-access programs based on the finite element method have been released, and many of these programs have been used as teaching tools [9,10,11]. As a result, a limited and free of charge students' version of commercial packages also started to be released. To make their product even more competitive, some companies have also allowed free access to a series of files containing lecture notes, problem workshops and tutorials based on the limited version of their software [12,13]. In their experience in teaching electromagnetics, Yin at al. have used a combination of two commercial simulation packages and in-house developed software [14].

To avoid the rigorous mathematical derivations of variational calculus and make the finite element method more attractive to students, J.R. Cardoso and his collaborators have developed a new mathematical approach to finite-element analysis based on the direct integration of Maxwell's equations [15,16]. In recent years, general-purpose mathematical software packages like MATLAB have successfully been used in the teaching of electromagnetics [17,18]. MATLAB programming tutorials and assignments are designed to deepen student engagement and accommodate different learning styles so students can learn more effectively [19]. Very often, students of electrical engineering use MATLAB extensively in other subjects, and their familiarity with that mathematical tool has been the principal reason for the creation of MATLAB-based electromagnetic-fields virtual laboratories [20,21]. The use of finite element methods in the teaching of electromagnetics is a topic of great interest, and new contributions to the art appear very often in specialized magazines [22], scientific journals [23,24] and conference proceedings [25,26,27,28].

The discussion presented in the following is based on the authors' teaching experience in the context of a thirty-hour course. The activities include 6 hours of lectures and 24 hours of laboratory classes. The object of the introductory lectures is to present basic concepts of the finite element method: domain discretization, use of simple boundary conditions, polynomial trial functions, and formulation of the system of equations. The lectures are followed by a series of laboratory meetings where analytical calculations and field computations are made on simple physical devices. One of these meetings focuses on the creation of the numeric model of a force-producing electromagnet. This numeric model is employed in six simulated experiments chosen to introduce numeric techniques to determine magnetic field distribution, evaluation of magnetic energy storage, generation of magnetic forces and eddy current losses.

2. THE TEST PROBLEM

To make the matter concrete, the step-by-step description of the numeric model for planar problems is based on the same device that appears in the simulated experiments: the *C*-core electromagnet shown in Fig. 1. The magnetic force generated in this device attracts the movable rectangular armature into the *C*-core electromagnet.

In the illustration, l_g denotes the length of the two small air gap regions that separate the movable armature from the stationary core. The depth of the device is l_z=3.0 cm. The winding has 250 turns and an intrinsic resistance of 7.5 Ω. In the *dc* operation, it carries a current of 5.33 A. In the *ac* operation, the peak current is also 5.33 A.

The electromagnet shown in Fig. 1 represents one of the simplest devices that produce electromechanical forces, and has long been used to teach methods of magnetic force calculation. Two of the most popular types of linear actuators have stationary cores in the shape of "C" and "E",

and are commonly referred to as *C*-core and *E*-core actuators, respectively. A *C*-core actuator has been chosen by Kim, Lowther and Sykulski [29] to evaluate the accuracy of force computation algorithms to determine global forces, as well as force distribution over the surfaces of magnetized bodies in contact. Different types of *C*-core actuators have also been used to demonstrate applications of the single-solution virtual work method [30].

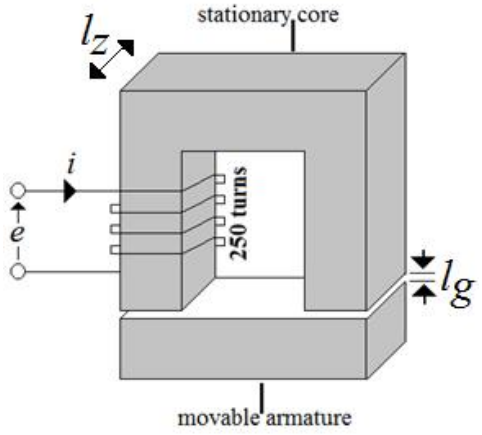

Fig. 1. Sketch of the *C*-core electromagnet

3. ANALYTICAL METHODS

Analytical calculations are important because they bring insight into the subject. When applied to devices with simple geometries, they can provide very accurate or even exact estimates of the quantity under investigation. It is the case of the analytic estimates of the magnetic field strength and attractive force of the *C*-core electromagnet described in Section 2. In problems involving more complicated slotted magnetized structures, all that can be expected from an analytical solution is to establish the order of magnitude of the quantity under investigation. The main disadvantage of analytical calculations is the lack of flexibility in accommodating alterations in the device's geometry, its sources and design constraints.

Analytical calculation of global parameters like stored energy, inductance and total forces are usually based on equivalent magnetic circuits containing the sources of magnetomotive forces and a number of interconnected reluctors crossed by the "circulating" magnetic fluxes. These circuits are used together with magnetic Ohm's law and Ampère's law to determine the approximate magnitude and direction of the magnetic field strength ***H*** or magnetic induction ***B*** in the regions of interest. In our simplified analytical approach, the iron sections of the device are modelled by assuming a high constant relative permeability, μ_r, in the *x* and *y* directions. As a result, the problems are treated as magnetically linear, and the magnetic energy storage is considered to be entirely confined to the air regions.

3.1 Ampère's Law

In the analysis of simple devices like the electromagnet shown in Fig. 1, the terminal current *i* and the number of turns *N* of the exciting winding are usually known, and Ampère's law provides a method for determining the magnitude of the ***H***-field,

$$\oint \vec{H}.d\vec{l} = Ni. \tag{1}$$

Consider the magnetic actuator depicted in Fig. 1 and a magnetic flux ϕ circulating in the clockwise direction. To facilitate the "hand" calculations, the integration contour indicated in (1) should be formed

by the union of line-segments that cross the magnetized parts and air gaps in a way that the ***H***-field is tangential to each segment or contour section. In the illustration of Fig. 2, each part or section of the integration contour is related to a number: section "1" follows the mean path of the stationary *C*-core; sections "2" and "4" follow the mean path of the air gaps; and section "3" follows the mean path of the movable armature.

Along each of the paths that form the integration contour, the magnitude of the ***H***-field is more or less constant, the field direction is almost tangential to the path, and the integration can be approximated by the summation

$$\sum_{k=1}^{4} H_k l_k = Ni \tag{2}$$

where *k* represents the number of the contour section.

Under idealized conditions, the magnitude of the ***H***-field and related magnetomotive force drops *Hl* along the iron sections 1 and 3 of the integration contour shown in Fig. 2 are negligible, so that

$$\underbrace{H_1}_{\to 0} l_1 + H_2 l_2 + \underbrace{H_3}_{\to 0} l_3 + H_4 l_4 = Ni. \tag{3}$$

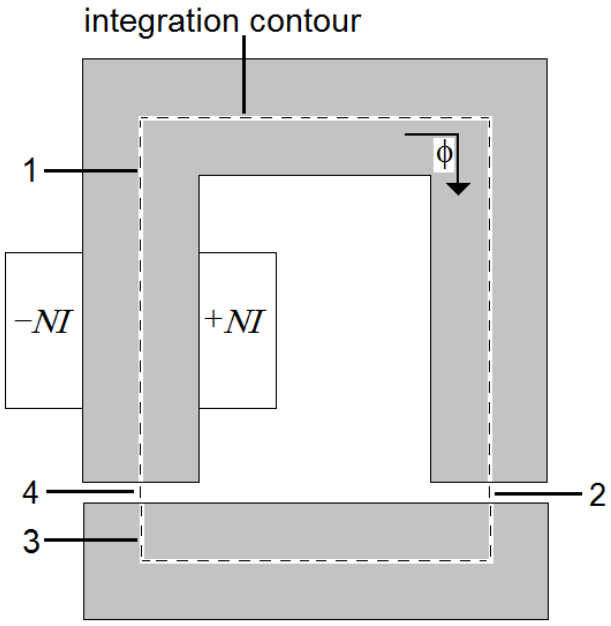

Fig. 2. Integration contour for application of Ampère's law

If the two air gap regions have the same geometric dimensions, $H_2=H_4=H_g$. If l_g denotes the length of one air gap, the estimate for the uniform magnetic field, H_g, in the air gap regions is computed by

$$H_g = \frac{Ni}{2l_g}. \tag{4}$$

Once computed the magnitude of the magnetic field in the air gaps, the calculation of the attractive force can easily be performed using the method of Maxwell stress tensor.

3.2 The Maxwell Stress Tensor Method

An enlarged view of the right-hand side air gap is shown in Fig. 3. In smooth magnetized surfaces, like the ones that form the millimetric gaps of this actuator, the ***H***-field practically does not vary in magnitude from point to point, and its direction is perpendicular to each iron surface. For a magnetic flux ϕ crossing the gap in the -*y* direction, the magnetic field intensity ***H*** emerges from the upper iron-air interface and penetrates the lower iron-air interface. To calculate the net force by integration of the Maxwell stress tensor method, it is firstly necessary to compute the distribution of the magnetic field in terms of the ***H***- or ***B***-field at all points in the air region surrounding the object on which the force is to be calculated. In the calculation of the total force acting on a rigid body, the integration surface *S* could be the surface of the body itself, but the value of the magnetic permeability over the magnetized surface changes from point to point. In contrast to this, the magnetic permeability over a surface of air is that of the vacuum everywhere. That is why, in computational practice, the calculation of the field distribution and the subsequent numeric integration are always performed over a "surface of air" attached to the iron surface.

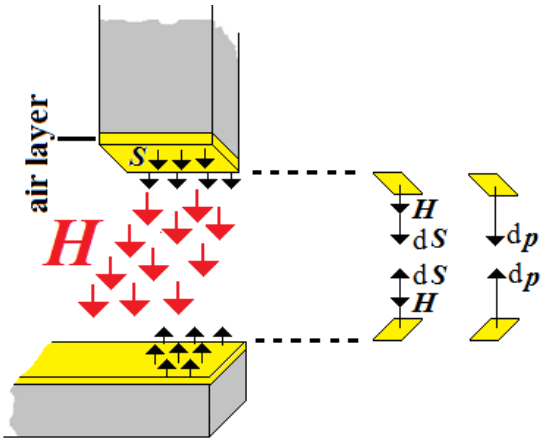

Fig. 3. Collinear vectors d*p* and d*S* on the two iron-air interfaces

The area *S* of the surface of air is usually taken as the geometric section of the magnetic pole, as indicated in the illustration. At any point of a given interface, the angle between the local force density vector d***p*** and the surface vector d***S*** -taken as the outward normal on the surface – is the double of the angle between the local magnetic field strength ***H*** and the surface vector d***S***. In this particular situation, both angles are equal to zero, and vectors d***p***and d***S*** are collinear on the two iron-air boundaries facing each other. In other words, the elemental local force density vector d***p*** is directed downwards in the upper iron-air interface and upwards in the lower iron-air interface. In the illustration, the small arrows emerging from the two artificial layers of air represent the uniform distribution of the elemental force density vector d***p***.

The above discussion helps to explain the nature of the attractive force generated at the air-gap region. The resulting magnetic force always tends to shorten the length of the air gap, and its value is computed by means of the surface integral of the local force density vector d***p***over one surface of air. According to Newton's first law, the force acting on the opposite iron-air surface has the same magnitude and opposite direction.

In two-dimensional analysis, when magnetic forces are calculated by the method of Maxwell stress tensor, the surface of integration becomes a contour of integration. In this example, the contour of integration should encompass the movable armature, and the choice of this contour affects the accuracy of computed forces. This happens because the computed field distribution, expressed in terms of the ***H***- or ***B***-field, is only an approximation to the true or "perfect" one, i.e., there is an inherent error in the numerical field distribution. As a result, the independence of the values of

computed forces relative to the choice of the integration contour disappears. To overcome the difficulties encountered in choosing integration contours to get accurate and consistent force calculations from imperfect numerical field solutions, McFee, Webb and Lowther [31] have proposed the weighted Maxwell stress tensor method. Despite the complexity of its mathematical derivation, the weighted approach became an essential simulation tool of modern electromagnetic CAD systems, wherein the contours of integration and weighting functions are calculated in a completely automated process. The post-processing tasks necessary to use this method are presented in Experiment No 4.

4. FINITE ELEMENT MODEL

4.1 Advantages and Disadvantages of the Method

The finite element method is a numeric technique based on the theory of interpolations to solve large-scale problems of high complexity employing a data structure that is, at the same time, simple and flexible. As a result, programs developed for a particular discipline can be applied to solve problems in a different field with little or no modification. The main advantage of the method is its enhanced capability to solve problems involving: (i) complex geometries; (ii) non linearities; (iii) non homogeneous media and (iv) time-dependent phenomena. The typical unstructured finite-element meshes allow good representation of curved objects, easy insertion of short gaps as well as increased local resolution in regions wherein rapid variations of the solution are expected to occur.

Despite its worldwide popularity, the method of finite elements has disadvantages, and these include its rigorous mathematical derivation as well as the use of a large amount of input and output data. The method does not produce a general closed-form solution, but only an approximate solution to the numeric model. The construction of a finite-element model invariably involves several user-defined parameters and numerous choices that affect the accuracy and consistency of the finite element solutions. In other words, different numeric models for a given problem may lead to different results, so the quality of the finite element simulations rely heavily on the experience of the user in constructing a finite element model “adequate” to the problem. Besides, experience and judgment are needed to extract and examine the results.

4.2 Problem Definition and Geometry

All numeric simulations are carried out using a two-dimensional open-access simulation software based on the finite element method [9]. The work involves one numeric model and a set of problems defined on that model. All experiments concern problems of magnetism,so it is necessary to select the solver for “magnetics” and, implicitly define the primary quantity of calculation, that is the magnetic vector potential $\boldsymbol{A}$. In the two-dimensional analysis of problems with translational symmetry, the magnetic vector potential $\boldsymbol{A}$ possesses only a single component in the longitudinal or z-direction, and may be treated as a scalar quantity A.

The selection of the type of symmetry to be exploited – longitudinal in the case of planar problems -, is followed by the identification of the length unit associated with the dimensions prescribed in the model’s geometry. In problems with longitudinal symmetry, care must be taken to specify the “depth” parameter. The value prescribed to this parameter - in the same length unit selected for the model’s geometry -, represents the length of the device in the “into the page” direction. In the illustration of Fig. 1, the distance l_z represents the depth of the C-core actuator.

An outline of the numerical model with geometrical dimensions in centimeter is shown in Fig. 4. The external rectangular region that appears in the illustration is an artificial boundary used to close the domain of analysis. The boundary conditions applied to this rectangular boundary are truncation of the outer boundaries. This technique assumes that no magnetic flux ϕ crosses the boundary in the normal direction. The usual way of applying this mathematical condition is by prescribing A=0 at this boundary. The main features of the numeric model are summarized in Table 1.

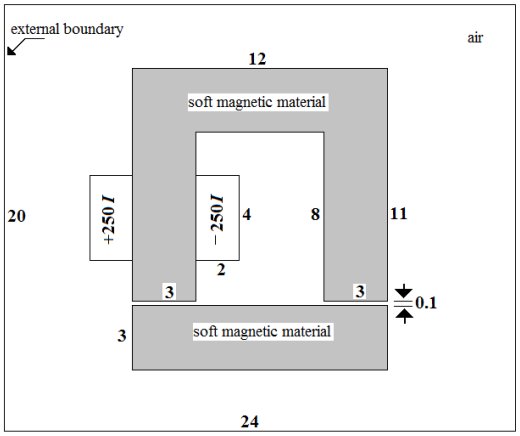

Fig. 4. Regions of the numerical model. Geometric dimensions in cm

Table 1. Features of the finite-element model

Type of problem	Magnetics
Potential solution	Magnetic vector potential
Type of symmetry	Longitudinal
Length unit	Centimeter
Depth of the device	3 cm
Boundary conditions	Truncation of the outer boundary
Type of mesh	Triangular elements
Interpolating functions	1st order

4.3 Problem Assembly

The subdivision of the geometric domain into regions or “blocks” must consider the need of extra degree of mesh fineness in small air-gap regions and pole tips, as well as the need of separately quantifying the energy storage in some regions or areas of the device. In this particular actuator, one single “block” could be used to model all regions filled by air. However, this would not allow to compute the amount of energy storage restricted to each small air-gap region, as required by some force calculation methods.

The proposed finite-element model contains eight regions, and these regions must be correlated to different material media. Initially, a label must be placed in each region, and this label will identify all triangular elements belonging to that region or “block”. The disposition of region labels in the geometric domain is illustrated in Fig. 5(a). Labels “X1”, “X2”, “X3” and “X4” are placed in the regions that model the two air gaps, the stator window, and the external area of empty space, respectively. In the same manner, labels “Y1” and “Y2” are placed in the two non-contiguous regions that represent the winding, and labels “Z1” and “Z2” are placed in the regions that model the stator and movable armature, respectively. Up to this point, the region labels are abstract entities, not yet defined. To carry on the problem assembly, it is necessary to associate material properties with region labels.

Since one kind of material may be used in different models, electromagnetic field simulators have a built-in library to facilitate the access to materials data files. The library for problems of magnetism contains several material property files of materials commonly used in the industry of electric equipment separated in file directories for conductors, permanent magnets and soft magnetic materials. Very often, the creation of new numeric models requires exchange of data files between the current numeric model and the materials library. For this model, it is necessary to “bring” to the directory entitled “Model Materials” data files that store the physical properties related to the air, copper, as well as data files containing the physical properties of the soft magnetic materials that will be used in the test problems. The correlation between region labels and materials data files is illustrated in Fig. 5(b).

It is worth noting that files of material properties may contain a large amount of information. Whereas the data file related to free space or "air" only provides the value of the relative magnetic permeability of the material medium ($\mu_{r,x}=\mu_{r,y}=1$), the data file of a soft magnetic material may contain all necessary information to fully characterize the ferromagnetic core of a power transformer, i.e., 1st quadrant *B-H* curve, loss curves, maximum relative permeability, electric conductivity, lamination thickness and lamination fill factor. Certainly, some familiarity with soft magnetic materials used in industry is important to future engineers. Experiment N° 6 takes this fact into account.

4.4 Exciting Winding

The winding is modeled by the two non-contiguous rectangular regions shown in Fig. 5(a). These regions are identified by labels "Y1" and "Y2". A "circuit property" must be assigned to both conductive regions. For a given circuit property, it is necessary to specify the magnitude of the terminal current and the winding's number of turns. In addition, both conducting regions must be defined as series-connected.

The terminal current is specified in units of ampere, either in terms of its constant value *I* in *dc* analysis or in terms of its peak value I_p in *ac* analysis. To enforce a magnetic flux ϕ in the clockwise direction, the specified number of turns is +250 for the left-hand side region and -250 for the right-hand side region. The sign on the number of turns indicates the direction of current flow associated with a positive-valued circuit current. According to the convention of this field simulator, a positive-valued circuit current flows in the "out-of-the-page" direction.

4.5 Mesh Refinement

The labels placed in the different regions of the model are also used in the dialog that defines the "grain" of the mesh in one or more selected regions. The method employed to control the level of discretization in each region is based on the specification of a parameter, δ, known as "edge size". This parameter defines a constraint on the largest possible size of the elements' edges allowed in that region. Values prescribed to this parameter in the eight regions of the model are indicated in the illustration of Fig. 6.

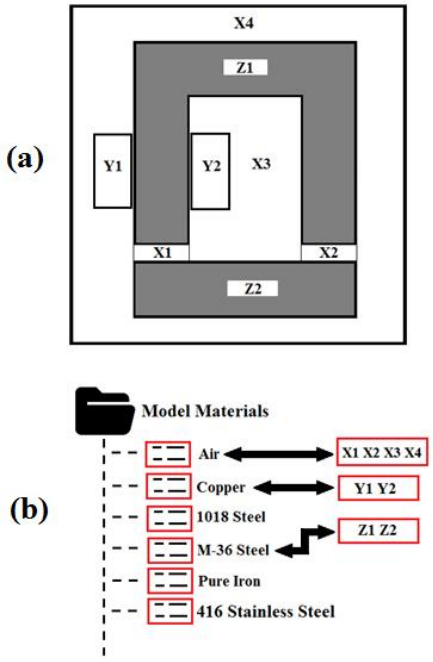

Fig. 5. (a) Disposition of region labels; (b) Correlation between region labels and materials data files

A view of the right-hand side air gap is shown inFig. 7(a). Two enlarged views of the small rectangular box highlighted in Fig. 7(a) are used to show the effect of mesh refinement. The zoomed view of Fig. 7(b) shows the coarse mesh created when the mesh generator is free to choose all elements' size, whilst Fig. 7(c) shows the result of the mesh refinement guided by the specified values of the parameter δ.

5. EXPERIMENTS

5.1 Experiment 1: Magnetic Force at *dc* Operation

Consider the *C*-core electromagnet shown in Fig. 1. A constant terminal voltage *E*=40 V is applied to the exciting winding. Use the analytic formulae presented in Section 3 and determine the attractive magnetic force acting on the movable armature.

5.1.1 Solution to experiment 1

In *dc* operation, the inductive reactance $X_L=j\omega L$ of the electric circuit is null, and the current is only limited by the resistance of the winding. The terminal current *I* is constant and computed by Ohm's law,

$$I = \frac{E}{R} = 5.33 \text{ A}. \tag{5}$$

Under idealized conditions, Ampère's law provides an estimate for the stationary and uniformly distributed magnetic field strength H_g in the two air gap regions,

$$H_g \cong \frac{NI}{2l_g} = \frac{250 \times 5{,}33}{2 \times 10^{-3}} = 666.25 \text{ kA/m}, \tag{6}$$

where l_g denotes the length of one air gap.

In the air-gap regions, the force density vector ***p*** is uniformly distributed, and its magnitude is computed by

$$p = \mu_0 \frac{H_g^2}{2} \text{ N/m}^2. \tag{7}$$

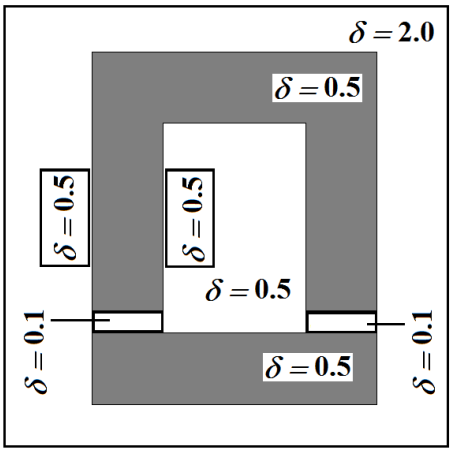

Fig. 6. Maximum triangles' edge size; values of the parameter δin centimeter

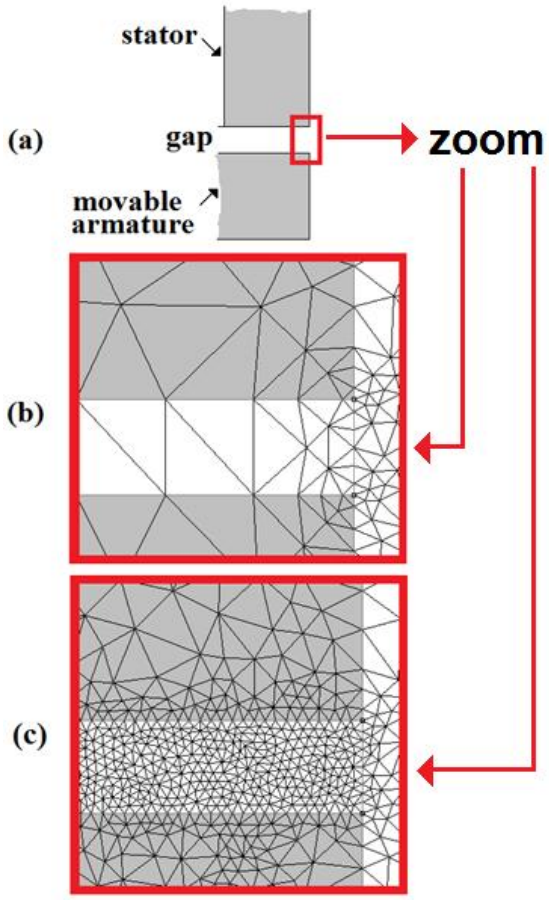

Fig. 7. (a) Enlarged view of the right-hand side air gap; (b) Coarse mesh; (c) Refined mesh

If *S* denotes the stator's geometric section, the attractive force F_g in one air gap is given by the product *pS*,

$$F_g = \mu_0 \frac{H_g^2}{2} S \text{ N.} \tag{8}$$

The total force, *F*, attracting the movable armature is the double,

$$F = 2F_g = \mu_0 \frac{(NI)^2}{4l_g^2} S. \tag{9}$$

Substitution of numeric values gives *F*=503 N for the idealized force calculation. It is worth noting that the magnetic force varies with the magnetic field intensity squared. Under idealized conditions and for a giving magnetomotive force *NI*, (4) yields the highest estimate for the air-gap field intensity and (9) produces the highest estimate for the attractive force acting on the movable armature. Computation of the attractive force under non idealized conditions will be subject of analysis on Experiment N^o 4.

5.2 Experiment 2: Relative Permeability and Tangential *H*-field

One of the most important properties of ferromagnetic materials is their large relative permeability μ_r. Iron with 0.2% impurities has a relative permeability of about 6000, and some alloys reach a relative permeability of 10^6. For a given excitation *Ni*, the idealized analytic calculations assume that the magnetic field intensity, ***H***, is null in the magnetized parts of the electromagnet and, therefore (4) yields the highest estimate for the magnetic field intensity, H_g, in the air gaps. To investigate what happens in computational practice, two similar problems may be defined on the numeric model. The only feature differentiating the two magnetostatic problems is the relative permeability of the soft magnetic material used in the magnetic core: 1018 Steel in the first solution and M-36 Steel in the second one. The corresponding values of the relative permeabilities are: μ_r=529 for the 1018 Steel, and μ_r=1616 for the M-36 Steel. In the investigation, both materials are treated as magnetically linear, and the quantity of prime interest is the tangential component, H_{tan}, of the magnetic field intensity.

5.2.1 Solution to experiment 2

To facilitate the analysis, the magnetic portions of the electromagnet, stator and armature, are treated as non laminated, isotropic and magnetically linear materials. The relative permeability of isotropic materials has the same value in all directions and, in a two-dimensional analysis, $\mu_{rx}=\mu_{ry}$. Under the assumption of magnetic linearity, the value of the relative permeability is constant, and does not vary with the magnetic field intensity. In the numeric model, properties of the two selected soft magnetic materials should be associated with labels Z1 and Z2: 1018 Steel in the first problem and M-36 Steel in the second one. Both material data files must be edited to enforce the option "Linear *B-H* relationship".

Mean values of the ***H***-field tangential component along the integration contour shown in Fig. 2 are summarized in Table 2. For the first problem, the averaged values of the tangential ***H***-field along the contour are shown in Fig. 8. In the mean, the magnitude of the tangential component, H_{tan}, in the two magnetic sections is only 0.2% of the averaged magnitude of the tangential component, H_{tan}, in the two air gaps. A careful observation of the results indicated in Table 2 shows that the contrast between these two magnitudes becomes even more pronounced when the core is made of the more "permeable" material M-36 Steel. As the relative permeability increases from 529 to 1616, the ratio of the tangential ***H***-fields in the two material media decreases from 0.2% to 0.06%. This helps to explain why in many simplified analytic calculations no attempt is made to compute the magnitude of the tangential ***H***-field in the magnetic sections.

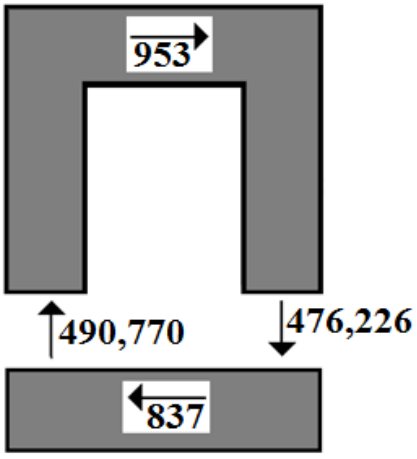

Fig. 8. Averaged tangential *H*-field in units of A/m when the core material is 1018 Steel

Table 2. Mean value of the tangential *H*-field in units of A/m

Region	Core material and relative permeability		Analytic calculation
	1018 Steel, μ_r=529	M-36 Steel, μ_r=1616	
Stator	953	389	0
Right gap	476,226	584,362	666,250
Armature	837	342	0
Left gap	490,770	599,013	666,250

5.3 Experiment 3: Energy Storage in Magnetic Materials

Investigate how the relative permeability of the material employed in the ferromagnetic core affects the storage of magnetic energy in the ferromagnetic core and air-gap regions.

5.3.1 Solution to experiment 3

In practice, magnetic materials do store a small amount of magnetic energy, and part of this stored energy is lost in the form of heat dissipation in the ferromagnetic core. With the aid of the numeric model, one may define a sequence of similar problems with increasing values of the core's relative permeability. To facilitate the analysis, the magnetic portions of the electromagnet, stator and armature, are treated as isotropic and magnetically linear materials. In the simulated work, the relative permeability varies from 500 to 20000, in steps of 500. For this, a series of new material data files have been created, each one containing a filename and values of the relative magnetic permeability in the *x*- and *y*-directions. To facilitate the future use of these materials files, the filename suggests the value of the relative permeability. For example, filename Mu_r 500 suggests a data file for a soft magnetic material with relative permeability μ_r=500 in the *x*- and *y*-directions.

When post-processing the finite-element solutions, it is necessary to quantify: (i) the energy stored in the ferromagnetic core; (ii) the energy stored in the two air gaps; and (iii) the energy stored in the whole geometric domain. The effect of an increasing magnetic relative permeability on the amount of energy stored in the ferromagnetic core and air gaps is presented in the graph of Fig. 9. The characteristic plotted using a solid line represents the percent stored energy in the ferromagnetic core, whilst the characteristic with circular marks represents the percent stored energy in the two millimetric gaps. Observation of former characteristic shows a pronounced decay of the energy stored in the ferromagnetic core along the leftmost portion of the curve: as the relative permeability increases from 500 to 4000, the percent stored energy in the ferromagnetic core drops from 27% to 4.5%. This variation ought to be compared to the simultaneous increase, from 60% to 80%, in the useful, force-producing stored energy in the two air-gap regions.

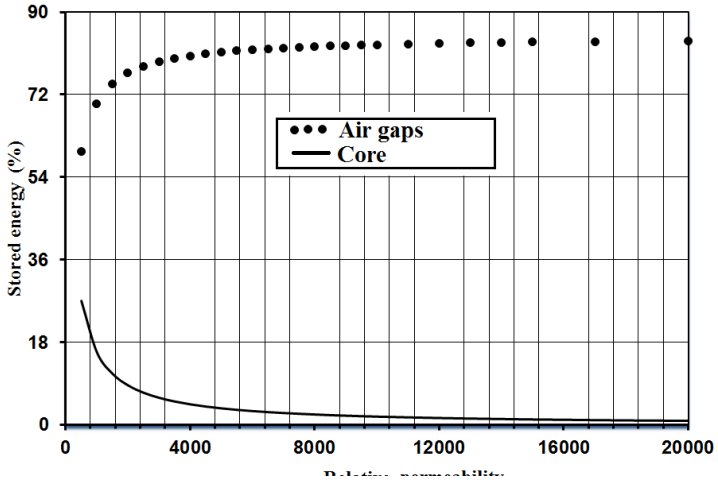

Fig. 9. Percentage of stored energy: (i) in the ferromagnetic core: solid line; (ii) in the air gaps: circular marks

5.4 Experiment 4: Relative Permeability and Magnetic Force

Investigate how the relative permeability of the material employed in the ferromagnetic core affects the value of the magnetic force acting on the movable armature when the exciting winding is supplied by a *dc* current of 5.33 A. The magnetically produced forces must be evaluated numerically, using the numeric method of weighted Maxwell stress tensor.

5.4.1 Solution to experiment 4

The first step of the investigation is the definition of a sequence of similar problems with increasing values of the core's relative permeability. Like in experiment N^{o} 3, values of the relative permeability varies from 500 to 20000, in steps of 500. Once the sequence of problems has been generated, it is necessary to launch the solver and then inspect the results. The post-processing of each finite-element solution involves three main steps, to know: (i) the block or region that represents the movable armature must be selected; (ii) the "surface integral" command must be selected; and (iii) the task "force via weighted stress tensor" must be chosen from the drop list.

Computed forces versus relative permeability are presented in the graph of Fig. 10. The dashed horizontal line represents the analytic, idealized value of the attractive force, to know, *F*=503 N. The solid line characteristic represents the force values computed numerically using the method of weighted Maxwell stress tensor.

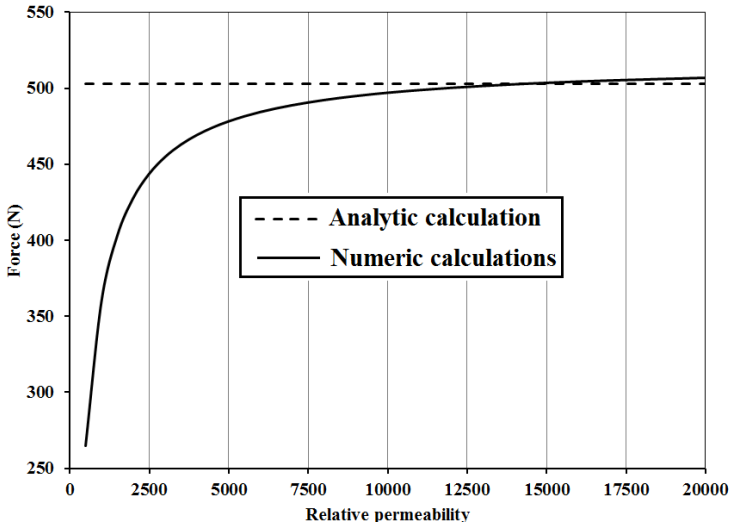

Fig. 10. Computed forces versus relative permeability: (i) Analytic: dashed line; (ii) Numeric: solid line

The characteristic that represents the numeric force calculations resembles a *B-H* curve and, along its excursion, one can identify the three different regions or portions that form a typical *B-H* characteristic: (i) firstly, the linear or quasi linear region where $500 \leq \mu_r \leq 2000$; (ii) secondly, a typical "knee" caused by the low to moderate saturation level of the ferromagnetic core; and (iii) the saturated region, where force values practically do not increase any more. The characteristic only exhibits a pronounced increase in force values along the initial portion of the plot. In this quasi linear region, the increase in successive pairs of computed forces falls from 36% to 3.7%. As a consequence of magnetic saturation, only a small increase in successive computed forces can be observed along the second region. For relative permeabilities close to 11000, the ferromagnetic core is already heavily saturated. As a result, the magnetic field strength at the gaps and the resulting attractive force converge to the values computed analytically by (6) and (9), respectively. For relative permeabilities greater than 11000, the percent error between numeric and analytic force calculations is less than 1.0%, i.e., numeric and analytic calculations of the attractive force are computationally equivalent.

5.5 Experiment 5: Magnetic Force at *ac*Operation

Consider the *C*-core electromagnet shown in Fig. 1. The exciting winding is supplied by an *ac* sinusoidal current at the operating frequency of 60 Hz. The peak value, I_p, of the terminal current is 5.33 A, the same magnitude of the terminal current at the *dc* operation. Use the analytic approach and determine the attractive magnetic force acting on the movable armature for this operating condition.

5.5.1 Solution to experiment 5

When the exciting winding is supplied by an alternating current, the magnetic field strength ***H*** alternates and so does the force density vector ***p***. If I_p denotes the peak value of the *ac* current, the instantaneous current is

$$i(t) = I_p \cos(\omega t), \tag{10}$$

and the instantaneous force density vector in the two air-gap regions is computed by

$$p(t) = \mu_0 \frac{n^2 i^2(t)}{8 l_g^2} \ \mathrm{N/m^2}. \tag{11}$$

The instantaneous force density vector can be expressed, either in terms of the fundamental angular frequency ω,

$$p(t) = \mu_0 \frac{n^2 I_p^2}{8 l_g^2} \cos^2(\omega t) \ \mathrm{N/m^2}, \tag{12}$$

or in terms of the double angular frequency 2ω,

$$p(t) = \mu_0 \frac{n^2 I_p^2}{8 l_g^2} \left[\frac{1}{2} + \frac{1}{2} \cos(2\omega t) \right] \ \mathrm{N/m^2}. \tag{13}$$

The product of the force density times the area *S* gives the attractive force in one air gap. For two air gaps, the value ought to be doubled. The alternating attractive magnetic force *F*(t) acting on the movable armature is thus given by

$$F(t) = (2S) \mu_0 \frac{n^2 I_p^2}{8 l_g^2} \left[\frac{1}{2} + \frac{1}{2} \cos(2\omega t) \right] \ \mathrm{N}. \tag{14}$$

Substitution of numeric values yields the following expression for the double-frequency attractive force:

$$F(t) = \frac{503}{2} + \frac{503}{2} \cos(2\omega t) \, \mathrm{N}. \tag{15}$$

In the graph of Fig. 11, one can identify three important features of the sinusoidal characteristic that represents the double-frequency magnetic force: (i) its peak value is equal to f_{dc}, the value of the stationary *dc* magnetic force, represented in the graph by the horizontal solid line; (ii) its minimum value is zero; (iii) its mean value, represented by the horizontal dashed line, is equal to $f_{dc}/2$, half the value of the *dc* magnetic force.

It is worth noting that the alternating magnetic field due to the exciting winding generates an alternating attractive force that drops to zero twice each cycle of the driving alternating current. This

would cause undesired mechanical vibration of the magnetized parts and metallic contacts attached to the actuator at the "closed" position.

In practice, this does not happen. Industrial *ac* actuators and contactors contain restoring springs and shading rings designed in a way that the net attractive force never drops below the mechanical forces created by the restoring springs. The reduction of the flux due to the exciting winding occurs simultaneously to the increase in the magnetic flux due to the currents induced in the shading rings, so that the circulating magnetic flux never drops to zero. A detailed discussion on the combined effect of the fluxes provided by the *ac* exciting winding and shading rings may be found in [32].

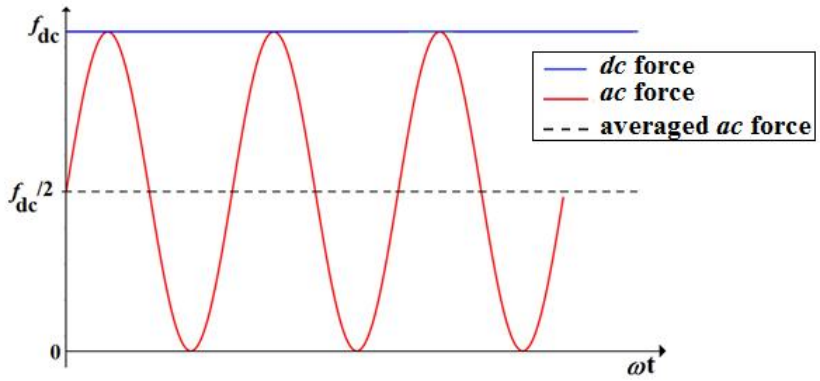

Fig. 11. Variation of *ac* and *dc* magnetic forces with respect to the angular frequency of excitation

5.6 Experiment 6: Eddy Current Lossin Laminated Cores

Specify the core of the actuator as a laminated structure and compute the magnetic loss due to eddy currents. Use the built-in library and select the material data file of the M-36 steel. In the analysis, the peak value of the terminal current is 5.33 A and the frequency of operation is 60 Hz.

5.6.1 Solution to experiment 6

Data files for soft magnetic materials are found in separate file directories, to know: (i) Low Carbon Steel; (ii) Magnetic Stainless Steel; (iii) Silicon Iron; (iv) Cobalt Iron; and (v) Nickel Alloys. The M-36 steelbelongs to the family of "silicon irons". Let us define the problem as magnetically nonlinear. Stator and movable armature are modeled as planar structures with the pack of laminations parallel to the *x-y* plane. In two-dimensional analysis, this kind of laminated structure is referred to as "laminated in plane". Other special attributes of the M-36 laminated structure include: the electric conductivity of the lamination σ_{lam}=2.0 MS/m, the thickness of each lamination d_{lam}=0.635 mm, and the laminations' fill factor, FF_{lam}= 0.98 per unit. If only the loss caused by eddy currents in the ferromagnetic core is to be computed, it is necessary to edit the M-36 steel data file and specify the maximum hysteresis lag angle as zero, i.e., ϕ_{hmax}=0.

When post-processing the field solution, it is necessary to choose the task "total losses" from the drop list of numeric surface integrations. This experiment illustrates an application where eddy currents are restricted by lack of space. For this problem, the eddy current loss amounts to 1.31 watt, and this represents only 0.6% of the input power. This level of power loss is completely satisfactory for most practical design constraints.

6. CONCLUSIONS

The work discusses the use of finite element programs as a complementary tool in the teaching of electromagnetics. All simulations in the virtual laboratory make use of a two-dimensional open-access software. An important aspect of the laboratory of simulations is its library of simulated experiments.

Considerable time and effort is necessary to build and maintain a library of simulated experiments. The library must be updated periodically, and new experiments must incorporate the enhancements of the field simulator. To reach an efficient and effective training, qualitative and quantitative issues have to be considered when planning the activities in the laboratory of simulations. A small number of assigned experiments may take the students to draw simple conclusions restricted to a particular class of problems. On the other hand, the indiscriminate use of a very large number of experiments may result in an exhaustive activity that adversely interferes on the time students need for exercising their creativity and thinking deeply during the laboratory classes and homework.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Chapter 8
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Place of Science in the Human Knowledge

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ABSTRACT

The simple model for the classification of knowledge is suggested. The four types of knowledge are considered: customs, arts, religions and sciences. The strict definition of science is suggested to distinguish it from other kinds of knowledge and from pseudo-science. The model indicates the methodology of the scientific research that is aimed to avoid conflicts between science and other kinds of knowledge. This approach is suggested to exclude some concepts from the scientific knowledge by some formal criteria at very beginning of the consideration.

Keywords: Fundamentals of physics; methodology; Mizugadro; physical mathematics; religion; science; TORI Axioms.

2020 Mathematics Subject Classification: 00A30; 00A35; 00A99.

1. PREFACE

This research is motivated by huge amount of fake results. Many of them pretend to be scientific. Especially grave the frauds are in Russia, due to the total corruption [1]. An example [2,3,4] of a fraud is presented in Fig. 1.

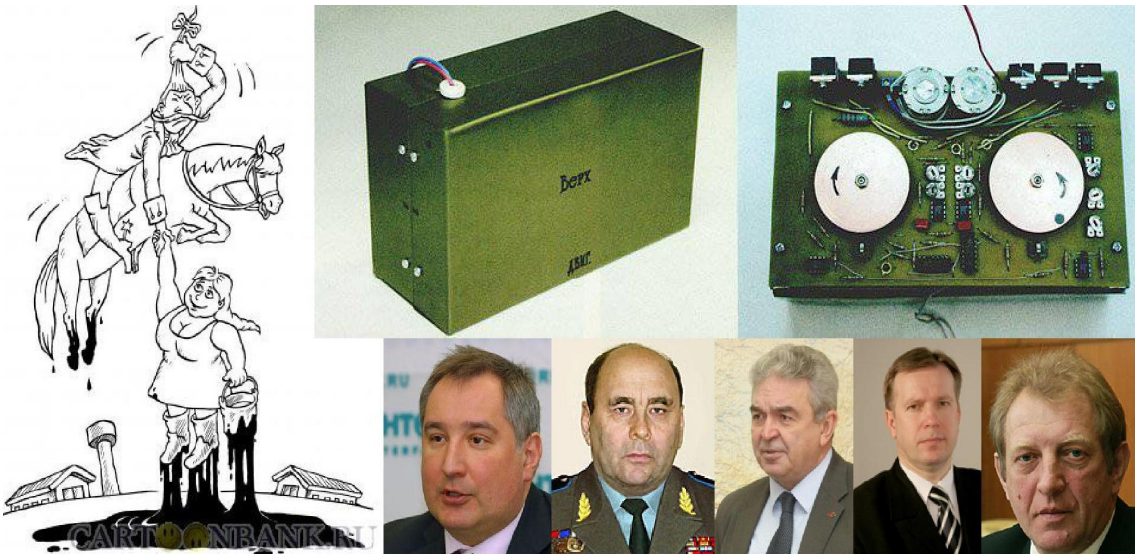

Fig. 1. Idea of propulsion of satellite "Yubileiny" [2]; "Gravitsapa" [3]; leaders of the Russian cosmic program: D. Rogozin, V. Menshikov, V. Nesterov, A. Seliverstov, A. Varochko [5]

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Fig. 1 shows the main idea of self-propulsion [2] of the satellite “Yubileiny”, the only available image [3] of inertioid “Gravitsapa”, installed there, and leaders of the Russian cosmic program. They pretend, that the “gravitsapa” provides the support-less force and changes the orbit of the satellite (breaking the fundamental laws of Physics) [4,6,7].

Bulletin [8] collects warnings about the danger trends in the development of the Russian science incentury 21. Many cases of the abuse are indicated.

The abilities of pseudo-scientists to publish fakes greatly exceed the abilities of enthusiasts to analyze and to criticize them. Then, the budget used for the money laundering, leaving no support for the scientific research. We need formal criteria to identify peseudo-scientific results. Such criteria (TORI Axioms) are main topic of this article.

Since year 2010, the Russian version of this article [9] provides the definition of science, that allows to qualify some results as non-scientific by the formal criteria, at very beginning of the consideration. That definition follows from the simple exercise [10], which, in its turn, is based on the ideas of refutability of scientific concepts; these ideas had been developed by Karl Popper [11,12,13] in century 20.

Phenomena similar to science (pseudoscience) occur not only in Russia. This motivated me to make the short English version, describing use of the TORI Axioms [14]; it appeared in 2013. Then, in year 2020, editor Ruma Bag asked me to extend it for book “New Insights into Physical Science”. I suggest this extension here.

2. ABOUT TRUTH

Often, it is supposed, that a scientific result is true, correct; while any pseudo-scientific result is false, wrong, non-correct. Then, for the qualification of any concept, it is sufficient to check it, to verify it, and, if it is wrong, to reject is. Such a common sense looks reasonable. Unfortunately, the abilities of pseudo-scientists to publish wrong, mistaken, fake papers and get foundation for pseudo-science greatly exceed abilities of scientists to criticize them, to reveal errors and to indicate, that some results are wrong.

In this paper, another approach is suggested. The idea is not to criticize each wrong concept, but to suggest the narrow definition of term “Science” in such a way, that any concept can be qualified as “scientific” or “non-scientific”, whenever this concept is correct or wrong. This cannot substitute the common sense, mentioned above, but gives the formal criteria, that allow to reduce the amount of results, that deserve a serious consideration.

Many Russian colleagues at school had to accept the strange concepts:

1. *Our Universe is infinite both in space and in time.*
2. *For photosynthesis, the green leaves use the central part of the visible spectrum of solar light.*
3. *The gradual evolution of a species with genotype of 48 chromosomes (monkey) led to the new specie with genotype of 46 chromosomes (mankind).*
4. *The communism in the USSR will occur within 20 years* [15,16]

Such concepts were suggested at the Soviet schools as a “scientific truths”. However, they are not truths, nor even scientific. At least, they do not fit the definition of science, suggested in section 8.

The Soviet veterans still declare the postulates of Sovietism (that, are I think, just wrong) as a truths, as scientific facts. The attempts to understand, what happened in century 20, why the communism was not built-up, why the USSR collapsed, why corruption become the main phenomenon that characterizes the entire life of the officials, why Russia is selling off the natural resources, etc. - are declared as ‘pseudoscience’ and ‘false history’ [17,18].

The list of popular wrong concepts could be much longer. Many of then can be qualified as Sovietism. They appears as a religion, although the Soviet teachers had considered them as scientific facts.

The goal of this article is systematization, classification of the knowledge in such a way, that many pseudo-scientific concepts can be disqualified at once. The formalism had constructed for Physics (for needs of the Quantum Optics and the Laser Science), but it applies also to other sciences.

In this work, the simple model of classification of the human knowledge is suggested. The model includes only four categories: customs, arts, religions and sciences. The narrow definition of science had been suggested in 2010-2013 [9,10,14]; here I retell and extend the description.

Religions [19] are important kind of knowledge, and they should be distinguished from sciences. So, this article deals with both sciences and religions. I show, that absolute truth is attribute of a religion, but not a property of a scientific concept, even if the concept is widely accepted as a "scientific fact" [20].

Often, a scientific fact may be considered as a "true" – until some new, modern theory provides more efficient or more general concept for the same phenomena. Here are examples:

Prior to the heliocentric system of the universe, Ptolemy's geocentric system is a scientific fact.

Prior to experiments with nuclear reactions, the concept of conserving the number of atoms of each kind (in a closed system) is a scientific fact.

Before quantum mechanics, the fundamental possibility of describing any system in terms of the coordinates and velocities of its components is a scientific fact.

Many scientific facts, that remained during centuries, are already refuted. In such a way, the "truth" cannot be main criterion for the scientific knowledge. Other criteria are necessary.

3. OBJECTIVITY AND KARL POPPER

Objectivity is often considered as a ***"cornerstone of science***" [21].

"I frame no hypothesis", Isaac Newton wrote [22].

Teplov Boris Mikhailovich believes, that the objective method is essence of science [23]: ***"..Objective truth is that part of our knowledge which correctly reflects reality and does not depend upon the subject, i.e. on human consciousness and will. Objective method, therefore, means the method that leads to knowledge of objective truth. For materialism, 'the recognition of objective truth is fundamental'; consequently all materialist science must be objective in method."***

Actually, the words about "objectivity" of science do not help to distinguish the true scientific results from the fake ones. The criterion of "objectivity" is used as a pretext for the physical extermination of opponents. In century 20, the repressions are especially grave in the USSR: ***"The revolution cannot be made in white gloves"*** [24]. This sentence justifies any crimes, if they serve the Great Idea.

During the USSR, of order of half of population of the country had been exterminated by the agents of KGB and other bolsheviks, claiming the struggle against the wrong concepts, for the "objectivity". In particular, the soviet fascists use this idea to murder the scientists. Practically, the idea of "objectivism" used to struggle against science and against scientists [25,26]. Researches, who worked with theory of relativity, with quantum mechanics, with cybernetics were suppressed in the USSR. Genetics had been exterminated. The psychiatry had been converted to the instrument of political repressions, for jailing and murdering of any citizen who does not accept postulates of Sovietism. The "objectivism", by itself, happens to be very subjective criterion: the concepts,

supported by the officials, by the usurper, are declared to be “objective”; any doubts are declared as subjective “pseudoscience”. In such a way, the idea of objectivity of science leads to destruction of science.

In century 20, Karl Popper extracts, discovers and describes the new, extremely efficient and useful kind of human knowledge [11,12,13]. He called it “science”, although the term “science” was used before in a little bit different meaning; that meaning included the claim of objectivity. K. Popper declares, that the main property, that makes the research, the result, the concept “scientific” is not its objectivity, but the principal possibility to criticize and to reject, refute (”falsify”) the concept [11]:

1. *It is easy to obtain confirmations, or verifications, for nearly every theory - if we look for confirmations.*
2. *Confirmations should count only if they are the result of risky predictions; that is to say, if, unenlightened by the theory in question, we should have expected an event which was incompatible with the theory - an event which would have refuted the theory.*
3. *Every “good" scientific theory is a prohibition: it forbids certain things to happen. The more a theory forbids, the better it is.*
4. *A theory which is not refutable by any conceivable event is non-scientific. Irrefutability is not a virtue of a theory (as people often think) but a vice.*
5. *Every genuine test of a theory is an attempt to falsify it, or to refute it. Testability is falsifiability; but there are degrees of testability: some theories are more testable, more exposed to refutation, than others; they take, as it were, greater risks.*
6. *Confirming evidence should not count except when it is the result of a genuine test of the theory; and this means that it can be presented as a serious but unsuccessful attempt to falsify the theory. (I now speak in such cases of “corroborating evidence".)*
7. *Some genuinely testable theories, when found to be false, are still upheld by their admirers - for example by introducing ad hoc some auxiliary assumption, or by reinterpreting the theory ad hoc in such a way that it escapes refutation. Such a procedure is always possible, but it rescues the theory from refutation only at the price of destroying, or at least lowering, its scientific status.*

Ideas by Popper are not widely accepted by colleagues; the believe in some “objectivity” remains [27]. The researchers suggest some non-refutable concepts in hope, that they do namely science, but not a religion: *“Why should I care about refutation of my results? I know, that they are true. They are irrefutable! If some reviewers have any doubts, let them search for a way to refute my results!”*

Such a hope, such a believe is used for fakes, destroying the science. It becomes impossible to understand, does the researcher believe in his/her own idea, or the case is an intentional fraud. One example of such a fraud is mentioned in the Preface. There are many such cases [28, 29].

Qualification of a research as “science” or “religion” depends on definition of science and on definition of religion. This indicates the need to elaborate the appropriate definitions, they are provided below in the special sections. The human knowledge is classified a way, that does not allow science to deal with non-refutable concepts.

This question is not only terminological. Many authors pretend, that their results are true; so true, they do not need to allow any refutation (sometimes, the term falsification is used in the similar meaning). This leads to the growth of various pseudosciences, which may be extremely efficient in obtaining funding, but useless in any other application.

The problem of classification of knowledge remains: neither “true”, nor “objectivity” serve as main criteria for scientific knowledge. However, the ideas by Karl Popper indicate the way to classify the knowledge. Such a classification is suggested in the following four sections; they describe customs, religions, arts and sciences.

4. CUSTOMS

Category of customs includes the commonly accepted behavior of humans. Also, it includes the habitual semantics of commonly used human languages.

The habit to drink from the bottle, shown in Fig.2, also should be considered as knowledge and even skill; especially, if all the alcohol goes to the throat and no one drop is missed. In the similar way, the money laundering with pretext of pray for reparation of roads, rockets or dams should be considered as a custom. The genre of the last 3 pictures in Fig. 2 can be interpreted also as a religion (considered below) – under conditions, that the popes, performing the magic, believe, that their actions may repair the faulty rocket, or stop the flood, or, at least, reduce amount of puddles and clay on the road.

The meanings of words, even in a religion, are customs. At least part of semantics appears as a custom. Habits to use science, technology, ritual dress or magic are customs. The usual meaning of the Bible is a custom, widely accepted in the Christian community. The sentence *"You shall love your neighbor as yourself"* allows various interpretations [31,32], dependently on the meanings of the word "love" and its Hebrew and Aramaic equivalents. Some interpretations are not popular, they are not customs. The interpretations of the New Testament by Tim Rice [33] and that Michael Bulgakov [34], due to the wide spreading, can be qualified not only as an art, but also as a custom, at least in certain literature or musical communities. Such an interpretation should be qualified a knowledge. In such a way, the meaning of words appear as a knowledge.

The folklore also falls in the category of custom. It is any knowledge, that is difficult to investigate by systematic methods. Any legend, story, narration leaves from category folklore, from category custom and becomes art or even science (history), as soon as it is written, published, criticized and considered in a scientific way as a possible historic evidence.

The semantics of the human languages and their understanding, the meaning of words is important part of a language. Customs, as kind of knowledge, give sense to other kinds of knowledge, considered below.

Fig. 2. Customs [30]: Drinking from the neck of bottle; use of magic for rockets, dams, roads

5. ARTS

Few examples of objects I consider as art [15] are shown in Fig. 3. In order to be more specific, I suggest the definition below:

"Art is any kind of knowledge that is free from internal rules and is realized in a reproducible form that allow its systematic investigation"

Such a definition corresponds to a goal formulated in the introduction, although it slightly reduces the set of things which could be called *art*. Usually a product of art has the following properties:

A1. Beauty: Here, the beauty is the extensive ability of any unexpected use. The prehistoric hunter, painting and observing an image of an animal on a rock, may guess how to catch this animal; the reader, laughing on a comedy, may ask himself: *Either I am free from all the evils shown?* - although the primary goal could be just laugh.

A2. Absence of structure: Intents to bring into the arts rules are not efficient. The arts use all other knowledges; the same product may have both artistic and scientific value.

A3. Wisdom: A painter, a writer, any artists with their works say more, than they planned to say, and more, than they understand by themselves. In this sense, the product of art may be wiser than the author.

A4. Entirety: Attempts to correct, to improve a product of art destroy it.

A5: Amoralism: Creatures that have goal to bring some moral to the society, have low artistic value if at all; the creature may violate any taboo of the society. Including the religious ones.

There exist very few examples of a product of art, created with goal to bring some certain moral to readers, that achieve this goal. Perhaps, of such a kind, there are

"King Matt the First" by Janusz Korczak
"Le Petit Prince" by Antoine de Saint-Exupéry.

In most of cases, the stronger the artist tries to bring some moral to consumers of his/her art, the farer from art is the product. The Soviet artists were highly motivated for bringing so-called "communistic moral" to the society. In the most of cases, instead of art, they were making propaganda, id est, misinformation. In the result, the population of the big country had been converted to criminals, alcoholics, drug-dependent barbarians with mafia of corrupted officials at the top.

There are special sciences about the art. Some references are collected in the special article
https://mizugadro.mydns.jp/t/index.php/Art

The art may affect humans through various senses. The object, performance or any other information can be qualified as "art", if it affects on emotions and behavior of a human. There is no formal ("objective") criterion, what is art and what is not art. Attempts to introduce such a criteria lead to censorship and suppression of art.

There are many sciences about art. Aiming the specific application of the classification, the topics of customs and arts are presented here only declaratively.

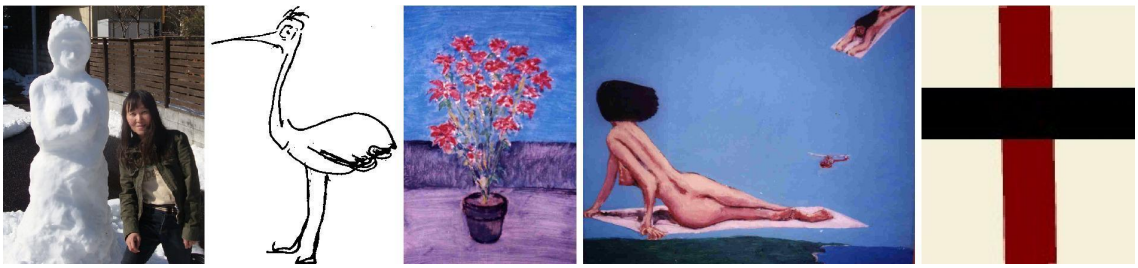

Fig. 3. Arts: Five examples of works by various artists [35]

6. RELIGIONS

Religion is kind of the human knowledge based on some (specific for each religion) set of irrefutable concepts, believes [36], texts, symbols and performances.

Usually, any religion is characterized with the most of followin:

R1. The existence of at least one God is presumed.

R2. There exist canonical sacred text, that allow the humans to guess the will of God(s) and follow it.

R3. God like some actions of human, these actions are called Good.

R4. God dislike some actions of human, these actions are called Evil.

R5. The suggested set of concepts pretends to play an organizing role in the society: The following to namely this religion provides abilities for the kindness, prudence and wisdom significantly wider, than any other religions.

It this article, God is generic term denoting any intelligent subject that in some way (that is not available for humans) has abilities that greatly exceed those of a human. Actions related to these abilities are called miracles, marvels.

God may look like a human (Jesus Christ, Buddha, Lenin), but also can be “non-material" (God - Holy Spirit, World Revolution, Marxism). God may be omnipotent (almighty), invincible, immortal and predicts future:

> *The Marxist doctrine is omnipotent because it is true [37].*
>
> *Long live invincible marxism-leninism-mao tsetung tonight [38].*
>
> *Lenin lived, Lenin lives, and Lenin will live [39].*
>
> *The generation of those who are now fifteen will see a communist society, and will itself build this society [15].*
>
> *The immortal beacon of Comrade Stalin will forever illuminate the path on which the Chinese people march forward [40].*
>
> *And he said unto Abram, Know of a surety that thy seed shall be a stranger in a land that is not theirs, and shall serve them; and they shall afflict them four hundred years [41].*

Some religions do not identify themselves as religions, pretending to be sciences [42,43].

The adepts consider their own belief as the only true concept, deny the dogmatic character of their believes [44] and treat any deviant behavior as crime, heresy and mental illness; the wrong-believers are punished or undergo the forced medical treatment [26].

Fig. 4. Religions: Illustrations by S. Tihomirov [52], V. Shmakov [53], O. Kuvaev [54]

Some religions justify lies (misinformation, propaganda), sacrifices, betrays, massacre, murdering and wars, if they serve the needs of God: You cannot make revolution in white gloves [24,45].

Most of religions avoid any refutable concepts. The concept is called refutable, if (and only if) in terms of this concept, some specific observation can be described, that negates the concept. Statement ***"The Current Generation of Soviet People Will Live Under Communism"*** [16] is refutable: based on such a declaration, the next generations (say, since year 1980) may shame, judge, punish, execute the Sovietveterans as liars and impostors. (This is an addition to the punishment for the war crimes, committed by bolshevicks since the beginning of the USSR; Sovietism approves and defends any crimes of the Soviet fuhrers with concept "***You cannot make revolution in white gloves"***; such a concept justifies any kind of genocide, even if 90% of population of a country are killed with such a slogan [45]).

Within few generations since creation of a new religion, it abandons, forgets its refutable concepts and becomes more stable. Here are the examples of irrefutable concepts:

God bless America [46].
Imperialism is evil [47].
God gives the immortal soul to everyone [48].
The righteous will be at Heaven [49].
Socialism and communism are the future of Humanity [50].

However, the last statement (about communism) becomes refutable (and wrong) as soon as the year (1980) and the country (USSR) of realization of such a project are specified [16].

The canonical texts describes the marvels, miracles, magic, specific for each religion. The miracle may refer to the magic conversion of water into wine, to the drastic increase of the efficiency of the production by the inspiration of the Führer, catching of the spies by children, destruction of an army of the enemy tanks by several heroic soldiers launching grenades, etc.

A honest and effective pray can also be considered magic - if it leads to the desired result. Otherwise (for example, if after an expensive religious ritual, consecration, a space rocket fails, see Fig. 2), the pray should be qualified as fraud and money laundering. Such a fraud is rather custom, than a religion.

Not all religions pretend to be “the only truth”. So-called “civil religions” recognize themselves as only parts of the human knowledge [51]. Such a recognition makes the civil religions efficient in stabilization of a society on the civilized development, favoring prudence, technology and science.

Religions form significant part of the human knowledge and play important role in the human history. While a religion is tolerant with respect to other kinds of knowledge (and in particular, to other religions), it may assist the prosperity of the society.

No one religion can substitute other kinds of knowledge, nor even other religions, as one specific science cannot substitute all other sciences. Any society, where one religion dominates in an aggressive way, becomes barbarian compared to other countries within few generations; the people of such a society lose the ability to analyze the information.

Religions go through the all hystory of Humanity. There are no examples of stable atheistic societies. Even if the goal of creation of an atheistic country is declared – soon, within few years, the new, and very barbarian religion appears, pretending to be science, but also claiming to be “the only true knowledge”. (So it happens in the USSR, in China and some other “socialistic”, “communistic” tyrannies in century 20.) In order to consider this claim, term “science” should be defined. This is matter of the next section.

7. SCIENCES

I illustrate schematically term “science" in Fig. 5. As it was mentioned in the second section, the term “science" may have different meanings. Following K. Popper, in this article, this term applies only to a refutable knowledge.

In order to distinguish science at the background of pseudoscience and religion, the term *science* should be defined as follows:

Science is kind of knowledge, activity and notations, based on concepts, that have all the six properties below:

S1. Applicability: Each concept has the limited range of validity, distinguishable from the empty set.

S2. Verifiability: In the terms of the already accepted concepts, some specific experiment with some specific result, that confirms the concept, can be described.

S3. Refutability: In the terms of the concept, some specific experiment with some specific result, that negates the concept, can be described.

S4. Self-consistency: No internal contradictions of the concept are known.

S5. Principle of correspondence: It the range of validity of a new concept intersects the range of validity of another already accepted concept, then, the new concept either reproduces the results of the old concept, or indicates the way to refute it. (For example, the estimate of the range of validity of the old concept may be wrong.)

S6. Pluralism: Mutually-conflicting concepts may coexist. The coexistence of mutually-conflicting concepts, satisfying requirements S1-S5 above is allowed. If two concepts satisfying S1-S5 have some common range of validity, then, in this range, the simplest of them has priority and should be considered as main, principal.

In the definition of science, all the six properties are compulsory.

For example, if the range of validity of a concept is the *full set* (id est, the concept is valid every time and everywhere), then, by definition, it is not scientific, as it does not satisfy the criterion S1, and there is no need to check properties S2-S6 to qualify such a concept as non-scientific.

Similarly, if there is no way to refute a concept, then it cannot be considered by scientific method; for such a concept, there is no need to check other criteria above.

In such a way, many concepts can be disqualified at once, loading the burden of proof to the inventors of a new concept.

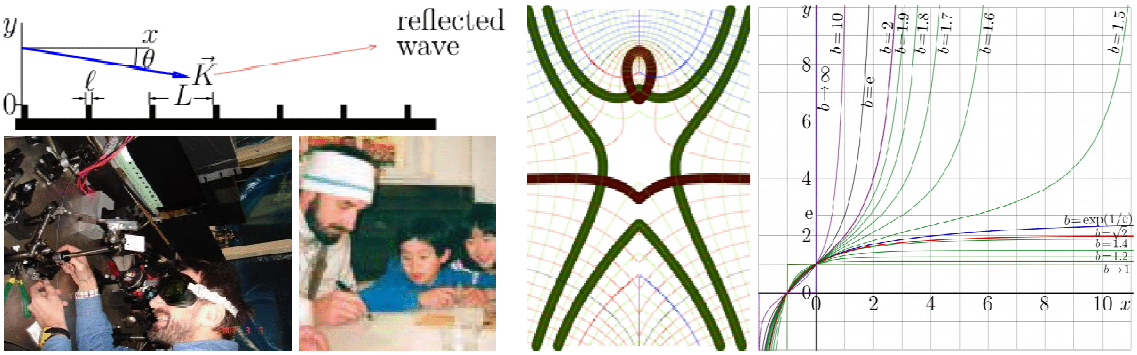

Fig. 5. How to draw Science? [52]

Scientific concepts are built on the base of observations, experiments, definitions, axioms, hypothesis, theorems and theories.

Observation means identification of some phenomena which are in some sense similar.

Definitions allow to use compact notations, making the description of scientific concept shorter and simpler.

Axioms are statements that are considered as initial at the building-up of some concept. Set of few concepts with commonly accepted axioms is called “paradigm".

Theorems are statements that are proven on the base of axioms and definitions. Sometimes, this term is used even in those cases then the proof of the statement is not yet constructed, but is expected to be constructed in future. In such a case, term “hypothesis" or “Conjecture" is more suitable.

If the hypothesis is deduced from the postulates and other, already proven theorems, it becomes theorem. If a hypothesis had predicted some non-trivial results of observations or experiments, it becomes theory.

Activity, related with development of new concepts is called research. The most important classification of sciences is based on the subject of the research, the goal and the methods, that dominate in the research: humanitarian - natural, fundamental - applied and theoretic - experimental.

In principle, such a structure could be applied to all the sciences. Not all sciences are developed sufficiently to allow the use of the full scheme above. The search for “mathematics in history” return links about history of mathematics: the historians describe history of mathematics rather than use mathematics in description of historical events. The known exception is the prediction of collapse of the USSR in century20 by Andrei Amalrik [53], “calculated” the collapse of the USSR during century 20. Since century 21, the calculus, the mathematics enter to all sciences, even to psychiarty [54].

8. HIERARCHY OF SCIENCES

Mathematic makes the basis of other sciences. No one science dares to contradict mathematic. The computational mathematics and cybernetics provides a bridge between mathematics and other knowledge. The general physics and theoretical physics relate mathematics with other sciences,

although some sciences (even humanitarian ones) may use, for example, the statistical methods without to refer to physics. All the sciences use logics, (Boolean algebra); usually it is so obvious, that it is not even declared.

Physics is considered so fundamental as mathematics. There are several examples, when the laws of physics are broken in sci-fi literature. There is only one example detected, where the laws of mathematics are broken - in fantastic essay ”Mizugadro number dream” [55]. That sci-fi had been written in order to get at least one example of braking of laws of mathematics in fantastic literature.

Hypothesis about internal contradiction of axioms of Arithmetic is not scientific: In is irrefutable; no way to reject it is supplied. However, it can be used (explicitly or implicitly) for frauds. Any inconsistency of arithmetic could be very useful at the summation of momenta of details of “Gravitsapa” (see fig.1) in order to violate the law of conservation of energy-momentum, getting a pretext to milk the budget, assigned for development of science.

Even more direct fraud can be based on tricks with arithmetics: Some official gets credit, say, a bullion rubles, while billion=10^{12}, and return the debt after devaluation [56] of billion for 3 order of magnitude, while billion=10^{9}. At high level of corruption among the state officials, similar operations can be performed with other ambiguous numbers (trillion, sextillion, etc). Publications indicate, that in century 21, such (or similar) operations are, indeed, are performed [57]; many billions rubles were stolen from the Russian budget in 2018, 2019 and, apparently, used for the support of the world-wide terrorism [58]. While the corrupted [1] officials can violate rules of arithmetics in summation of momenta of details of an inertioid (“Gravitsapa”), there are no mechanism that could prevent use of the same trick counting money in the state budget. The state, that can declare, that ”2+2=5”, can violate all other rules and laws, suppressing the citizens [59].

Usually, all sciences respect physics and mathematics. However, the organizers of a financial pyramid may claim, that all the participants get their benefits (that contradict the law of arithmetic). In the similar way, the fraudsters may claim, that the sum of momenta of particles, moving inside an inertioid, depend on order of the summation, that leads to violation of law of conservation of momentum (Fig.1). However, in both such cases, the claim should be qualified as fiction or fraud.

If, in some science, some concept contradicts the basic paradigms of mathematics or physics, then, according to axiom S5, there should be indicated a way to see, that the commonly accepted paradigms are wrong. To avoid the confusions, the term science should be used only in the sense of the definition above. In all other cases, terms pseudoscience, sovietscience, christianscience, quasiscience may be used to specify, that some activity or knowledge looks similar to science or similar to a scientific research.

9. SCIENCES AND THE SOCIETY

Usually the sciences, and especially the fundamental ones, do not give a fast benefit. The spending of the budget funding for satisfaction of the personal curiosity of researchers requires some justification.

There were attempts to submit the development of science to other goals (creation of facilities of the modernization of the industry, or increasing of the military power of a country, etc.). Some researches, especially applied ones, can be motivated in such a way; sometimes the results have the scientific value. Often, the results of such a research are just fake.

During the human history, there was not developed more efficient motivation for science, than curiosity of researchers who do it. Yet, there is no other way to make the deep science. However, the needs of industry can be mentioned as motivation for the financial support of the curiosity of researchers.

The distribution of funds, assigned for the development of science, is serious problem. Administrators of funds cannot drill deeply into the research they finance. The funds are distributed on the base of the formal criteria: publications, citation, participation in the conferences. The ability to write the grant

applications and good relations with colleagues and the distributors of funds become important, if not dominant, factor in the success in the getting of the financial support. For the same reason, the spectacular nature of a new effect is important for its promotion.

Especially non-efficiently the funds are spent in the countries with corrupted bureaucracy; and not only because the significant part of foundation is spent for bribes and the private security. The government being unable to keep the growth of the technology of the country at the international level begins to secret the scientific achievements in order to enable the monopolistic use in the military industry. The secrecy protects them from critics and opens wide field for both, intentional frauds and unwanted mistakes.

In a totalitarian country, some sciences are not only left without foundation, but are affected by the physical repression of researchers, as it happened in the USSR with the theory of relativity, quantum mechanics, cybernetics, genetics and other sciences [26]. Previously, in Europe, in the epoch of the Holy Inquisition, the similar phenomena took place with respect to astronomy and astronomers.

Perhaps, in some cases, the executors, destructing the science, indeed do not understand, that they act against the human civilization and against interests of their country; they do not consider themselves as bloody murderers, not as enemies of the people of their country. In such a case, the qualification, classification of the human knowledge may help.

The properties S1-S6 allow to separate scientific concepts from others without fighting the pseudoscience. For this reason they are combined into definition of science above.

Qualification, classification of the human knowledge is important for the development of science. The correct, efficient terminology is required for this classification. Questions of the terminology are considered in the next section.

10. ABOUT TERMINOLOGY

Often, the errors are caused by a smooth, fussy definitions of terms and the concepts. The most crying examples refer to the humanitarian science. In 2009, Dmitry Medvedev had announced the setting up of a commission to counter the falsification of history [17,18]. This makes the Russian concept of history non-refutable (not falisifiable) and disqualifies it as a science.

There is still hope, that this is just terminological confusion, and that commission does not have aim to destroy the historic science. The goal of this paper is not to provoke conflicts, but to mitigate them. I suggest not to use words “falsification”, “falsifiability”, at least in the scientific texts. Such terms are ambiguous. They may mean the negation of a concept for the contradiction to observations, as well as the misinformation. With respect to historical texts (whenever they scientific or not), the terms revisionism, opportunism and reformism appear in the similar (ambiguous) meaning.

Any term, that has two opposite or different senses, should not be used without specification, namely which of them do the authors mean. Often, the authors omit such a specification.

In this paper, the term “refutability” is used. However, if refutation of the Russian official version of history is also prohibited, then there is no way to attribute the confusion to terminology, and that concept should be qualified as non-scientific. This would not be a big loss, because the Soviet concept of history (Sovietism) anyway is just wrong; it is full of internal contradictions and disagrees with visual observation of that happened to the USSR in century 20. The goal of this research is not to convince someone to stop destroying science, to stop prohibiting critics of the “official” scientific (and not so scientific) concepts. The goal is the analysis of the historical events and elaboration of the adequate (non-ambiguous) terminology for this description. This is just scientific interest, to denote a fraud with term “fraud”. Things should be called by their proper names.

11. IMPORTANCE FOR PHYSICS

I would not like to teach colleagues, what to write and how to write, but just indicate, what properties make the research scientific. This section explains, why I boil up so old question, and why it is important for physics.

I used to meet several “strange” concepts, that pretended to be scientific. I mention examples below:

Estimate of the statistical significance of a “second” peak at the correlation function, using the Poissonian model of random (independent) distribution, that can be rejected due to the significant ”first” peak [60].

Quantum annihilation of the optical soliton [61].

Extrapolation of the quasi-optical approximation in the atmospheric physics [62].

Quantization of the magnetic flux in a free space [64].

Violation of the Kramers-Kronig relation for the active laser materials [65].

“Non-equivalence” of the van der Vaals potential to the index of refraction in paraxial atom optics [66].

“Proportional increase” of the power of a disk laser with increase of the size of the active element [67].

“Impossibility” of real-holomorphic superexponential [68].

The square root of factorial as having “no sense” [69].

The inertioids (that violate the law of conservation of momentum, Fig. 1) [10,70].

I had participated in discussions, originated in different branches of physics. The common feature of these cases is, that the colleagues do not specify the range of validity of their concepts, do not indicate a way to refute their concepts, do not show the relations with previous results, and discuss applications of some effect without to indicate the contradictions with the scientific facts, with already commonly-accepted concepts.

In principle, there is nothing wrong in the contradiction of some experiments to some widely accepted theory. Contrary, such a revolutionary discovery is very interesting and important; it may indicate the need to revise, improve the most important concepts. However, such a contradiction is a main result of the research. Such a contradiction should be mentioned in the title, in the abstract, in the conclusion as the main achievement of the author(s). if the authors found violation of rules of arithmetic, the title of the scientific article article should cry: ***The internal contradiction in axioms of arithmetic***. But the title of a scientific publication about such a revolutionary discovery should not mention the application for recovery of agriculture (destroyed by genocide, extermination of farmers), nor making the 5-year plan of production of metal in 4 years.

Idea of use an effect, that contradicts basic laws of physics, appears as subject of humor in the sci-fi novel “Tale of the Troika” [71] (Сказка о Тройке 1968) by Russian writers Boris and Arkady Strugatsky. The ”Troika on the Rationalization and Utilization of Unexplained Phenomena” is described. However, the same idea is applied for the money laundering at the space research centers and other secret organizations even in century 21.

12. MORE EXAMPLES

For illustration of the basic ideas expressed above, in addition to cases mentioned in the previous section, I consider two more examples. The examples of the concepts that, from my point of view, are not scientific (although are declared to be scientific). One of them deals with the effective cross-

sections of emission in the laser material (Fig. 6); another one refers to so-called “global warming” (Fig. 7).

An example of a non-scientific concept is shown in left hand side picture of Fig. 6. It is figure from Appl.Phys.Lett. [72], year 2006. It shows dependence of the effective cross-section of absorption and emission of light in the Yb doped Gd 2 SiO 5 crystal on the wavelength. The curves for absorption and emission, shown in the left picture, contradict the McCumber relation. Such a contradiction leads to violation of the Second Law of thermodynamics. With such a crystal, one would be able to arrange not only a good laser, but also the Perpetual Motion machine of second kind.

In order to avoid redistribution of fake curves, the left hand side picture of Fig. 6 is marked with words MATERIAL FOR PERPETUAL MOTION.

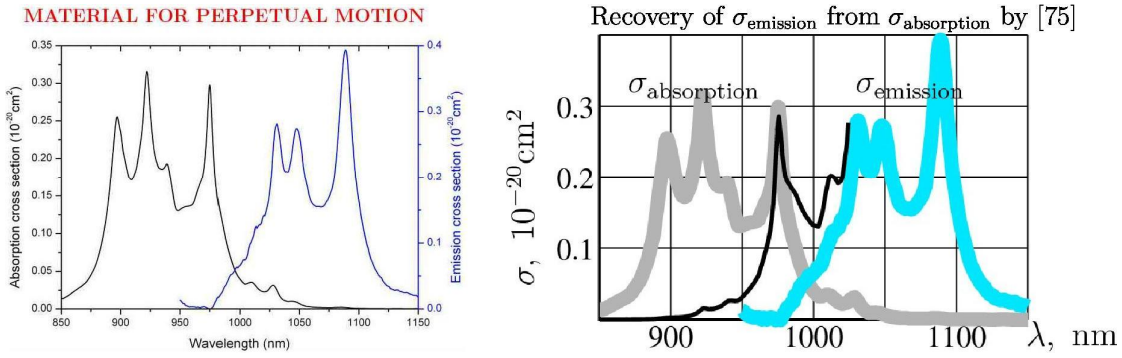

Fig. 6. Fake result [72,73,74]; correction of $\sigma_{emission}$ by the McCumber relation [75] (thin line)

Perhaps, both curves for the cross-sections in left plot of Fig. 6 are wrong. The hypothesis, that the only emission is wrong, is considered; then, emission can be recovered from the absorption. An example of such a recovery, correction [75] is shown in the right hand side picture of Fig. 6 with black curve. This curve is not extended to the right hand side of the plot: there, values of absorption are small, and the error of the recovery is huge.

The Second Law of thermodynamics is scientific fact: no experiment, that breaks it, is known. It would be methodically correct, to claim the tremendous discovery, revision of the fundamental physical concepts. Instead, the authors claim the efficient laser material. Such a claim contradicts the 5th of the TORI Axioms (Principle of correspondence) and makes the concept non-scientific, according to the definition suggested. (However, it may still be considered as “scientific” in other system of notations, that make no difference between science and religion).

The wrong effective cross-section mentioned cannot be interpreted as an occasional mistake of a single researcher. A dozen of authors have published similar curves in various scientific journals: Applied Physics Letters [72], Optics Express [73] and Solid State Communications [74]. In such a way, the error should be qualified as methodological: Often, the results are not revised from point of view of self-consistency (Axiom S4), nor for the principle of correspondence (Axiom S5).

I think, the contradiction of results to the McCumber relation (and therefore to the Second Law of thermodynamics) should be revealed and declared by the authors before it is found by the reviewers and other colleagues.

It is difficult to believe, that among a dozen authors, six reviewers and 3 editors, no one knows about McCumber formula and its relation to the Second Law of Thermodynamics.
Perhaps, the common methodological, systematic mistake takes place. The authors consider own results as a truth, that does not need any refutation, nor even comparison with the scientific facts.

On the first glance, the left hand side of Fig. 6, if we remove words “MATERIAL FOR PERPETUAL MOTION”, looks more scientific, than first picture of Fig. 1 (that shows the idea of propulsion of the Russian satellite Yubileiny with device Gravitsapa on board). However, if we look at the meaning of quantities plotted as ordinates, we see, that the difference is not so big: in both cases, the fundamental laws of physics do not work.

The similarity goes further. In both cases, the inventors, instead of to claim, that the basic physical concepts should be revised, just declare, that their invention can be useful. Such a statement looks similar to the claims of organizers of a financial pyramid: they promise dividends to all the participants, and do not care about law of conservation of money; apparently, the laws of arithmetic in their calculus are broken.

Another example refers to the Global warming. Since year 2019, this concept is associated with name of Greta Thunberg [76] shown in first picture of Fig. 7.

Fig. 7. Greta Thunberg, 2019 [76]; Japan, Tamagawa 2013.01.14 [77]; Peterburg 2017.07.22 [78]

Several links about Global warming are collected at Citizendium [81] and Mizugadro [82]. The common fault of the adepts of the global warming is, that no way to reject this concept is found in the bunch of literature on the topic.

From the first glance, the absence of snow during summer at Europe (say, at the latitude of Peterburg) and absence of snow anytime of year at the Japan latitude (say, at the level of Tokyo) was supposed to confirm the concept; and the presence of precipitation of water in solid state (in the conditions mentioned) should negate the concept. This happened to be not a case: after the heavy snow at Tokyo area 2013.01.14 [77] and at Peterburg 2017.07.22 [78], the adepts of the global warming still keep their claims. Since that, it is not possible to consider the global warming as a scientific concept: It is not clear, which observation would be sufficient to refute it.

In order to help the adepts of the global warming, I suggest an example: Assume, during century 21, all the seas, even in the tropical zone, happen to be covered with layer of ice. Then, one should admit, that the concept “Global warming” is just wrong. Such an example is exaggerated, but, since century 20, no other (more soft) example of hypothetic observation, that could refute the concept, is found. Rate of the “global warming” is of order of 1°C/century; it is difficult to make any non-trivial, but still refutable prediction on the base of concept of the “global warming”.

On the base of this result, the global warming is qualified as non-refutable concept. It does not satisfy axiom S3 (**Refutability**) and, by this reason, cannot be considered by scientific methods. However, the behavior of adepts of the global warming can be subject of scientific research. Avoiding both verifiability and refutability (basic principles of the scientific knowledge) can be qualified as a custom, making analogy with other customs; for example, with that shown in first picture of Fig. 2: There is some similarity in poses of the two persons shown. In the same way, the bzz about the “global warming” may look similar to science. Pseudoscience reproduces some elements of science, in the similar way, as the “Cargo cult” reproduce the exterior of airplanes (instead of to learn mathematics,

aerodynamics, thermodynamics, metallurgy; - instead of to construct gliders and motors, and only then try to combine them).

Such mimicry is not an exception in the human society. A visit by a fat oligarch to a high-ranking restaurant has nothing to do with the nutrition of his body. Using the services of a prostitute has nothing to do with the reproduction of humanity. The activities of the so-called ”Liberal Democratic Party of Russia” have nothing to do with either liberalism or democracy. Even the Red Rose (Lancaster) and White Rose (York) [79] clans have nothing to do with gardening. The readers will agree with me, if they try to answer: How many physicians know physics? Or estimate, in °C, temperature of an “absolutely cold tea” [80]: +40, +18, +4, 0, -273?

The near-scientific activity of researchers and politicians, who do not care about scientific meaning of their concepts, has nothing to do with making of science; it is just money laundering. The TORI axioms are suggested to reveal and qualify such a kind of activity.

It is difficult to write a separate Erratum or article on each case; only few popular mistakes are mentioned in the publications cited. I suggest to adjust the criteria, that the scientific results are supposed to satisfy. This does not mean to make the requirements harder, but to soften the struggle between the authors and reviewers, that sometimes takes the strange form: the authors try to hide the cases, when the concept fails, while the reviewers are supposed to reveal these cases.

Criterion S1 (**Applicability**) strongly suggests, that the researchers estimate, until where their concepts are valid. Criterion S3 (**Refutability**) invites any authors to indicate, which result of which experiment would show, that they are wrong. Such indications and estimates greatly simplify the consideration (and refutation) of concepts. This makes them scientific.

This approach should help to deal with strange phenomena like observation of the “torsion fields” or the “cold nuclear fusion”: either to reveal an error of the concept at very early stage, or to turn the researches into the scientific, making them different from a circus trick. The definition of science suggested allows this without to struggle against pseudoscience; such a struggle is dangerous for science.

13. TECHNOLOGIES

Science is used in technologies. Technologies are so important as sciences. Technologies are older than sciences. First, Homo Habilis, and then - Homo Sapiens.

Science without technologies become meaningless. I illustrate this with two examples:

1. Jonatan Swift describes the society, where science is highly developed, but separated from technologies [83]. Such a society looks as a parody on the idea of domination of science.
2. There existed some science in the USSR. Due to the total corruption of the Soviet administration, the scientific achievements could not come to industry. So, the USSR became the “*Upper Volta with missiles*” and had collapsed.

Technologies can be qualified as customs, but they are close to both sciences and arts. On the one hand, technology uses the scientific achievements (and in this sense is close to science). On the other hand, any good technological solution is product of art. The margin between science and technology is determined by the definition of Science. Technologies have no need to demonstrate the evidences nor correctness of their concepts; the proof of technology is the efficiency in business, or, better, the efficiency of a new device. (It is conceivable to have good business with a device, that does not fulfill its utility.) The intents to boost the technology with governmental support are not efficient; they boost the pseudo-science, money laundering and other kinds of corruption. I consider the governmental foundation of technologies, especially sponsorship of the secret research, as a fraud. I think, the results of any research, sponsored by government, should be presented in a form of scientific concepts.

The classification of the human abilities and the analysis of the foundation of technologies is interesting and important topic. It falls out from the scope of this article and may be subject for the independent research.

14. DISCUSSION

I suggest examples, that show, that namely the TORI Axioms S1-S6 are essential for the efficient building-up the scientific knowledge. I explain, how and why do I distinguish it from other kinds of knowledge.

In certain sense, this is question of terminology. One may insist on the old, “Newtonian” interpretation of science as a “true” knowledge [22], that does not need any hypothesis nor refutations. Then, the new term is necessary to denote the phenomenon, that is denoted with word “science” in this paper and in publications by Karl Popper [11,12,13].

I justify the need of the TORI Axioms with analysis of the observations, presented in the list of references below. This is not fully correct: this analysis is, by itself, based on the TORI Axioms. It is unavoidable: one cannot describe the Boolean algebra, using the motivated reasoning (Female logic) [80], as one cannot describe the Female logic, using the Boolean algebra. I explain why and how I come to the TORI axioms. But I cannot prove the TORI axioms, using the motivated reasoning, mentioned above. In the similar way, I cannot prove anything to the people, who insist on some “objective knowledge”.

The TORI Axioms can be considered a religion: I cannot prove them. (The logic axioms also can be considered as a religion; one cannot prove them.) I consider this religion to be extremely efficient in building-up the scientific knowledge. In the similar way, Muslims consider Islam as the most efficient way to Heaven. In the similar way, the Soviet veterans consider Sovietism as the most efficient way to built-up the heaven (”communism”) for themselves (even if they have to convert their country to concentration camp in order to achieve this goal). The TORI Axioms can be treated as other religions - as Buddhism, Judaism, Cristianity, Marxism and Islam – if we look not at the amount of adepts, but on structure of the believes.

The readers may consider the TORI Axioms as hypothesis, and compare the efficiency of this hypothesis with other models. Other models can be more efficient in obtaining the huge grants for the scientific (and not so scientific) projects. Perhaps, for getting foundation, the motivated reasoning (“Female logics”) [80] is more efficient. Here I do not discuss, is this good or bad; I only analyze the observed phenomena.

One may consider also any alternatives, what should be called “science”, and what should not. Provide your definition of term “science”, and compare its efficiency to that I named.

If you use another definition, have you revealed, that the bzz by Valery Menshikov about “Yubileiny” and “Gravitsapa” are just fraud, money laundering, analogy of claims by Baron Munchausen?

With your definition, have you revealed, that the material with effective emission and absorption cross- sections, shown in left hand side of Fig. 6, violates not only the McCumber relation, but also the Second Law of Thermodynamics?

Or anything else? Can you suggest an example, when your definition allows to reveal a mistake or a fraud, and the TORI Axioms do not?

Or any example, when the TORI axioms disqualify some scientific result, that gives a good profit for the Humanity?

Or any similar comparison?

15. CONCLUSIONS

The strict definition of science with criteria S1-S6 (TORI Axioms) is suggested. These criteria are based on the idea of falisibiability developed by Karl Popper. Terms “falsification”, “falisifiability” cause confusions; in particular, they disproves the Russian concept of history. This problem may come to other sciences, for example, into physics. To avoid confusions, term “**refutability**” is better.

According to the definition above, the scientific results should include all the properties S1-S6.

Recognition of these six conditions as compulsory is necessary to save physics and other sciences from profanation.

I suggest, that the civil organizations and the courts consider as fraud any governmental foundation of any research that does not satisfy the criteria S1-S6.

I suggest, that the editorials of the scientific books and journals (and the chairs of the scientific seminars) accept S1-S6 as the main requirements for the scientific results.

This applies to all kinds of scientific researches in all countries.

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COMPETING INTERESTS

Author has declared that no competing interests exist with respect to the text above.

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Academician Nikolai Ponomarev-Stepnoi, vice-president of the Kurchatov Institute national research center, noted in early March. He made this statement at an international conference in Moscow that discussed nuclear-powered spacecraft.// We would develop such an engine and propulsion unit by 2017, if the relevant international decision was adopted today, Vladimir Smetannikov, chief designer of the Dollezhal R&D institute, believes. Consequently, it would be possible to launch a manned space ship toward Mars by that time.// According to Ponomarev-Stepnoi, the world's countries understand that long-range space ights are impossible without nuclear propulsion units. Incidentally, nuclear engines can be used to accelerate spacecraft, also serving as their power-supply systems.// It should bementioned in this connection that the Energomash science-and-production association (NPO) had developed the first Russian nuclear rocket engine back in 1981. However, its comprehensive tests never took place because of tougher nuclear environmental-safety requirements in space research. The United States also conducted similar experiments, failing to test even a prototype version. // Nonetheless, theoretically nuclear-powered rocket engines cannot be called something entirely new. For its own part, the R&D institute of space systems near Moscow is busy developing a perpetuum mobile (perpetual-motion engine), of sorts. This engine that will have a virtually unlimited service lifecould be used on Earth and in outer space. // Our institute's staffers have been developing a non-jetpropulsion unit for several years in a row, Valery Menshikov, who heads this institute, said in mid-March. A liquid or solid-state propulsive mass moves along a preset tornado-shaped trajectory insidethis engine, thereby ensuring sustainable propulsion. Quite possibly, we are witnessing a hithertounknown interaction between the propulsive mass and little-studied fields, including the gravitation field, Menshikov explained.

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Greta Thunberg to world leaders: How dare you? You have stolen my dreams and my childhood'. Sep 23, 2019. Guardian News // 'You have stolen my dreams and my childhood with your empty words,' climate activist Greta Thunberg has told world leaders at the 2019 UN climate action summit in New York. In an emotionally charged speech, she accused them of ignoring the science behind the climate crisis, saying: 'We are in the beginning of a mass extinction and all you can talk about is money and fairy tales of eternal economic growth - how dare you!'
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APPENDIX

Appendix is available below this link: http://bookpi.org/doc/Appendix_2020_BP_4131D.pdf

Biography of author(s)

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Institute for Laser Science, University of Electro-Communications, 1-5-1 Chofugaoka, Chofushi, Tokyo, 182-8585, Japan.

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Research Area: Physics, Mathematics, History.

Number of Published papers: 101 (https://mizugadro.mydns.jp/PAPERS/)

DISCLAIMER
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