Scientific Research Publishing

Journal of Modern Physics, 2024, 15, 2023-2168
https://www.scirp.org/journal/jmp
ISSN Online: 2153-120X
ISSN Print: 2153-1196

Fundamental Interaction Bridging Elements, in Supplement to the Standard Model

Christos Tsikoudas[1*], **Theodore Karacostas**[2]

[1]R&D, SoftDsk LLC, Florida, USA/European Representative, Greece
[2]Faculty of Science, Aristotle University of Thessaloniki, Thessaloniki, Greece
Email: *christos@softdsk.com

How to cite this paper: Tsikoudas, C. and Karacostas, T. (2024) Fundamental Interaction Bridging Elements, in Supplement to the Standard Model. *Journal of Modern Physics*, **15**, 2023-2168.
https://doi.org/10.4236/jmp.2024.1512086

Received: September 14, 2024
Accepted: November 3, 2024
Published: November 6, 2024

Abstract

An interdisciplinary-field research brings new elements in bridging the gravitational interaction with the Standard Model, by focusing on 3 factors. The involvement of inductive and capacitive-like phase shifts in the gravitational interaction, the exploration of swapping between parameters of time and space, and the provision of a way to handle imaginary terms. The existence of phase shifts in the gravitational interaction is documented via re-interpretation of older quantitative predictions, and is specifically linked to the Higgs field mechanism. Same as in electronics, a phase shift splits energy into real and imaginary coordinates. This allows to quantitatively treat inertia as an inductive-like potential, alongside the swapping of parameters of time and space. That also allows to treat the Bernoulli pressure in quantitative analogy to a magnetic potential, as well as barrier penetration in quantitative symmetry to the crossing of displacement-current through a capacitor. The findings shed light on how fields & forces, including reaction forces function, while the role of imaginary numbers is analyzed. Interaction of fields with quantum particles is discussed to involve a Fourier-series effect that results in energy quantization. The role of phase shifts becomes essential in bridging between wave nature and effects of relativity, and the Weinberg angle is explained to have the role of an inductive-like shift. The precise value of this angle is proposed to link to elementary particles' properties like spin, or the value of quarks' charge. Symmetries introduced allow to address the abundance of matter over antimatter in certain analogy to theory from electronics, to address galaxy rotation curves through an interaction involving negative energy, and more. The new concepts open up room for advancements in energy exploitation over interdisciplinary areas.

Keywords

Fundamental Interaction, Higgs Field, Phase Shift, Inertia, Weinberg Angle, Displacement Field, Galaxy Rotation, Negative Energy, TOE Framework

1. Introduction

There is a number of conventional forces that current theory does not adequately assign to either of the 4 fundamental interactions of nature. For example, theory does not explain whether the inertial force, or, the force behind the Bernoulli pressure which lifts an airplane's wing, may in some way refer to the gravitational interaction to which they seemingly most closely associate. Or, how forces behind large scale effects as the ones associating with observed spiral galaxy rotation velocities, or even to the observed accelerated expansion along the universe, clearly and adequately assign to one of the 4 basic interactions. Or still, how small-scale forces, like the one behind the Pauli exclusion principle clearly and deeply function. Could such queries find clarifying answers through separate theories, or could there be a single collective model that would be able to address such points together. And if so, would that model bring into surface new elements that could contribute toward a s symmetry-driven bridging between the 4 basic interactions.

The present paper addresses the above questions by adopting principles similar to those of electric induction and capacitance, over the gravitational interaction. More specifically, it presents and documents the existence of inductive-like and capacitive-like phase shifts in the gravitational interaction, which brings new clues in addressing a number of fundamental unresolved questions (much like the electric induction and capacitance have allowed to resolve numerous effects of electronics, which wouldn't be possible to resolve otherwise).

The gravitational and electromagnetic interactions are shown to follow symmetric laws that are subject to a particular way of exchanging parameters of time and space. Such exchange often requires to affect a reciprocation of terms, which in turn is shown to allow for a way to interpret certain equations' imaginary portions. A split of energy distribution into real and imaginary coordinates provides new clues on how the Higgs field mechanism appears to be functioning in "dressing" matter with inertia. The splitting into real and imaginary coordinates additionally brings up new orthogonalities between coordinates, providing a new perspective in the comprehension of how fields and forces function at the fundamental level. On this basis, new insights arise on how certain mechanical forces, like inertia or pressure, may link to the gravitational interaction. Furthermore, the Weinberg angle is discussed to have the role of an inductive-like phase shift, which provides new grounds for bridging quantum nature with effects of relativity.

The above have direct implications in astrophysics, allowing for a way to address the abundance of matter over antimatter, spiral galaxy rotation curves, and also appear to bring new insights in the evolution of particular transitional processes in core-collapse supernova. Furthermore, an extrapolation on theory by Feynman-Stückelberg leads to predicting the existence of cosmic regions where the metrics of time and space may take negative values where that may provide stable habitat for different particles. The latter appears to comply with, and resolve particular unconventional astrophysical observations.

The findings may serve as elements for two-way bridging between interactions: The application of concepts similar to those of electronics upon the gravitational interaction (like inductive-like and/or capacitive-like phase shifts) sheds much light on the inner-workings of numerous effects of gravity/mechanics. But at the same time, this brings into surface reflections on the theory of the electroweak interaction, providing new insights on the reasoning behind the quantized nature of interactions and the energy exchange between fields and elementary particles. Also, it contributes to the particular relationships between classical fields and the field components carried by the mediator particles of the electroweak interaction.

The present research commenced in the mid-90s upon earlier work by the first co-author (C. Tsikoudas) on a method of energy transfer he had conceived, which required associating imaginary numbers with reaction potentials. A long-lasting quest that he pursued led to the development of the present model, whose completion was supervised by the co-author (T. Karacostas). More respective info is provided in the section "Authors Contribution", below. The concepts presented appear to have particular technological interest over interdisciplinary areas of physics, opening up a new window for future technological innovation in areas which may include energy transfer, micro-propulsion at the quantum scale, ultra-fast communication, and exploitation of negative energy interactions, which triggered this research in the first place.

The sections ahead provide a step-by-step approach into the corresponding findings: Section 2 explores and provides a mostly qualitative introduction on how specific effects concerning gravity and mechanics have a symmetric parallel to certain effects of induction/capacitance in electronics. Section 3 establishes the quantitative grounds behind these symmetries, it brings new insights on effects of inductance/capacitance as well as on gravitational counterparts of those, and discusses the introduction of raw units in corresponding field measurements. Section 4 provides insights into how the new concepts may adapt to quantum theory, sheds light on the role of imaginary terms, introduces new concepts which appear to address the cause of quantization of energy and provides insights into how particles' classical fields like the gravitational or the electric get to link to quantum nature. Section 5 focuses on the direct implications of the findings in astrophysics, discusses theory predictions on the existence of cosmic regions that serve as stable habitat for different leptons based on the characteristics of the time metric and the space metric per region. Among else, this allows for a way to address the abundance of matter over antimatter, and provides a negative-energy process that may address spiral galaxy rotation curves. Section 6 brings an overview of implications over the weak interaction with particular reference on the mass of the Z^0 and the charge of the $W^{\pm}$ s, while section 7 discusses theory extrapolations.

2. Linking between the Gravitational Interaction and Mechanical Potentials

This section is meant to provide certain theoretical grounds on how the gravitational *action* differs from the inertial *reaction*, how the Bernoulli pressure around fluid flow is generated in certain symmetry to the way a magnetic potential is generated around a current carrying wire, as well as how vortex flow shares certain analogy to Lenz's law in electronics.

2.1. Gravitational Force Functioning and Directionality

According to the laws of relativity the presence of mass curves spacetime, which implies that time "passes" slightly slower near a massive object than further away from it, where this difference directly refers to the gravitational force between material objects. (Reference is made here on the time curvature, while space curvature shall be addressed later). But current theory does not resolve the process through which this curvature causes the acceleration of matter. This may be approximated through a particular effect of relativity.

Consider a rocket-ship in outer space (far away from any gravitational influence) having its thruster on so it accelerates. According to the laws of relativity, for any material object that accelerates, time "passes" slightly faster in the front part than it does in the rear part, due to a Doppler-like effect developing in the time domain [1]. Assuming that the velocity is not relativistic (thus $\upsilon^2/c^2 \to 0$), the difference between the clocks at the front and the rear parts of the rocket-ship differs by a rate of $\left(1+gd/c^2\right)$ where g is the acceleration and d is the distance between the two clocks. Same as it holds with an accelerating rocket, it similarly applies for any accelerating material object, as for instance an apple that accelerates while falling: Time moves slightly faster at the apple's lower part (the direction of acceleration toward the ground), than at its upper part.

It turns out that this difference in the "fastness of passing time" due to *acceleration* (e.g. while falling), points in the opposite direction, and balances out the difference in the fastness of passing time of the (external) *gravitational* curvature. Actually, due to the principle of equivalence, it is the same difference in time $\left(1+gd/c^2\right)$ that applies between two clocks in a gravitational field g separated from each other by the height d. Through this counterbalancing process, the *potential difference* that the apple experiences due to gravity (gravitational curvature in time), gets to be relaxed and released once the apple accelerates to fall and develops the opposite-directed curvature in time caused by the acceleration. The corresponding release of potential energy (in time curvature) while accelerating to fall, is what causes the acceleration of the apple to develop by its own (much like a compressed spring tends to de-compress by its own for releasing the potential energy of compression). The difference in the "fastness of passing time" attributed to an external gravitational field, therefore, should be treated as a *potential difference*, with an associated potential energy (like a compressed spring also possesses potential energy). That potential difference is released and relaxed only once an opposite potential difference in time may develop in parallel, which is done (via the Doppler-like effect in time) when the material object accelerates to fall. That process of release of potential energy in time is what drives the self-acceleration. Actually, to confirm the concept, for these two processes to cancel out each other it should require that a falling object should feel no gravitational force while it falls. It should feel weightless, and this is indeed the case, just like it holds with astronauts' training in a parabolic flight, as they feel weightless while they free fall.

That the gravitational force gets to act due to the Doppler-like release of potential energy in the time domain is of particular significance, as we shall later figure that the same Doppler-like process lies behind other fundamental forces too. Just like the difference in the fastness of time associated with gravity constitutes a potential, and that may get to drive acceleration, we shall soon figure that it similarly applies with the curvature of other metrics, as well as with the curvature of inverse-variants (negative-reciprocals of the metrics in particular) of these metrics, which also cause acceleration via similar Doppler-like processes, affected upon particles' properties aside their mass.

Regarding the directionality of the gravitational force, this is conventionally an attractive force. However, it is possible to theoretically predict processes where it could exhibit a repulsive character, under conditions as follows:

1) If the curvature of spacetime in a certain cosmic region undergoes opposite inclination.

2) If the curvature involves the negative time metric.

3) If gravity applies upon negative form of matter (to be specified later).

We shall consider the first of the above here, while we shall particularly refer on the latter two in a following section. As gravity associates to the curvature of spacetime, the time metric reads lower values (time "passes" slower) the closer to a celestial body. Saying the same inversely, the time metric reads higher values (time "passes" faster) the further away from a celestial body. But then, how far would this statement be valid for? What holds at really far distance away, like as far as reaching the outer universe? Would time at the far distant universe reach a flat value, or could the metric of time possibly keep reaching higher value the further away? In relation to concepts that shall be presented ahead and relate to the physics of reaction potentials at the large scale, the new model specifically predicts that beyond some point at mid-distant universe, the time metric starts to take lower values as we reach toward more distant outer universe. The particulars shall be elaborated in section 5, but the broad concept that the time metric reads lower values radially away toward the very distant universe appears to be valid even at a preliminary level as it comes in good match with, and allows to addresses, a number of astrophysics-related points which shall be elaborated ahead, like the observed accelerated expansion over regions of the universe, the abundance of matter over antimatter in the universe, conditions that hold near quasars, or the evolution of particular transitional processes in core-collapse supernova.

The possibility of an opposite inclination of curvature at the outer universe comes along with a significant implication, that the metric of time should progressively approach a nodal condition as we reach toward the very distant outer universe, beyond which the time metric could eventually take negative values. A consideration on what could hold on such nodal region(s) and beyond, shall be elaborated ahead through a phenomenological approximation and reference to particular astrophysical effects. For the moment, we shall focus at the lowering of the fastness of passing time radially outward (toward the far distant universe), referring to the condition (1) of above. The corresponding opposite inclination of curvature should gravitationally attract distant celestial matter toward the direction where time moves slower, meaning outward-and-away (toward the very outer space), for the same reason that matter is gravitationally attracted by the inclination of time-curvature near a black hole. It is the same force, pointing in the opposite direction, radially outward instead of radially inward, due to the opposite inclination.

This process appears to serve as the reason that, the further away the celestial matter, the faster it appears to accelerate away. This model may address adequately well the observed accelerated expansion of the universe (which needs not be symmetric toward all directions) without need for dark energy or a cosmological constant in association with it. More will follow in relation to this as we move further on the topic, ahead.

2.2. Gravitational Field in Positive & Negative Metric

The gravitational field of either a large celestial body, or of a microscopic particle constituent of that body, is radial-like (has open-ended field "lines"). In relation to the curvature of time, the trail that each gravitational field "line" follows is meant to describe the direction in which the time metric (the fastness of time) changes. In a case like that, one may come up with semi-philosophical questions like: Should a gravitational field "line" be considered infinitely long? If its trail depicts time moving faster up to some distant point, and then moving slower further on, should it eventually reach some nodal point? If so, what holds beyond that nodal range? Would a gravitational field line then describe curvature in the negative time metric? Would that come along with (simply) negative, or rather, with imaginary attributes?

Let us consider the gravitational field of a black hole, in reference to **Figure 1**. In this figure, the amplitude of the Time Metric's curvature is meant to schematically represent the magnitude of the vector of time in various regions (depicting how fast time "passes" at various ranges) over the cosmic scale. Point *g* supposedly represents the surface of our galaxy's black hole (an event horizon), where time reaches a halt, hence the value of the metric of time has the value of zero. To the left of point *g*, the figure depicts what holds at some distance from the galaxy's black hole. A solar system (given the distance from a galaxy's black hole) schematically refers to point *e* where time (the metric of time) has a moderate value.

Further away toward mid-distant universe (point *d*) time moves faster (alongside the distance from celestial matter), and reaches some maximum. According to the schematic (simplified, for now) model of curvature described here, beyond that range time starts moving slower and slower (to the left of point *d*), which is represented by the time-metric curve having smaller amplitude. The fastness of time eventually reaches another nodal value at point *b*, at the far outer universe, where time should again reach a halt.

In terms of an initial simplified approximation, one may loosely conceive of point *b* to resemble an immense hypothetical sphere (event horizon) lying at the very outer universe (this needs not to be symmetric toward all directions). Notice the opposite inclination of slope that the time curvature exhibits toward the right vs. toward the left of point *d*. The inclination toward the right is responsible for the gravitational attraction toward a black hole (in the direction $d \rightarrow g$), while the inclination toward the left, appears to concern the accelerated expansion of the universe (in the direction $d \rightarrow b$). The closer to the nodes (approaching *b* from its right side, or *g* from its left side), the stronger the steepness of the Time Curvature, thus the stronger the attraction of celestial matter towards the nodes, hence the observed accelerated rate of expansion of the universe toward the distant point *b*. As mentioned, this is yet a simplified model, to be refined later, in section 5.

At the left of nodal point *b* and at the right of nodal point *g* time is predicted to take negative values, as the figure indicates. The issue of negative time needs to be treated with cautiousness, as it has absolutely nothing to do with things moving backwards like in a video run in reverse. There is currently little relevant reference to negative time in bibliography, and this relates to quantum theory where negative time associates to reversal of sign of charge as per the Feynman-Stückelberg interpretation [2], while a more specialized reference on that topic is provided later in section 4.7. According to material to be presented throughout sections 4 and 5, regions where time is negative should correspond to ones where effects follow causality but nature is in a difference balance, as it should be antimatter that reaches stable form, while conventional matter should be unstable in these regions. However, that does not prohibit a gravitational field "line" to "dive" into negative time territory, getting to represent time curvature in the negative direction of time. And as illustrated through the waviness of the Time Curvature in **Figure 1**, the negative direction of time should also exhibit a negative peak (at the tip of the negative antinode of the Time Curvature). This is so, as the "fastness" of passing time could not go infinite in either the negative or positive directions of "passing of time", as that could imply energy infinities, which does not constitute a realistic option.

Just like the curvature of the time metric is shown to go through negative values, it similarly holds with the curvature of the Space metric which also reaches into negative values, and should follow a similar type of waviness. The depiction of the curvature of space in **Figure 1** should be understood to incorporate a graphical "normalization", which allows to schematically fit cosmic regions of both immense extend (distant outer space) as well as regions of compactified contents (like near a black hole). In this way, this schematic representation may facilitate an extrapolation in describing regions of unconventional characteristics of space, like space of negative metric. To clarify, the notion of negative space metric has nothing to do with measurement in the opposite direction. It refers to a deeply fundamental concept, which reaches into theory involving negative energy and/or existence of an exotic form of negative matter [3]. Existing theory does not adequately clarify the notion of negative matter, or the way that this may interact. Neither it predicts a phase difference between the waviness of the metric of time and the waviness of the metric of space that the present model introduces as per the illustration in **Figure 1** and we shall elaborate upon shortly. The present model provides specific predictions on what holds with respect to the negative space metric, as well as with respect to negative matter, which shall later be associated to specific properties of neutrinos and antineutrinos.

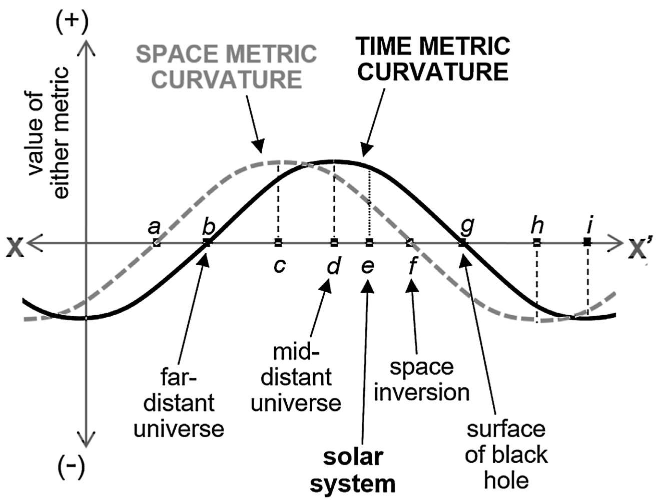

Figure 1. Schematic depiction of the curvatures of the Time metric and the Space metric at the cosmic scale (simplified form). The horizontal axis depicts a hypothetical trail, from distant universe (point *b*) toward a black hole (point *g*). The vertical axis represents the value of the metric of Time or the metric of Space. High amplitude corresponds to Time "passing" faster and Space being more stretched correspondingly.

At this point the focus shall turn toward yet another unconventional condition, that the existence of negative portions of the metrics of time and space allow for the waviness to behave as if it allowed for a loop, where the left end of **Figure 1** supposedly re-attaches to the right side of the figure. This is equivalent to assuming that the axis XX' of **Figure 1** forms a large *hypothetical* loop, as if X and X' correspond to the same point in spacetime. In that sense, the illustrated waviness of the Time and Space Curvatures also follows a loop-ness, which allows for the peaks of the negative antinodes of Time and Space at the left side of the figure identify with the negative peaks at the right side of the figure.

Considering that (a) the gravitational field of a celestial body (and the associated contribution of each of its constituent matter particles) refers to the curvature of the metric of time, (b) each gravitational field "line" represents a trail upon which the curvature in time changes, and (c) this change may form a hypothetical loop at the cosmic scale, that leads to an assumption that each gravitational field "line" may extend to eventually assume a *hypothetical* loop, of which we may perceive only the portion which refers to the conventional curvature of the positive metric of time. As a gravitational field "line" graphically "departs" radially away from a particle, it represents time moving faster and faster, then after some range at mid-distant universe it starts representing time moving slower and slower, until reaching the nodal point *b* of **Figure 1**. Then, a marginal range follows (referring to the range between points *b*-*a*), where the time metric takes negative values while the space metric is still positive. This is a critical portion that shall later be considered to relate to the particle's engagement in effects of reaction (like the inertial reaction). Then, to the left of point *a* the metric of space also turns negative, and that part of the field is not possible to directly perceive, as it exhibits imaginary attributes (with respect to the classical world). Such imaginary portion of a gravitational field "line" may be understood to resemble a theoretical "return" portion of a gravitational field line, where that is hidden from classical perception since it may be accounted for by imaginary numbers. Assuming that such imaginary return portion might follow the hypothetical loop until reaching back to the actual particle, then it needs to go through another marginal portion, referring to the range between points *g*-*f* where the metric of time turns positive while the metric of space has still negative values. That portion is also critical, as it shall later be considered responsible for particles' marginal engagement in the weak interaction, which shall be discussed in section 6. That completes an initial conceptual approach on how each gravitational field "line" may follow a trail along a hypothetical loop, of which we directly perceive only a portion.

On the basis of the above concepts, the conventional representation of a gravitational field being radial-like (open-ended) is incomplete, as it refers to only the "real" portion of a gravitational field. In addition, the conventional radial-like representation of the gravitational field is insufficient, in the sense that it misses to represent the rate at which the curvature of time changes, as well as the inclination of its slope (with time progressively moving faster, and then progressively slower, until it eventually turns negative). So, what we call a "radial-like" gravitational field is pretty much an illusion, that could be loosely/graphically compared to how the magnetic field "lines" of a bar-magnet visually look like when watching them from "above the one pole". In such an intuitive comparison, the magnetic field "lines" appear radial-like (since the other magnetic pole is hidden behind), but what looks to us as being radial-like misses to depict the depth of the curvature (of the trail of the magnetic field "lines"). In fact, if one wished to schematically incorporate this curvature (depth) in the illustration of a *gravitational* field line, an option would be to draw more dense field line "arrows" to account for larger depth (steeper inclination). Furthermore, the return portion of the gravitational field lines (at the range where the space metric has negative values) is hidden from direct classical perception. The word "hidden" is selected to be more appropriate than a word like "nulled" or "cancelled", since we shall figure that part of this portion of the field lines might engage in interactions under conditions of negative energy that will be discussed later.

Here, it is of reason to clarify that, just like it holds with the gravitational field of a celestial body, it similarly holds for the gravitational field of each elementary particle's contribution to a total gravitational field. For instance, a gravitational field "line" of an electron (supposedly located outside a black hole) may also be considered to form a hypothetical loop, where time moves faster and faster away from the elementary particle until mid-distant outer space, then it moves slower until it reaches the far distant outer universe, and beyond that, time should turn negative as described earlier.

The above concerns a preliminary approach regarding the essence of the gravitational field. As already mentioned, that model is simplified so as to describe the concept of waviness, as well as the loop-ness of the curvatures of time and space. The actual universe instead, rather looks like a "sea of waves", but more will be said on that in section 5. Further concepts shall also be presented ahead in reference to the negative and imaginary portion of the gravitational field lines, as well as on phase shifts that become involved. These phase shifts allow for the particle's engagement in effects of reaction, with a limiting case of particular interest allowing for a classical-physics-like approximation to understanding the effect of particles' entanglement.

2.3. Functioning of the Inertial Force

Today's theory does not address the nature of the inertial force, neither may describe how it functions. It is conventionally assumed that "action equals reaction" but this is not an accurate statement because if it were, a pushed particle/object would not be able to change its motional status (accelerate or decelerate).

According to Einstein's principle of equivalence, the acceleration force applied on a passenger of a rocket accelerating at g, feels exactly the same as the force of gravity applied on a person standing on earth. Here, the force felt by the passenger in the accelerating rocket is apparently the inertial force. In such case, since the inertial and gravitational forces feel the same, should this imply that they have similar nature? According to the present model, this is not the case, as these two forces have different origin, as well as different essences. Gravity is an action force, while inertia is not exactly a force, it corresponds to a reaction potential, much like the electromotive force is also a potential, not a force, as it is measured in units of Volt, not in Newton. So, let us see how this arises for the case of inertia:

Time and space are known to be tightly correlated entities, yet according to the model introduced above, the waviness of the metric of time and the waviness of the metric of space may be separated by a phase shift. This of course is not by coincidence, and we shall address the reasoning behind it in section 5, where we shall figure that it refers to a reaction effect that arises via a symmetric cause to that of the Voltage-Current phase shift in the theory of electronics. And other than the analogy in the cause of either of these phase shifts, they also yield similar *outcomes* in each case.

The existence of a phase shift between the wavinesses of the metric of time and the metric of space may be traced through a completely new interpretation to older quantitative predictions. According to those, there exists a particular surface outside a black hole, at either side of which, interactions point in opposite directions [4]. In particular, the centrifugal force points in the opposite direction, light is predicted to bend in the opposite direction, and angular stresses are also predicted to transfer in the opposite direction. We shall here interpret this place (which we here refer to point *f* of **Figure 1**) as a "Space node". Considering that gravity is experimentally confirmed to link to the curvature of time, where the curvature of time exhibits a node at the black hole's event horizon (corresponding to point *g* of **Figure 1**), this leads to the assertion that the Time and Space curvatures are subject to a phase shift between them. This phase shift constitutes an inductive-like effect, and as we move on with this theory we shall be figuring out how this phase shift allows to resolve a large number of effects, ranging from particle physics to astrophysics. (That applies, much like conventional induction and capacitance explain a large number of effects in the theory of electronics). In one example, the region between point *g* and point *f* of **Figure 1** acquires properties that have it associate (in part) to the theory of rotating black hole's ergospheres, which shall be referred to in section 4.7 point (iii).

It turns out, that this inductive-like phase shift directly refers to the Higgs field that permeates spacetime [5]. And this is responsible for "dressing" matter with the impeding property that we perceive as "inertia", in similar way to as a Voltage-Current shift causes impedance in the operation of electric engines. This symmetry is not arbitrary, as in section 3 we shall quantitatively describe that the gravitational and electromagnetic interactions are subject to a particular symmetry when swapping between parameters of Time and Space, which may in turn imply that a Voltage-Current phase shift also roots into a symmetric process taking place between parameters of time and space. Notice for instance, that in the electronic regime the inductive phase shift develops in time (a lag), while in the gravitational regime the inductive-like shift (between the waviness of Time and Space) develops over space, as shown in **Figure 1**. Later, in section 3.7(b), we shall be in position to specify the particular value of this angle of phase shift, and explore why (and how) it relates to the Weinberg angle which has a key role in the electro-weak interaction. Furthermore, in section 5.3 we shall also be in position to figuring the reason of existence of the Weinberg angle.

Due to this shift of the space curvature with respect to the time curvature, the supply of energy used in accelerating an object acquires two coordinates, a Real and an Imaginary. The Real coordinate of energy is the only one that does work in accelerating an object, while the Imaginary coordinate causes an inefficiency, which exhibits itself in the form of impedance, and that corresponds to what we perceive as "inertia". The way inertia functions, is therefore symmetric to the way inductive impedance applies in electronics. In this respect, inertia corresponds to an impeding potential, which is accounted for through a sine coordinate (of the angle of the phase shift) of the energy spent to accelerate an object. This Imaginary potential is less strong than the driving gravitational force, so the material object is able to accelerate.

We shall here attempt to provide an early indication on the quantitative particulars of how the inertial potential functions, which shall then be further elaborated in section 3.7 after certain new concepts will be introduced meanwhile. It turns out that the inertial potential which drives the inertial impedance may be described by a symmetric formula to the one of its inductive counterpart which drives the inductive impedance. The latter involves a particular variant of the electric field E, of reaction character, which theory assumes to have loop-like field lines (since the electromotive potential deploys over a circuit loop of length $\mathrm{d}\ell$), rather than having *radial-like* field "lines" as of the conventional electric field. The corresponding effect in electronics is described by the relation (1), where dI/dt concerns the change in current, and L concerns the circuit's inductance. Inductance, here, refers to a time lag affected on the current oscillation with respect to the voltage oscillation.

$$\oint E \cdot d\ell = -L\left(\frac{dI}{dt}\right) \tag{1}$$

$$\oint g \cdot d\ell_t = -L_g\left(\frac{dp}{dx}\right) \tag{2}$$

By symmetry, the inertial counterpart of this interaction may be initially approximated through the symmetric relation (2), which we shall now explore. This is meant to involve a newly introduced variant of the gravitational field g, which is involved in effects of reaction. Just like it's electric counterpart, this variant should have its field "lines" form loops (to be elucidated below), instead of being radial-like as of the field "lines" of the conventional gravitational field. In fact, it shall eventually turn out that in *all cases of reaction*, the mediating potential follows an inverse geometry to the one of the driving potential. That is, if the action field (e.g. the electric field, or the gravitational) has radial-like field "lines", the reaction field variant shall have loop-like field "lines" (e.g. the variant that drives the electromotive reaction, or here, the variant that drives the inertial reaction), and vice versa for other fields like the magnetic which shall be considered later. This stems from the fact that reaction should deploy orthogonally to the driving action, meaning that either one should be imaginary with respect to the other (as an imaginary coordinate is by default orthogonal to a real coordinate). It shall further arise, that the loop-like field variant involved in the reaction process comes along with the phase shift (a displacement) in time or in space, where this displacement is the one which accommodates the mentioned inverse geometry. In the electric case the phase shift typically develops in *time* (as in an inductive lag), while in the mechanical/gravitational case it refers to a phase shift in *space* (like the shift of the space metric with respect to the time metric illustrated in **Figure 1**). Furthermore, according to material to follow ahead, a reaction potential should typically engage negative (opposite) energy, which implies that it should have imaginary character, and this should not allow it to yield results in the real world. That restriction, however, gets to be overcome due to the existence of the phase shift which provides the means for the reaction process to take place, as shall be elaborated ahead.

Since in the mechanical/gravitational context the reaction potential applies on matter (not on charge), it reacts a change in momentum p (instead of a change in current I). In relation to what follows, the inertial reaction appears to involve the wave-nature of matter: In particular, it reacts a change in p with respect to space dx, in the sense that momentum associates to the particle's wavelength λ through the relation $p = h/\lambda$ $\left(= h/x\right)$ and that comes in symmetry to the electric current I associating to time through the relation $I = Q/t$ (where one may additionally notice that for an elementary particle, both the charge Q as well as the Planck constant h have a precise value).

Furthermore, the term L_g of Equation (2) refers to the inductive-like phase shift in space (between the curvatures of Time and Space as illustrated in **Figure 1**), where the subscript g is meant to indicate that it concerns the gravitational interaction. [A list of notations is provided in Appendix]. This comes in symmetry to the electric inductance L which concerns a lag in *time*, however, the mechanical-type of inductance L_g is a fundamentally different entity to L, as it concerns a shift in *space* (instead of time) between the curvatures of the metric of space and the metric of time as depicted in **Figure 1**. We shall later determine that the precise value of this shift gets to refer to the Weinberg angle, which has significance in terms of paving a bridging of the gravitational interaction with the Standard Model.

As for the term $d\ell_t$, that concerns a loop in time, over which the phase shift takes place. In the case of inertia, the loop refers to the whole hypothetical loop that rides a gravitational field "line" as described above, including both the real and imaginary portions of it. This grounds on the fact that a gravitational field "line" concerns a trail where time passes progressively at different rate the further away from a celestial body. (This notion shall become more and more clear as we move forward in this theory and further familiarize with its corresponding particulars). Even though this loop seems immense in spatial terms, it concerns time so its spatial extent is rather irrelevant.

It is also of significance that the inductive-like shift L_g (whose value in terms of degrees of angle shall later be elaborated to refer to the Weinberg angle) directly concerns the Higgs field that permeates spacetime. And in that respect, the relation (2) concerns the underlying process through which the Higgs Field Mechanism "dresses" matter with the property of inertia. Following further concepts to be introduced ahead in section 4, it shall then be possible to address how the Higgs field may exhibit particle-like nature and interact in the form of a boson, the Higgs boson. Further associated details and deeper insights concerning inductive-like, as well as corresponding capacitive-like phase shifts in space and/or time, will be provided ahead, through reference to specific effects and interactions.

The above concludes the basics on the essence of inertia. A point worth-mentioning, is that the relation (2) describes a reaction to a change in "momentum" (ascribing to the particle's wave nature), and not a change in "velocity" alone (where that would rather ascribe to particle nature). This will later be shown to be of significance in bridging quantum nature (associating to wavelength) with effects of relativity. Furthermore, in relation to the above, the conventional assertion that "action equals reaction" is therefore inaccurate, since an action force and its reaction counterpart are of fundamentally different essence, as well as of different scale, and that is why an object may accelerate at all.

2.4. The Bernoulli Pressure as a Potential

A common textbook paradigm of the Bernoulli pressure illustrates a water-carrying pipe, whose diameter changes and gradually becomes thinner. For the volume of fluid through the thick and the thin parts of the pipe to stay unchanged, the fluid should move faster in the thinner section. According to the Bernoulli effect, the side pressure on the walls of the pipe is HIGHER at the part where the fluid moves slower, and LOWER at the part where the fluid moves faster. While theory of fluid mechanics may estimate the Bernoulli pressure difference, it hardly provides an adequate explanation on how this arises. A usual explanation broadly attributes the difference in pressure to the principle of conservation of energy and the first law of thermodynamics, according to which, an increase of kinetic energy comes along with a decrease in potential energy. But this does not really explain what causes the lower pressure around the faster flow. And in addition to that, the particular force behind the Bernoulli pressure is not clearly associated with one of the four basic interactions (while the gravitational interaction could seemingly constitute the closer match). An attribution to Van der Waals forces among molecules of water may have a primary role, but an explanation with respect to those also seems inadequate.

We shall here take a look into the theory of electronics in search of any traces of mere symmetry to be found with the effect of the Bernoulli pressure developing around fluid flow. The flow of electric current sets up a magnetic field around it, however no similar field (magnetic-like) is traced to develop around a stream of fluid flow in mechanics. There is an element of symmetry, however, in that the density of the magnetic field around a current-carrying wire may be understood to constitute a coaxial radial-like magnetic potential, in certain degree of symmetry to the radial-like Bernoulli pressure around a stream of fluid flow. There, as long as the magnetic field is evenly set around the current-carrying wire, the magnetic potential is balanced out so no net magnetic force arises to push sideways the current-carrying wire. While, if an external influence deforms this even distribution of the magnetic field, then a net sideways magnetic potential pushes the wire to the side.

We shall here raise a particular question, whose answer shall later lead us to specific fruitful clues. Supposedly a hypothetical field developed around fluid-flow of matter, in symmetry to as the magnetic field develops around a current in a wire. And this hypothetical field supposedly has imaginary characteristics, meaning that its description would require the involvement of imaginary numbers, and for this reason it would not be a readily detectable field. But let us assume that there is some indirect way that such a (magnetic-like-looking) imaginary field could exercise a radial-like potential, and that is, supposedly, the one that powers the Bernoulli pressure around a stream of fluid flow (in analogy to as an evenly-balanced magnetic potential develops around the flow of electric current). If such a (magnetic-like) imaginary field and potential existed in fluid mechanics, then what would its (imaginary) properties be like, and what characteristic traces would such properties leave, if any, in the real world, so that we seek to find such traces? On the basis of symmetry, we may expect for the characteristics of such a field of imaginary character (developing loop-like around the stream of fluid flow) and its associated potential (developing radially across the fluid-flow), to have as follows:

(i) Very short range: A first characteristic of such imaginary field's potential, is that it should have very short range of action. This is so, since imaginary essence refers to negative energy, and a negative energy field should quickly damp out and vanish in the real world, just like it holds with the field components of the so-called evanescent electromagnetic waves in electronics, which quickly vanish. Under such case, it would not be possible for that field to be detected at some distance from matter flow. It should rather apply in the range of molecules and atoms. Note however, that it could be possible to provide measurable results at a considerably larger range through collective (transmissive) action of a large number of neighboring molecules.

(ii) Direction degenerate: A second characteristic of such field and potential, is that it should be direction degenerate, meaning that it should apply the same way regardless the direction of its field "lines". (Just like the centrifugal force applies the same way regardless if the rotation is clockwise or counterclockwise). The reason for such degeneracy turns out to be that, unlike charge which may have positive or negative sign, matter is of only one sign, only positive. Actually, not only matter, but antimatter too, are gravitationally attractive so they may both be considered "positive" form of matter. And, since matter involved in mechanical interactions is all of same sign, this imaginary potential (in response to the flow of matter) would apply any possible force independently of the direction of "arrows" of its field "lines".

(iii) Inverse behavior: A third characteristic of such field would require to look deeper into its imaginary essence, to which the present model brings certain new insights. Imaginary numbers involve the term *i*, and by definition it holds that

$$i^2 = -1 \quad \text{hence} \quad i = -\frac{1}{i} \tag{3}$$

On the basis of this equivalence between an imaginary term and its negative reciprocal, the new model introduces a notion (to be elaborated ahead) that "*fields of imaginary origin may produce actual results in the real world through their negative reciprocals*". The grounds for that to be plausible, will be provided in section 4.1, by the fact that equations (65) and (67) will need to be satisfied at the same time. In relation to this notion, it turns out that such a field of *imaginary* essence may produce real results when interacting with another *imaginary* property or entity, so the two imaginary terms together may yield a negative real result. Actually, in relation to the negative sign in the relation (3), interactions of pairs of imaginary terms appear to engage in effects of *reaction*.

Effects of reaction exhibit over every aspect of physics. In the present case, this negation appears to result in that the Bernoulli pressure should be pointing in the opposite direction, than the direction a conventional pressure force would point toward. We shall explore this opposite directionality of the Bernoulli pressure through a specific reference to the airplane's lift force:

As mentioned in point (i), even though the Bernoulli potential is of very short range, it may bring result further away through collective (transmissive) action of a large number of neighboring molecules. In the case of an airplane's wing, existing theory tells that, since the upper part of the wing is more curved, air gets to flow faster above the wing, than below it. The faster flow of air comes along with lower side pressure at that region, due to the Bernoulli effect, and that lower local pressure causes the net lift force. While this explanation is correct, it is however rather inadequate as it does not actually resolve why this side-pressure is lower. In fact, according to common sense, since the air above the wing gets denser, it should rather be pushing the wing *downward*, instead of lifting it upward. The answer to this puzzling behavior may arise by the fact that the lifting potential appears to associate to this newly introduced imaginary field, whose force points in inverse direction, due to the minus sign in relation (3). That is, the minus sign appears to be responsible for pulling the wing up instead of pushing it down. According to material that will be presented later (in reference to quantum nature), this imaginary field of mechanics may come in two variants, either in the form of a conventional field having loop-like field lines, or as an intrinsic field variant of inverse geometry (just like the magnetic field may also come in two variants, the conventional classical magnetic field as well as an intrinsic magnetic field variant). The intrinsic field variant of this mechanical field appears to link to the Van der Walls forces.

It is now time to give a name to this imaginary field (and force) that is proposed to drive the Bernoulli pressure. We shall name it "gravitomagnetic" for the sake of symmetry in the naming to the conventional magnetic field, even though they constitute completely different fields. And we shall denote it by the letter T. [Re. A list of notations is provided in Appendix]. The gravitomagnetic field T will be shown to relate to the gravitational field g in a somewhat similar way to as the magnetic field B relates to the electric E, and we shall specify their quantitative relation soon, as we move ahead. A point of attention is that, for both the gravitomagnetic field around the flow of matter (in fluid form, where molecules have freedom to displace), as well as for the magnetic field around the flow of charge (in the form of an electric current), the loop-like field "lines" around the flow constitute equipotential lines/surfaces. That is, a gravitomagnetic field "line" developing around a stream of fluid flow (through the collective/transmissive involvement of neighboring particles) may be understood to constitute an equipotential "line of equal Bernoulli pressure" (or a "surface" of equal Bernoulli pressure, if more field "lines" are involved). This is much like the fact that, each "line" (or more lines) of a magnetic field that is evenly formed around a current-carrying wire represents a equipotential line (or surface respectively) of a radial-like magnetic potential. Respective formulas for the gravitomagnetic field shall be presented in section 3, by comparison to corresponding formulas of the electromagnetic interaction.

The new theory introduces further symmetries between the way the magnetic and the gravitomagnetic potentials apply. Like in the way that both fields may affect a sideways deflection force: When a free moving charge is subject to an external magnetic field, the charge is being displaced *sideways* without changing its kinetic energy. In the mechanical case, in turn, the lift of an airplane wing follows the same general principle. To clarify how that works, we may refer to **Figure 2**. Since air flows faster above the wing and slower below the wing, the wing itself may be considered to (roughly) concern an "equipotential surface". In such case, the extend of the wing itself may be thought of to roughly coincide to a gravitomagnetic field line (see wing's cross section with the field of T entering the page OR popping out of it, as either direction makes no difference since this field is direction-degenerate). Given such general direction of the T field and the direction of motion υ, the right-hand or left-hand rule may be used to provide the gravitomagnetic force F_T, which tends to deflect (lift) the wing *sideways*, once again without changing its kinetic energy (same as in the case of the magnetically-deflected charge). In other words, according to this model, the lift force applies as if it tends to get the wing follow a respective curved-like path upward (re. dashed circular arrow) like the figure depicts, even though this path may not be followed in real due to all other co-involved factors, as a wing is not a "point-mass"

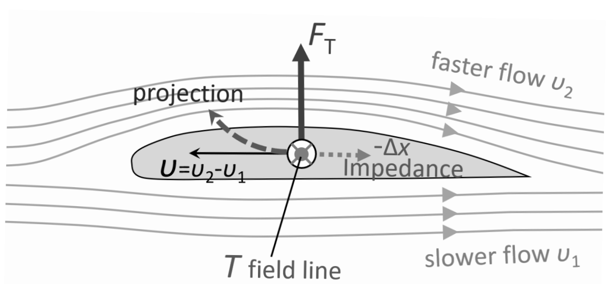

Figure 2. Wing lift, engaging principles of sideways deflection and inductive-like impedance (drag), bears field symmetries to the case of a magnetically deflected moving charge.

(in any similar sense to as a charge is point-like in the magnetic deflection case), thus rotational-inertia, as well as gravitational and frictional influences engage in parallel.

Later we shall also describe in quantitative terms further symmetries between mechanics and electronics, in reference to effects of induction and capacitance. For instance, we shall figure how an inductive impedance to a change in current compares to an inductive-like drag affected on an airplane wing (re. thin doted arrow indicating impedance in **Figure 2**, where the $-\Delta x$ broadly represents a shift in space in reference to the increased sideways proximity of the air particles the faster their flow by the center of the swirling that follows the wing).

(iv) Action with respect to reciprocal radius: The relation (3) designates an equivalence between an imaginary term i and its negative reciprocal $-1/i$. As previously mentioned, it arises that when fields of imaginary origin produce results in the real world (via interaction with another imaginary entity), the outcome appears in the real world with respect to the negative reciprocal of a parameter of space or time. A direct consequence of that behavior, is that the strength of the force produced by an imaginary field like the gravitomagnetic, should change with respect to reciprocal radius (instead of with respect to plain radius). Such behavior would be more clear to measure if a case existed, where the gravitomagnetic force could apply over a long range (unlike its typical short-range action in the real world, since it is a field of imaginary characteristics). Such a long-range action shall be described to apply under specific negative-energy conditions, which seem to hold at the astrophysical scale, where observations appear to verify this field's strength changing with respect to reciprocal radius. The long-range action in that case is plausible if the gravitomagnetic field (which has imaginary nature) applies upon a particular form of "negative matter" which ascribes to negative energy and imaginary essence (to be specified ahead). Then, since both these entities are imaginary, they should interact with each other "conventionally", meaning at long range. In such case, the change of strength of the gravitomagnetic force with respect to reciprocal radius is possible to verify. Following certain new concepts that shall be provided in section 4, we shall be in position to trace this behavior upon the observed spiral galaxy rotation curves, in section 5.6.

2.5. Vortex Flow Symmetries

According to Lenz's law in electronics, a change in magnetic flux through a metal ring induces a loop-like flow of charge (an inductive current) in the metal ring. That current is driven by an electromotive potential, which involves a variant of the electric field that has loop-like field lines, as it deploys over the circuit loop of the metal ring $\left(\oint E \cdot d\ell\right)$. In relation to quantitative concepts that will be analyzed in section 3, this appears possible to approximate through an alternative way, engaging a negative energy variant of the displacement-electric field.

In mechanics, an analogous process causes the loop flow of matter during vortex flow, as in the case of the whirling of water. Here again, this potential should be direction degenerate (direction-indifferent), the reason being, once again, that conventional matter has only one sign of matter, always positive, and as a result either direction of turn provides an equally balancing condition. A candidate potential to be responsible for such rotational flow, is a gravitational counterpart of the electromotive potential, which was discussed above to be involved in inertial impedance. For reasons of symmetry in the naming, we may refer to it as "gravitomotive" potential. However, despite the broad symmetry between the inductive flow of current in the metal ring and the vortex flow of matter, these two processes differ to each other in a very particular fundamental way: The electric version (accounted for by Lenz's law) is triggered by a change in "field flux" (not a change in "flow of charge"). While instead, the mechanical version is driven by a change in "flow of matter" (not a change in "field flux"). This fundamental inversion is due to an effect of reciprocity, which arises from an orthogonality between the gravitational and the electric interactions, and requires the introduction of certain new concepts which shall be considered in section 3.8, via a comparison between vortex flow and its electric counterpart.

On a side-note of significance, we shall later also discuss that the same form of orthogonality also becomes involved in the rotation of celestial bodies. While a steady current comes along with a magnetic field around it, it similarly applies in mechanics, where a steady flow of matter comes along with a steady gravitomagnetic field. However, due to a specific orthogonality between matter and charge, the gravitomagnetic field has imaginary characteristics. When the gravitomagnetic field interacts with a particular "negative-matter" property which may be traced in baryonic matter and shall be addressed in section 4.10, then the gravitomagnetic field engages in the form a classical "flow" (instead of flux), and that shall be shown to hold responsible for the rotation of celestial bodies.

Due to the numerous concepts introduced here on the gravitational interaction, is was considered helpful to provide a nutshell at a qualitative lever in the present section. In the next section, these notions are to be supported by quantitatives, by comparison to the theory of electronics. We shall then figure how effects of induction and capacitance have counterparts in the gravitational interaction. Furthermore, while above we have made an introduction to the inductive phase-shift case only, we shall next also explore the capacitive case too. That shall allow to bring up further symmetries, like between the displacement of matter in barrier penetration, versus the crossing of charge through the plates of a capacitor. Or, between the interaction that powers the operation of the electric battery and the interaction that powers exergonic (bio-chemical) reactions.

3. Electric Induction/Capacitance and Symmetries in the Gravitational Interaction

3.1. The Electric Field in Terms of Curvature

The electric field of a point particle has radial-like (open-ended) field "lines", just like the gravitational field also does. This may raise the question that, since the gravitational field concerns the curvature of space-time, shouldn't the radial-like electric field also concern some analogous form of curvature? Recall that when we presented how inertia functions in section 2.3, we described that the curvatures of the space metric and the time metric are subject to a phase shift between them. That corresponds to a shift in space, which presumably extends over the cosmic scale. The existence of such shift brings a very particular consequence. Even though space and time are tightly correlated to each other, the fact that they may be separated by a phase shift suggests that they should be treated as distinct entities, just like the voltage and current oscillations are distinct entities in electronics even though they are closely correlated to each other. That also implies that the gravitational field could not directly refer to the curvature of *both* space and time. It should rather stick to the curvature of either of them, while the curvature of the other could have a complementary role. In such case, gravity appears to directly associate to the curvature in the metric of time, as experimentally verified, while the curvature of space appears to have a counterbalancing role (to be specified ahead).

In consideration to the above, the next question that arises, is if the curvature in the metric of space could associate in some way to some other field. That of course could not directly concern the electric field, because if it were, the existing curvature of space near a celestial body would require for the same celestial body to exhibit a net electric charge. While instead, celestial objects do not typically exhibit a net charge since they are composed by an almost equal amount of positive and negative charge, carried by their constituent elementary particles. Other than that, however, it appears that effects of time and effects of space are subject to a particular orthogonality between them. This is meant in a similar sense to as a Real coordinate axis is mathematically orthogonal to an Imaginary axis, and these two coordinates complement each other. Along this concept, the 90 degrees of angle in such orthogonality translates in that, effects associated to either one of Time or Space, appear imaginary with respect to the other. Such a relation between the two, does not however restrict them from coexisting, in the contrary, it could have them complement each other in terms of energy balancing, as we shall later figure to be the case. By extend, this form of orthogonality implies that effects concerning the curvature of time should not directly interact with effects concerning the curvature of space, since either one senses the other as a non-real entity.

Considering that the curvature in the metric of time is already tied to the essence of the gravitational field, could there be some other, indirect way, that the curvature of space could have any association to the electric field? Notice that since either one of space and time perceives the other as an imaginary entity, that triggers what was stated earlier in relation to Equation (3), that entities of imaginary origin appear toward the real world through their negative reciprocals, as per $i = -1/i$. We shall take this point to lead toward a preliminary notion that the electric field could possibly associate to curvature of "negative reciprocal space". Where that could alternatively be referred to as curvature of "imaginary space".

Despite how unfamiliar the notion, it turns out that *the curvature of negative reciprocals of metrics may also behave as fields*. A supposed association between the essence of the electric field and potential with the curvature in negative reciprocal (therefore imaginary) space, actually appears to come in good match with units in conventional formulas subject to certain additional points to be introduced ahead.

The addressed connection of the electric field to the curvature of negative reciprocal (therefore imaginary) space is not arbitrary at all, and constitutes a consequence of the symmetry between the electric and gravitational interactions, which are analyzed in this paper. A point that needs to be clarified is that, if each of the gravitational and electric fields are indeed imaginary with respect to the other, how is it then possible that both exist and function as "real" fields in the classical world we live in. The answer to this question arises through the aforementioned negative reciprocation, as follows: Since the gravitational field concerns the curvature of positive time, we may pick this field as being the reference "real" field. Then, if we consider that the electric field concerns curvature of negative reciprocal space, this should be the one that has imaginary essence, consequently it should not be possible to affect a real action force in the real world. But then, the negative reciprocation process serves by itself as a co-involved second imaginary effect. In such case, the "imaginary of the imaginary" yields a negative real result. Hence, the electric field may also constitute a "real" entity, and we may perceive its action as a real force. In fact, the negative sign involved in the reciprocation process should imply that an electric force should point in opposite direction than a gravitational force would do. And indeed, the electric force points in opposite direction than the gravitational, since two charges of same sign repel each other, while two matter particles gravitationally attract each other.

Notice a point of importance, that from an electric field's own perspective (meaning its interaction with other charges), an electric field does not appear to be imaginary. It behaves as a real field. While it still maintains orthogonality with respect to the gravitational field which concerns the curvature of time, making these two fields act as independent fields. In fact, since the one relates to the curvature of space and the other the curvature of time, this allows for the energy in either one of these two curvatures to counterbalance the energy involved in the other. This has particular implications on the co-existence of matter and charge, which shall be possible to elaborate upon later, after further material becomes presented in section 4.

This concludes an initial approximation on the essence of the electric field, in its conventional variant which has radial-like field lines. However, the involvement of the electric field in effects of capacitance and inductance comes along with additional characteristics:

- In relation to *capacitance*, the crossing of charge between the plates of a capacitor involves a "displacement-electric" variant of the electric field, described by the relation $D = \varepsilon E$. This engages the electric permittivity ε, which is a complex entity since it is known to involve a real as well as an imaginary coordinate [6]-[7]. Because of that, the displacement-electric field also acquires a real and an imaginary coordinate, and that makes it a far richer entity than E, with implications on how it associates to a capacitive lead in time which shall be addressed in separate later.

- In relation to *inductance*, as per Lenz's law the electric field variant involves the electromotive potential which has loop-like field "lines" as it deploys over a circuit loop. Existing theory treats the induced current as a conduction current. However, we shall consider that it carries attributes of a displacement current, driven by a displacement-electric variant of inductive character (instead of capacitive character which concerns the case of the capacitor). That variant is also complex as it involves a real as well as an imaginary coordinate. This brings new clues on the functioning of an inductive phase lag, as well as on the displacement current that this may produce, which shall be addressed below.

3.2. Electric Force Functioning

It was earlier explained that while a material object accelerates (e.g. an apple falls), time moves slightly faster at the front (the lower part of the apple) than at the rear. And that difference in the fastness of passing time (due to acceleration) points in the opposite direction and counterbalances the difference in fastness of time due to gravity. A same kind of Doppler-like effect applies with regard to contraction of space, when charge (instead of matter) accelerates. In that case, space effectively becomes less stretched at the front part of an accelerated charged entity than in the rear part, by a similar factor to the one applied for the case of gravity (with the acceleration now concerning electric acceleration). Actually, while the electric field was stated to associate to the curvature of imaginary space (negative-reciprocal space), an interaction from its own reference viewpoint (meaning the way the electric field perceives another electric or magnetic field) applies as a curvature of *real* space. In this respect, when accelerating, a charged entity becomes subject to a difference in the stretchiness of space, which counterbalances the difference in the stretchiness of space associated to the external electric field. Therefore, a charge's self-driven acceleration (in respond to an external electric field) relaxes and releases the externally imposed potential energy of the external electric field, and this is what lets acceleration take place all by itself (much like a compressed spring would stretch out all by itself for releasing its potential energy).

As per the above, the gravitational and electric potentials apply in similar manner, subject to the swapping between the curvatures of time and (imaginary) space. Actually, from the point of reference of the electromagnetic interaction, the electric field may be referred to as curvature in ordinary space. Furthermore, the swapping between parameters of time and space that applies between the electromagnetic and gravitational interactions does not only concern action forces (like the gravitational and the electric), it also applies on reaction potentials, like the inertial and the electromotive, as well as their capacitive counterparts, as shall be discussed ahead. Later, in section 4.6(b) we shall further consider how charge and its electric field become subject to effects of relativity.

3.3. Raw Units of the Electric Field

Considering the above, it is possible to introduce "raw" units for the electric field, along similar lines to as is done for the gravitational field whose units correspond to [meter/sec^2]. The latter units work well for gravity due to the principle of equivalence, since acceleration brings a curvature in time which is equivalent in magnitude, and counterbalances the curvature associated to gravity, as explained in section 2.1. Therefore, the units of the former may also work for units of the latter. Other than that, however, these units of gravity do not really reflect the actual curvature in the metric of time which constitutes the essence of the gravitational field. Aside this limitation, they do serve well in conventional equations.

By symmetry, and subject to the same limitation (now affected with respect to space), the electric field may be described to refer to units of acceleration. From the point of view of the electromagnetic interaction, this may lead to assuming unconventional "raw" units of the electric field, that we shall consider to correspond to an inverse relation between space and time, having the form [sec/meter^2]. Despite how unrealistic this may seem, it shall get to become justified as it gets to comply with the units in conventional relations of electromagnetism that we shall consider ahead. In addition to that, it also comes in good match with new clues that shall be introduced concerning the essence of all four leptons' interactions, to be addressed in section 4.7.

On a supplementary note, a differentiated approach to account for the units of fields (like the electric or the gravitational) may arise on the basis of metric curvature, to be addressed in section 7(c).

3.4. Displacement Magnetic Field (*H*) vs. Magnetic Flux Density (*B*)

The magnetic field is conventionally represented through either of two, distinct but closely related alternative terms, the magnetic flux density B (measured in Tesla), or the magnetic field strength H (measured in Amperes per meter). These two associate to each other through the relation (4), where μ is the magnetic permeability, a measure of the magnetization that a material obtains when it is subject to an applied magnetic field.

$$H = \frac{1}{\mu} B \tag{4}$$

According to textbook theory these two representations differ on how they account for magnetization, while in vacuum they are the same. It turns out however, that these two representations differ from each other in a very fundamental way, as the magnetic permeability is shown to have a far deeper role than simply being a measure of magnetization of materials. The units of permeability refer to Henries per meter, where the Henry is the unit of inductance. Inductance is responsible for the creation of a phase "lag" in the oscillation of electric current with respect to the oscillation of voltage in a circuit. Textbook theory explains that the inductive lag concerns the "delay in time" which is needed for a magnetic field to change. This explanation does not seem adequate however, considering that an analogous intuitive explanation may not be provided for the case of a capacitive lead, which takes place "forward in time". Even though a capacitive *lead in current* may theoretically be treated as a *lag in voltage*, it still appears that the current understanding of inductance and capacitance is not that complete, as if something were missing.

Based on analysis over the upcoming sections, it is proposed that the phase "lag" corresponds to a displacement in time as that being a non-classical physics notion that engages the use of imaginary terms to account for. This in fact, complies to that the magnetic permeability is a complex number, having a real as well as an imaginary part (just like the electric permittivity also does) [6] [7]. The involvement of the magnetic permeability μ within H, makes the latter a far richer entity than B, in terms of ways it may engage in interactions. Actually, instead of calling H the "magnetic field strength", it would be more appropriate to call it "displacement magnetic field" by symmetry to its electric counterpart, the displacement electric field $D = \varepsilon E$ which applies between the plates of a capacitor. There, the electric permittivity ε is measured in Farads per meter, where Farad concerns the units of capacitance, and associates to a phase shift forward in time, a phase "lead". The displacement forward in time would likewise be a non-classical physics notion, and in relation to that, the electric permittivity is also a complex entity as it has a real as well as an imaginary coordinate. To cope with that, the term ε should be treated in the form of $\varepsilon(\cos\theta - i\sin\theta)$, where θ concerns a phase angle involved, which shall be considered ahead, and this lets distinguish between the two separate coordinates involved. Same condition applies for the magnetic permeability as well, which should likewise be treated as $(1/\mu)(-\cos\theta + i\sin\theta)$, with an inversion in the sign of the coordinates attributed to the orthogonality between the electric and magnetic fields. That the permittivity and permeability are complex entities, further implies that each of H and D also involve two coordinates, a real and an imaginary one, as follows.

$$D = \varepsilon(E\cos\theta - iE\sin\theta) \tag{5}$$

$$H = \frac{1}{\mu}(-B\cos\theta + iB\sin\theta) \tag{6}$$

Due to the orthogonality that holds between a real and an imaginary axis, each of the two coordinates of H and D should be possible to engage in separate interactions. That has critical implications in the deeper understanding of numerous effects of electromagnetism. We shall particularly consider that a displacement electric field does not only engage in effects of capacitance (e.g. across a capacitor's plates). It also comes in an oppositely-displaced variant that may engage in effects of inductance, as in generating an inductive current in a metal ring via the electromotive potential. In a similar sense, its displacement-magnetic counterpart shall also be discussed to engage in both inductive and capacitive processes, like in the operation of the electric battery (via an inverse interaction) or in the application of a magnetic force (to be addressed ahead).

Furthermore, on the basis of symmetry we shall later describe analogous conditions concerning the gravitational and the gravitomagnetic fields g and T, which should also have displacement field variants g_d and T_d, engaging in effects of reaction. [Re. list of notations in the Appendix]. The latter field variants shall also be discussed to engage in intrinsic-field interactions.

3.5. Displacement Current vs. Barrier Penetration

(a) Displacement Current

The crossing of charge through the plates of a capacitor takes place in the form of "displacement current" I_d which is described by the relation (7). According to textbook theory the *displacement current* behaves similar to a conduction current [8], but no adequate clarification exists on its deeper nature, neither on how exactly it correlates to a capacitive lead in time. We shall attempt to shed light on both these issues here.

$$I_d = \varepsilon_0 \frac{\partial \Phi_E}{\partial t} = \frac{\partial \Phi_D}{\partial t} \tag{7}$$

Since in this relation the electric flux Φ_E co-exists with the electric permittivity ε, the displacement current involves the "displacement-electric flux" Φ_D. The *displacement* variant constitutes a fundamentally different entity, of complex nature since the electric permittivity involves a real as well as an imaginary coordinate, consequently the displacement electric flux also gets to acquire a real and an imaginary coordinate. The crossing of charge through the plates of the capacitor appears to engage the imaginary coordinate, as that can be traced through the following characteristics that it exhibits:

<u>(i) Short range of action</u>: The displacement-electric action applies over a short range only, and that should reflect on the imaginary essence of the coordinate involved, which refers to conditions of negative energy. This gets it damp out quickly in the real world, same as it also holds for the fields of evanescent modulation of electromagnetic waves which damp out quickly in the real world [9]. This is why the plates of the capacitor need to be at close range, while it similarly holds in terms of proximity requirements for other devices which operate on similar grounds, like the wireless chargers which rely upon similar basic principles.

<u>(ii) Involves a shift in time</u>: The permittivity term comes in units of Farad per meter. Farads are the units of capacitance. The present model proposes that capacitance involves a phase shift in the time domain, denoted as $+\Delta t$, where the Greek letter delta is meant to indicate the shift in time, and the plus sign indicates that the phase shift is in the forward direction (capacitive, instead of inductive). The units of permittivity therefore, appear to refer to a condition like $+\Delta t/\mathrm{d}x$. The phase shift, or phase "lead" by Δt, is not a notion referring to classical physics. But may be loosely accounted for in units of seconds (of displacement), as an

alternative to measuring it in terms of angle of phase shift. That may be considered to imply that the units of Farad may associate to "*seconds of shift in time*". The validity of the use of seconds (of displacement) shall be substantiated later through a match in units with known equations. The phase shift in time allows for conveying an effect of reaction across the (elements of the) circuit loop concurrently (since it concerns a loop-like process). These elements include the circuit's electric source, from which it tends to suppress the process of energy retrieval.

(iii) Instantaneity: That the shift in time is conveyed concurrently (therefore instantaneously) throughout the whole circuit loop, is feasible for the same simple reason as when rotating a bicycle's wheel, all elements of the wheel rotate concurrently at once. Such attribute of effects of reaction is of significance, as it allows for instantaneous responses, with this having a parallel in the effect of entanglement which shall be referred to in section 7. That a response is mediated instantaneously, goes along with the involvement of an imaginary coordinate in the accounting of energy (in fact, imaginary numbers comply to superluminal attributes that instantaneity implies). Such fastness concerns the conveyance of a reaction phase shift, and appears to hold for effects of reaction in general, in view of conservation of energy and momentum, which according to this model has to be immediate. Furthermore, in association to the imaginary character of the field components involved in effects of reaction, these fields should deploy in the real-world subject to an inverse geometry:

(iv) Inverse geometry: Unlike the conventional electric field which has radial-like field "lines", the displacement-electric variant deploys over the circuit loop thus its field "lines" form loops. That applies for both its capacitive-displacement version which mediates a capacitive shift over the circuit loop, as well as for an inductive-displacement variant involved in the electromotive potential which shall be discussed in section 3.7. Such inversion of geometry, from radial to loop-like, or vice versa depending on the particular field and the sign of energy involved, actually applies for all reaction potentials. Effects of reaction typically involve a negative energy variant of fields (to be analyzed in section 4.8). The negative-energy variants may not directly project to the real world, but they may do so when they engage in a displacement process, like the displacement in time Δt contained within the units of the permittivity and permeability terms (Farad or Henry). It is important to clarify that this displacement is actually the root-cause of the inverse geometry (and not the negative-energy field variants themselves).

The displacement may take place in two ways. Either when a *negative*-energy variant of the field displaces with respect to conventional positive space (or positive time), or, if a *positive*-energy field displaces with respect to *negative* space (or negative time) as shall be elaborated ahead. In either case, a displacement-electric field could apply as if it has loop-like field lines (instead of radial-like). Likewise, a similar type of geometric inversion applies for the displacement-magnetic field, and has it apply as having *radial-like* field "lines" (instead of loop-like). Actually, for any field with radial-like characteristics we may directly perceive only a portion of the field "lines" that has real nature (same as for the electric or the gravitational fields) and we may not directly perceive the opposite energy portion which has imaginary nature, which may however engage in effects of reaction. We shall soon discuss such capacitive-like variant of the magnetic field in the case of the electric battery in section 3.6. But we shall also meet such inversion of field geometry in effects of reaction over and over again throughout different areas of physics.

(v) Flux instead of Field: The relation (7) involves a change in flux, not a change in field. Existing theory does not elucidate how a flux differs from a flow, but we shall attempt to clarify that here. A classical flow is measured "with respect to" the area the flow goes through, so the area should be in the denominator. A flux instead, is measured "times the" area, which in fact does not make clear intuitive sense. The reasoning behind that, appears to refer to the projection of that field upon opposite space (or time) metric, where that triggers the involvement of the reciprocation mentioned in relation (3). In the particular case of the capacitor, this translates to measuring the electric field with respect to an area of "negative reciprocal space" instead of conventional space. What this tells, is that an electric flux refers to a flow with respect to a negative reciprocal area $\left(1/dx^2\right)$, instead of with respect to the conventional area dx^2. In such case, the term $\left(1/dx^2\right)$ gets flux effectively being measured with respect to space as that being imaginary, symbolically represented as idx^2. In relation to that, relation (8) displays why the area appears as being in the position of a numerator. In fact, the same applies for the magnetic flux too, as per relation (9).

$$\Phi_E = Edx^2 = \frac{E}{\frac{1}{dx^2}} = \frac{E}{idx^2} \tag{8}$$

$$\Phi_B = Bdx^2 = \frac{B}{\frac{1}{dx^2}} = \frac{B}{idx^2} \tag{9}$$

This is meant to elucidate the *difference between a flux and a flow*, with the flux being measured in reciprocal units, and a flow being measured with respect to an area dx^2. We shall meet this point over and over again, across numerous areas of physics.

On a side-note of significance, the same concept may also apply in reverse, when a negative-energy field (like the gravitomagnetic, which has imaginary field characteristics) is measured with respect to positive space or time. Then, what we perceive in the real world corresponds to a "flow", not a flux. This actually directly refers to the root cause of celestial objects' rotation, as was first mentioned in section 2.5.

In relation to the above, therefore, the changing displacement electric flux term $\partial\Phi_D/\partial t$ in relation (7) applies as if it involves the imaginary portion of (5), which is referred to as $D_{im} = \varepsilon\left(-iE\sin\theta\right)$, where θ is an angle of phase shift that shall be elaborated ahead. Since this coordinate of the displacement electric field is imaginary, it damps out quickly in the real world (same as evanescent modulation also does).

On a side-note, in sections 4.8 and 6 we shall elaborate on the negative-energy variants of fields. It shall then arise that a negative energy variant of the electric field $\bar{E}$, directly associates to the "neutral currents" of the Weak interaction. Just like above we considered that the imaginary coordinate of the displacement electric field may apply in the negative space metric, a symmetric coordinate of the negative-energy displacement variant may apply in positive space, through a symmetric coordinate referring to $\bar{D} = \varepsilon\left(-\bar{E}\sin\theta\right)$, causing a displacement-current when there is a change in flux of $\partial\Phi_{\bar{D}}/\partial t$. That is an imaginary process that marginally applies in the classical world, in close range only (to be associated later to the short range of the weak interaction).

(b) Barrier Penetration

An attribute symmetric to capacitance is proposed to hold in the theory concerning gravity/mechanics. It may be referred to as "mechano-capacitance" in order to differentiate it from the electric counterpart. Mechano-capacitance will be explained to engage in the effect of barrier penetration, in analogy to the crossing of displacement current through the plates of a capacitor in electronics, and this allows to approximate barrier penetration through a new, classical-like way.

Just like the electric flux Φ_E engages in the transfer of displacement-current in electronics, a symmetric quantity is introduced for the gravitational interaction, which we shall call gravitational flux, and denote it with the symbol Φ_g, as per equation (10). [Re. list of notations in Appendix].

$$\Phi_g = gdt^2 = \frac{g}{\dfrac{1}{dt^2}} = \frac{g}{idt^2} \tag{10}$$

$$\Phi_T = Tdt^2 = \frac{T}{\dfrac{1}{dt^2}} = \frac{T}{idt^2} \tag{11}$$

This relation involves the gravitational field g, as well as a newly introduced measure, area-like, concerning time. A peculiarity of the latter, is that the adoption of the term dt^2 should imply the existence of (at least) 2 dimensions of time, instead of a single dimension of time that conventional theory considers. The possibility of existence of more than one dimensions of time is key to numerous effects and may be supported through a thought-paradigm as follows:

Consider two rocket ships, A and B, travelling side-by-side, near lightspeed. Crew A ages SLOWER than people on earth (due to its relativistic velocity). But concurrently, crew A ages SAME as Crew B, since the two rocket ships have same velocity. This implies the co-existence of two variances, and therefore two dimensions of time for Crew A (or any other observer under similar conditions). This conceptual paradigm allows to accept the two dimensions of time as a conventional notion, hence the plausibility of existence of the term dt^2 in (10). By extend, the same conceptual paradigm may similarly involve a third dimension as well. In fact, the relation (10) itself may be understood to assume the existence of 3 dimensions of time: One along the direction of the flux $\left(\Phi_g\right)$, and another two through which the flux is measured against $\left(dt^2\right)$. A similar relation actually has to apply for the gravitomagnetic flux, as shown in (11) for later reference. The existence of 3 dimensions of time constitutes a key ingredient of the new theory, and in relation to discussion that takes place in section 7(c) the 3 dimensions of time and 3 dimensions of space, along with a particular reference to real and imaginary coordinates, appears to account for nature's all interactions without the need for extra dimensions.

Let us now figure how these concepts may apply in barrier penetration. The present model approximates barrier penetration as an effect of "displacement momentum p_d", in symmetry to the "displacement current I_d" of electronics. These two may actually be described by symmetric relations, as of (7) and (12):

$$p_d = \varepsilon_g \frac{\partial \Phi_g}{\partial x} = \frac{\partial \Phi_{g_d}}{\partial x} \tag{12}$$

$$\varepsilon_g = \frac{C_g}{dt} \to +\frac{\Delta x}{dt} \tag{13}$$

Just like the displacement current involves the electric permittivity ε which was stated to refer to a measure of a shift in time $+\Delta t/dx$, the displacement momentum should involve a similar term ε_g where the subscript g indicates that this refers to the gravitational interaction. We shall call ε_g "mechano-permittivity", to keep the symmetry in the naming. [Re. list of notations in Appendix]. The mechano-permittivity has completely different essence to its electric counterpart, and associates to a phase shift forward in space $+\Delta x$, measured with respect to time, as shown in relation (13). So its units refer to [meters(of displacement)/second]. Note that the phase shift in space $+\Delta x$ may be understood to refer to a capacitance-like quantity (in symmetry to as capacitance C in electronics associates to a phase shift in time $+\Delta t$). We may call this new quantity "mechano-capacitance" so as to distinguish it from its electric counterpart, and shall denote it by the letter C_g where the subscript g again indicates that this refers to the gravitational interaction. The C_g is fundamentally different to capacitance C as it concerns a phase shift forward in space $+\Delta x$ (instead of time). This shift corresponds to a non-classical attribute as well, and it is accounted for as a complex number too.

That the relation (12) involves the gravitational flux Φ_g along with the mechano-permittivity ε_g, signifies that it actually describes a change in "displacement-gravitational flux" $\Phi_{g_d} = \varepsilon_g \Phi_g$. In such way, it describes a "displacement forward in space" $+\Delta x/dt$ which exactly refers to a process of tunneling in space (of matter's wave nature, through a barrier) in similar way to as (7) described a "displacement forward in time" which refers to a form of "tunneling in time" (of charge through the plates of a capacitor).

The presence of the mechano-permittivity ε_g term also allows for the existence of a corresponding "displacement gravitational field g_d", defined as per

(14), by symmetry to the displacement electric field $D = \varepsilon E$. And just like ε involves a phase shift forward in time which concerns a non-classical attribute so it is accounted for as a complex term, it similarly holds for the mechano-permittivity ε_g which involves a phase shift forward in space $+\Delta x$ which also constitutes a non-classical attribute, and it is represented by a complex number, having the form $\varepsilon_g(\cos\theta - i\sin\theta)$. Likewise, the displacement gravitational field g_d should read as shown in relation (15).

$$g_d = \varepsilon_g g \tag{14}$$

$$g_d = \varepsilon_g\left(g\cos\theta - ig\sin\theta\right) \tag{15}$$

Consequently, the displacement gravitational flux Φ_{g_d} in relation (12) should also have a real as well as an imaginary coordinate. And its engagement in the effect of barrier penetration appears to involve the imaginary coordinate (similar to the case of the capacitor). Under these conditions, the imaginary attributes that characterize the displacement gravitational flux which drives the displacement momentum, have as follows:

<u>(i) Short range</u>: Due to its imaginary essence, the displacement gravitational flux damps out quickly in the real world, as it becomes evanescent (just like the electromagnetic fields do in evanescent modulation in electronics, or, as the displacement electric flux does in the case of the capacitor). This is why the probability of barrier penetration gets significantly reduced by an increase in the width of the barrier.

<u>(ii) Involve a phase shift forward in space</u>: This happens due to the involvement of the mechano-permittivity term ε_g, which in turn involves mechano-capacitance C_g, where that refers to a phase shift in space $+\Delta x$. That phase shift, or phase "lead" Δx, is not an attribute of classical physics, but may still be loosely accounted for in units of meters (of displacement) as an alternative to measuring it in terms of an angle of phase shift.

<u>(iii) Instantaneity</u>: This concerns the displacement in space, and directly refers to tunneling in space. This is instantaneous in the same sense as the displacement-current was explained to shift concurrently over the whole spatial circuit loop (much like when rotating a bicycle wheel, all elements of the wheel rotate together at once). In the mechanical case here, the displacement shift concerns a loop in TIME. To address the nature of the momentum-displacement requires new concepts which shall be discussed in section 4.1. These concepts lead to a particular association between the imaginary portion of a particle's wave function, and matter's gravitational properties. For the moment, the shift may be (preliminarily) understood to concern a shift in the parameter of time which rides the cosmic trail of a gravitational field "line" (axis of **Figure 1**). Even though that cosmic loop is immense, the corresponding shift concerns time, so the spatial extend is irrelevant.

<u>(iv) Inverse geometry</u>: The phase shift may be considered to ride over gravitational field "lines" of the particle along the direction of matter wave propagation

(and displacement). While a conventional gravitational field "line" appears radial-like so we may only perceive the real portion of it, the phase shift rides over the whole loop (both the real and the hidden imaginary portions of it). The shift takes place concurrently (therefore is affected instantaneously) over this loop, as per the previous paradigm of the bicycle wheel.

(v) Flux instead of field: The effect of barrier penetration involves a change in flux, not a change in field. This flux concerns a measure of the gravitational field with respect to an "area" of negative reciprocal time, as per relation (10). What this tells, is that the gravitational flux refers to a flow with respect to $(1/dt)^2$, instead of with respect to dt^2. That again, implies that the shift has imaginary character, hence the negative reciprocation of the parameter of time. The division by a reciprocal is equivalent to a multiplication, and that brings the parameter of time-squared to appear as being in the numerator, as shown at the left part of relation (10).

In relation to the above, therefore, the changing displacement gravitational flux $\partial\Phi_{g_d}/\partial x$ in relation (12) engages the imaginary portion of relation (15), referred to as $g_{d_{im}} = \varepsilon_g(-ig\sin\theta)$. That being an imaginary coordinate, it damps out quickly in the real world (same as evanescent modulation also does in electronics).

On a side note, in sections 4.8 and 6 we shall discuss the existence of negative-energy variants of fields. That will include a negative energy version of the gravitational field $\overline{g}$, which will be linked to "negative matter" and referred to the field components of the Weak interaction bosons. Just like above we have explained that the imaginary coordinate of the displacement gravitational field may displace with respect to negative-reciprocal-time (imaginary time), the same may apply in opposite energy, in which case a negative-energy coordinate may displace with respect to positive time. This involves a symmetric coordinate of the form $\overline{g}_d = \varepsilon_g(-\overline{g}\sin\theta)$, causing displacement-momentum, as a change in flux of $\partial\Phi_{\overline{g}_d}/\partial x$. This is also an imaginary process which marginally materializes in the real world, in close range only, where that associates to the short range of action of the Weak interaction bosons. The negative-energy gravitational field which is involved in this effect of displacement, will be discussed (in section 4) to associate to properties of neutrinos and anti-neutrinos.

In conclusion to the above, barrier penetration of matter appears to be the mechanical counterpart of the crossing of charge between the plates of a capacitor. The treatment of the latter as displacement current I_d is analogous to the treatment of the former as a displacement momentum p_d. The one is mediated by a displacement of gravitational flux through imaginary time squared, and the other is mediated by a displacement of electric flux through imaginary space squared.

The above processes similarly apply with respect to other orthogonalities, as well as through the involvement of the real coordinates of fields. An example of a different orthogonality refers to the effect of frustrated total internal reflection, which concerns the transfer of electromagnetic waves in negative energy. Electromagnetic waves and their propagation shall be discussed in sections 3.11 and 6(a).

3.6. Electric Battery vs. Exergonic Reactions

(a) On the Electric Battery

In section 3.5 we addressed electric capacitance and provided insights about the displacement-current that crosses between the plates of a capacitor. We shall now consider how the process involved in an electric battery differs to the process involved in a capacitor. And in relation to that, we shall consider why the battery may provide a lasting potential, while a capacitor may quickly discharge. As well as, why a battery drives a conduction current I, while the crossing of charge through a capacitor involves a displacement current I_d.

The battery is conventionally considered to be powered by the electromotive potential. But that potential typically engages in effects of induction, and has a REACTION character. Therefore this assumption seems inaccurate, as the battery should rather be powered by a comparable process of ENHANCING character.

The displacement current was earlier associated to a change in the imaginary coordinate of the displacement electric flux $\partial\Phi_D/\theta t$. Now we need to look for a different field component to be responsible for powering the electric battery. And that other field component should still be mathematically orthogonal to the imaginary coordinate of the displacement electric flux, so as to concern a distinct interaction. Such condition may be met if the interaction engages the imaginary part of the displacement magnetic flux, instead. Let us figure how that flux may arise from the displacement magnetic field H. As per the relation (6), H was considered to have two coordinates, a real and an imaginary one, of which we shall here be focusing on the imaginary one, which corresponds to (16). Notice that when this coordinate is compared to the imaginary component of (5), it appears to be subject to an opposite sign. This negation (due to the involvement of the magnetic field instead of the electric) is analogous to having the shift in time $-\Delta t$ (which is contained within the term μ) to develop in the opposite direction, therefore functioning like $+\Delta t$. That in turn, resembles transforming μ (which refers to $-\Delta t/dx$) to ε (which refers to $+\Delta t/dx$), without any change in units whatsoever. In this case, it is the negative-energy variant of the magnetic field that appears to be engaged, denoted by the letter $\overline{B}$. Consequently (16) effectively concerns (17), where the permittivity term implies a capacitive-like behavior (instead of an inductive-like one).

While it may seem unrealistic for a magnetic term to be accompanied by the permittivity ε (instead of the permeability μ), this appears to actually hold, in relation to the involvement of the opposite-energy version of the magnetic field. (In fact, the use of ε in this case is nothing more than using the permeability with a minus sign $-\mu$). And in relation to that, an opposite flow of energy appears to leak that energy toward the real domain, providing an enhancing effect (instead of impeding), which the electric battery produces. We shall also meet a corresponding swapping between the terms ε and μ in more cases as we move ahead.

$$H_{im} = \frac{1}{\mu}\left(iB\sin\theta\right) \tag{16}$$

$$\bar{H}_{im} = \frac{1}{\varepsilon}\left(i\bar{B}\sin\theta\right) \tag{17}$$

We now need to prepare a relation describing the flux of $\bar{H}$, and then figure how a change in that flux $\Phi_{\bar{H}}$ may generate a current in the case of the electric battery, in analogous way to as a change in displacement electric flux causes a displacement current as per $I_d = \varepsilon_0 \partial\Phi_E / \partial t$. It turns out that the specific process is not a conventional one, since we are dealing with an imaginary (non-real) flux version $\Phi_{\bar{H}}$, where the whole process should concern negative energy. To handle that, it requires certain new concepts that shall be introduced in section 4, but we may here provide an early indication as follows:

(i) Recall that a Voltage-Current phase shift splits energy to two coordinates, a real and an imaginary one. The imaginary coordinate is accounted for by a sine term, which applies as an impeding potential when changing the current. The sine coordinate is less effective than the action force, so it only applies as an inefficiency in changing the current (it does not generate a current by its own).

(ii) In the case of the electric battery, we have an opposite flow of energy, from the imaginary toward the real domain. The interaction develops in negative energy, which requires imaginary terms, and in this case the corresponding coordinate of negative energy leaks energy toward the real world (instead of the usual, other way around). That causes an enhancing action (instead of impeding), which is the one that provides power to the electric battery.

(iii) The phase angle that becomes involved in defining field coordinates in this case, does not arise due to involvement of any sort of inductive or capacitive element (like a coil or a capacitor, as it holds for an electric circuit loop). It concerns the quantum oscillator, and the angle of shift concerns the Weinberg angle (which was earlier associated to the phase shift between the time and space curvatures illustrated in **Figure 1**). The corresponding coordinate in this case refers to the sine of 60˚ (equal to 90˚ minus the Weinberg angle) due to the opposite flow of energy toward the real world, so it may also be expressed as a cosine of 30˚. This angle in fact, allows for this enhancing coordinate to be stronger than the impeding coordinate, hence the battery may provide a surplus of energy.

(iv) Since the interaction concerns negative energy, the enhancing potential should not arise from a conventional interaction with electrons. It arises from a particular negative energy property of baryons, in this case the protons, which shall be described in section 4.10. Notice that protons have positive charge just like positrons do, however, the protons are stable particles (having extremely long half-life) while the positrons are not stable particles (as they engage in annihilation processes). The reason why positrons are not stable will be addressed in section 4, and has to do with their quantum oscillator engaging the negative direction of time (in alignment with the Feynman-Stückelberg interpretation which shall be discussed ahead). In the other hand, the reason why protons are stable, stems in the nature of quarks. According to additional material that will be introduced in that section, the phase shift which equals the Weinberg angle (of 30˚) is responsible for the very existence of quarks and gets a portion of their nature to dive into negative energy. In simplified terms, because of the Weinberg phase shift, a quark loosely resembles being 1/3 of an electron and 2/3 of a neutrino, or vice versa, depending on the flavor. Unlike positrons which associate to the negative time metric, this phase shift gets quarks have a portion of their quantum oscillator diving into the negative space metric too. The co-existence of two negative metrics (the negative time and negative space metrics) yields a positive energy product, which contributes to the quarks being stable. This provides the possibility to the negative energy portion of quarks to engage in effects of reaction which releases positive energy toward the real world, which powers the electric battery.

Due to the opposite sign of energy involved, the flux term $\Phi_{\bar{H}}$ should be measured with respect to opposite-space curvature. Therefore, unlike the magnetic flux $\left(\Phi_B = Bdx^2\right)$ being measured in reference to the area dx^2, and its displacement flux version alike being $\Phi_H = Hdx^2$, now the negative energy flux should be measured with respect to reciprocal area $\left(1/dx^2\right)$, as shown in relation (18).

$$\Phi_{\bar{H}} = \bar{H}\left(\frac{1}{dx^2}\right) = \frac{\bar{H}}{dx^2} \tag{18}$$

This however keeps the term dx^2 in the denominator (instead of the numerator), so we are dealing with a conventional "flow" with respect to an area dx^2 (instead of a "flux" with respect to ($1/dx^2$) as in the case of the magnetic flux). This characteristic of "flow" instead of flux is of significance, as it is responsible for the electric battery generating a conventional "conduction" current (instead of displacement current).

What remains to be figured, is what should the flux $\Phi_{\bar{H}}$ change with respect to, so as to generate a current in the case of the electric battery (in analogy to (7) of the capacitor's case). In relation to material that shall be introduced in section 3.11, the magnetic and electric fields oscillate with respect to opposite domains of time and space. And this should similarly hold for their displacement-field variants too. So, while in the case of displacement current $\left(I_d = \varepsilon_0\, \partial\Phi_E/\partial t\right)$ the electric flux changes with respect to time, the magnetic flux appears to change with respect to space, as shown in relation (19).

$$V_d = \left(\frac{1}{\varepsilon}\right)\frac{\partial\Phi_{\bar{B}}}{\partial x} = \frac{\partial\Phi_{\bar{H}}}{\partial x} \tag{19}$$

This however, brings another consequence. Since the change takes place with respect to space (instead of time), the displacement produced concerns a displacement voltage V_d (instead of a displacement current I_d). Furthermore, due to its imaginary essence, the corresponding displacement flux should be subject to an inverse geometry, meaning that its field "lines" should be radial-like (instead of loop-like as of the conventional magnetic field). This in fact, is what allows for the corresponding displacement field to create a (capacitive-like) Voltage difference across the poles of the battery.

As per the above, the electric battery appears to be powered by the a negative-energy magnetomotive potential (instead of the electromotive potential). We have addressed (i) why this brings a surplus of power to the real world (instead of shifting power toward the imaginary domain and create impedance), (ii) why the current created is a conduction current (since it concerns a flow instead of flux), and (iii) how it involves an effect of displacement (in voltage instead of current). In this way, the radial-like displacement-voltage powers the lasting voltage across the poles of the electric battery.

The negative-energy version of magnetic flux introduced in this section shall be referred to as "anti-magnetic" flux. That field variant relates to the negative-energy electric field that was introduced above (and that shall later be referred to as "anti-electric" field) where these two interact with each other through Maxwell-like relations with respect to imaginary space and imaginary time metrics, in relation to theory coming ahead. The above described process through which a displacement voltage causes a lasting potential is of significance, as in section 4.10 it shall come in compliance to theory concerning the fractional charge ±1/3 or ±2/3 of quarks. In any case, as per the above, it's the quarks inside protons that should be responsible for powering the electric battery.

(b) On Exergonic Reactions

A symmetric process to the one of the electric battery appears to take place in mechanics. In section 3.5 we introduced the concept of mechano-capacitance C_g which is contained within mechano-permittivity ε_g as per relation (13), and we addressed how that becomes involved in causing "displacement-momentum p_d" which is responsible for the effect of barrier penetration. That effect was stated to associate to a change in the imaginary coordinate of the displacement gravitational flux $\partial\Phi_{g_d}/\partial x$, as per (12). Now, we shall look for an orthogonal interaction that may yield an enhancing potential, being a mechanical counterpart to the case of the electric battery. The corresponding field should be mathematically orthogonal to the imaginary coordinate of the displacement gravitational flux, so as to engage in a distinct interaction. Such condition may be met if the interaction engages the imaginary coordinate of the displacement-gravitomagnetic flux. Let us consider how that flux may arise from the displacement gravitomagnetic field T_d. The latter may be described by a relation of the form (20), where μ_g is a mechano-permeability term, which refers to a phase shift in negative space $-\Delta x$ (a phase drag) with respect to time, so it refers to $-\Delta x/dt$. An example of where such drag may physically apply, concerns the potential that drags an airplane's wing backwards, as an expense against exerting the lift force. The phase shift in negative space in this case relates to the increased sideways proximity of the swirling air particles, the faster their flow by the center of the swirling, that follows the wing.

This phase shift is not a classical physics attribute, and the term μ_g corresponds to a complex number, which has a real as well as an imaginary coordinate. Because of that, T_d should also have a real as well as an imaginary coordinate, as shown in relation (21). In exergonic reactions the phase angle does not arise in reaction to some effect of mechanical action (like the lift of a wing). Instead, it concerns the quantum mechanical oscillator, and the phase angle refers to the phase shift between the metrics of Time and Space illustrated in **Figure 1**, which corresponds to the Weinberg angle θ_w whose value is 30°.

$$T_d = \frac{1}{\mu_g} T \tag{20}$$

$$T_d = \frac{1}{\mu_g}\left(-T\cos\theta_w + iT\sin\theta_w\right) \tag{21}$$

$$T_{d_{im}} = \frac{1}{\mu_g}\left(iT\sin\theta_w\right) \tag{22}$$

$$\bar{T}_{d_{im}} = \frac{1}{\varepsilon_g}\left(i\bar{T}\sin\theta_w\right) \tag{23}$$

We are interested in the imaginary part of (21), which comes with a positive sign instead of negative. This negation is equivalent to a shift in space $-\Delta x$ (contained in the term μ_g) developing in the opposite direction, therefore functioning like $+\Delta x$. This effectively applies as if μ_g (which corresponds to $-\Delta x/dt$) has transformed to ε_g (which corresponds to $+\Delta x/dt$), without any change in units whatsoever. In this case, it is the negative energy variant of the gravito-magnetic field that becomes engaged, denoted by the letter $\bar{T}_d$. Consequently, the interaction actually refers to relation (23), instead of (22), where the mechano-permittivity term implies a capacitive-like effect of action (instead of inductive-like). While it may seem unrealistic for a gravito-magnetic term to be accompanied by ε_g (instead of μ_g), this appears to hold, due to the involvement of the opposite-energy version of the gravito-magnetic field. And through this way, it accounts for an enhancing effect (instead of impeding) that an exergonic bio-chemical reaction produces, and engages in providing power to living organisms. In fact, we shall meet a corresponding swapping between ε_g and μ_g in more cases as we move ahead.

We now need to prepare a relation describing the flux of $\bar{T}_d$, and also figure how a change in that flux $\Phi_{\bar{T}_d}$ may generate physical motion, (in analogous way to as a change in $\Phi_{\bar{H}}$ was described to drive a conduction current via (19)). Here again, the whole process should concern negative energy, and for handling that, it requires material that shall be introduced in section 4. But we may provide an early indication as follows, same as we also did previously for the case of the electric battery:

(i) Recall that the phase shift between the Time and Space metrics splits energy in two coordinates, a real and an imaginary. The imaginary coordinate is accounted for by a sine term, which applies as an impeding potential in changing a particle's momentum. In the typical case the sine coordinate is less strong than the action force, so it only applies as an inefficiency in changing the motional status of matter, like in the effect of inertia (or like in the impedance to a change in current in electronics, as explained earlier).

(ii) In the case of exergonic reactions, we are considering an opposite flow of energy, from the imaginary toward the real domain. The interaction develops in negative energy, which requires imaginary terms, and in this case the corresponding coordinate of negative energy leaks energy toward the real world (instead of the usual, other way around). That causes an enhancing action, which is the one that provides power to exergonic bio-chemical reactions.

(iii) The phase angle that becomes involved in estimating the field coordinates in this case, again concerns the Weinberg angle (the 30˚ phase shift between the time and space curvatures illustrated in **Figure 1**), as this is a resonant value that engages in the quantum world. (The reason of existence of this angle is addressed later, in section 5.3). The corresponding coordinate in this case refers to the sine of 60˚ (equal to 90˚ minus the Weinberg angle), which may also be expressed as a cosine of 30˚ (due to the opposite flow of energy, toward the real world). This particular angle makes this enhancing coordinate stronger than an impeding coordinate, hence the exergonic bio-chemical reactions may provide a surplus of energy.

(iv) Since the interaction concerns negative energy, the enhancing potential should not arise from a conventional interaction with electrons. It arises from a particular negative energy property of baryons which shall be described in section 4.10, and directly relates to the Weinberg angle, as that angle appears to allow for the very existence of quarks, and gets a portion of their nature to dive into negative energy. In simplified terms, a quark loosely resembles being 1/3 of an electron and 2/3 of a neutrino, or vice versa depending on its flavor. Unlike positrons which associate to the negative time metric, this phase shift gets quarks have a portion of their quantum oscillator dive into the negative space metric too. The co-involvement of two negative metrics (the negative time and the negative space metrics) yields a positive energy product, which contributes to the quarks being stable. This provides the plausibility for the negative energy portion of quarks to engage in effects of reaction which releases energy toward the real world. This negative energy portion of quarks, will later be discussed to refer to "negative matter".

Due to the opposite sign of energy involved, the flux term $\Phi_{\overline{T}_d}$ should be measured with respect to negative-time curvature. Therefore, unlike the case of the gravitomagnetic flux (Equation (12)) being measured with respect to the area-like term dt^2, now the negative energy flux should be measured with respect to a reciprocal area of the form $\left(1/dt^2\right)$, as shown in Equation (24). This however keeps the term dt^2 in the denominator (instead of the numerator), so we are dealing with a conventional "flow" with respect to dt^2 (instead of a "flux" with respect to $\left(1/dt^2\right)$, as of the case of the gravito-magnetic flux). This characteristic of "flow" instead of flux is of significance, as it is responsible for an exergonic reaction yielding conventional motion (actually "momentum"), like in moving a human muscle (instead of yielding a "displacement-momentum" as in barrier penetration).

$$\Phi_{\bar{T}_d} = \bar{T}_d \left(\frac{1}{dt^2} \right) = \frac{\bar{T}_d}{dt^2} \tag{24}$$

What remains to be figured, is what should that flux $\Phi_{\bar{T}_d}$ change with respect to, so as to generate a potential (in some analogy to relation (19) of the electric battery). In relation to material that shall be considered in section 3.11, the magnetic and electric fields oscillate with respect to opposite domains of time and space, and that should similarly hold between the gravitational and gravitomagnetic fields. While in the case of displacement momentum (Equation (11)) the gravitational flux was described to change with respect to space $\left(p_d = \varepsilon_g \, \partial\Phi_g / \partial x \right)$, here the gravitomagnetic flux should change with respect to time, as shown in relation (25).

$$N_d = \left(\frac{1}{\varepsilon_g} \right) \frac{\partial \Phi_{\bar{T}}}{\partial t} = \frac{\partial \Phi_{\bar{T}_d}}{\partial t} \tag{25}$$

This however brings another consequence. Since the change takes place with respect to time (instead of space), the displacement produced concerns a displacement-pressure potential, which we shall denote by the term N_d (instead of producing displacement momentum p_d). Furthermore, due to its displacement character, the corresponding displacement flux should also be subject to an inverse geometry, meaning that its field's "lines" should be radial-like (instead of loop-like as of the conventional gravito-magnetic field). This in fact, is what allows for the corresponding displacement to create a (capacitive-like) pressure that may power human muscles.

As per the above, exergonic reactions are powered by a negative-energy gravitomagnetomotive potential (in symmetry to the negative-energy magnetomotive potential in the case of the electric battery). We have addressed that: (i) this potential brings a surplus of power to the real world (instead of shifting it toward the imaginary domain and create impedance), (ii) that the momentum created is of conventional form (in moving muscles) and not of displacement form, since it concerns a "flow" instead of a "flux", and (iii) that it involves an effect of displacement-pressure (instead of a displacement-momentum as of barrier penetration). In this way, the radial-like displacement sets a lasting potential, which is the one that powers living organisms.

The negative-energy flux variant introduced in this section shall be referred to as "negative-gravito-magnetic" flux. This relates to the negative-gravitational field (the gravitational field of "negative matter") through Maxwell-like relations subject to a swapping of parameters of time and space, so as to account for the gravitational interaction (instead of the electromagnetic).

The above described process through which a displacement-pressure causes a lasting potential, is of significance, as in section 4.10 we shall consider that it relates to the essence of quarks. It appears that it is the negative energy portion of quarks that are responsible for powering exergonic reactions (and by extend support life).

3.7. Induction-Inertia Symmetries

(a) Induction in Electronics

An inductive phase shift, or "lag", concerns a delay in time of the current oscillation with respect to the voltage oscillation. As proposed above, this concerns a non-classical attribute of displacement in time, as if the unit of inductance, the Henry, refers to a measure of a phase shift in time. In such case, the Henry can be corresponded to "seconds of shift in time" (an alternative to a measurement per angle of phase shift). Such unit of seconds comes in good match to known equations, as we shall figure ahead. And in this sense, an inductive phase shift corresponds to a shift backward in time, and we shall denote that as $-\Delta t$, where the letter delta signifies displacement, and the negative sign indicates that the displacement takes place in the negative direction of time. Consequently, the permeability μ which comes in units of Henty/meter refers to $-\Delta t/dx$. And any equation involving the magnetic permeability (or the electric permittivity respectively), therefore, seems to engage such a non-classical effect of a shift in time.

The shift in time should serve as the means to react a change in current. The reason behind that shift however seems to be deeper, and appears to react the *consequences* of what a change in current brings. Where that concerns the change in the magnetic potential set around the current-carrying wire (that the change in current brings along). Since the inductive phase shift in time rides over the circuit loop, it applies concurrently upon all circuit's elements, including the electric source, and that allows to instantaneously suppress the process of retrieval of energy from that source, by diminishing its efficiency. The lessening of efficiency comes from the split of energy in two coordinates, a real and an imaginary, of which the imaginary does not deliver work so it accounts as an "expense paid" in return to changing the magnetic potential (and applying a net magnetic force if that potential is not evenly distributed).

The way this is done is more straight through to understand via reference to the theory of electric engines, where a phase shift $(-\Delta t)$, is responsible for causing impedance in the operation of electric engines. As mentioned, due to this shift the energy consumed in the circuit splits in two coordinates, a real and an imaginary. Only the *real* coordinate of energy does work in accelerating charges (changing the current, and along with that, changing the magnetic potential formed around it), while the *imaginary* coordinate causes an inefficiency which we perceive as "impedance". This impedance reacts the operation of electric engines, since it consumes part of the energy supplied by the electric source, without delivering work. Notice that this process has a strong parallel to the way inertia functions in mechanics, which was qualitatively described earlier, and shall be quantitatively supported later in the present section.

The conventional relation describing the electromotive reaction to a change in current (26) may be loosely re-written in a way that may provide clues about the process that takes place. In particular, the term $-L$ may move to the left side of the equation to join the term $d\ell$, where these two together match in units the reciprocal magnetic permeability $(d\ell/-L) \to (1/\mu)$. The relation may reach the form (27), which specifies that a change in current dI/dt causes an inductive displacement of the electric field $(1/\mu)E$, due to the existence of the permeability term μ which contains a displacement of extend $-\Delta t$.

$$\oint E \cdot d\ell = -L\frac{dI}{dt} \tag{1) or (26}$$

$$\oint E\left(\frac{d\ell}{-L}\right) = \frac{dI}{dt}$$

$$\oint E\left(\frac{1}{\mu}\right) = \frac{dI}{dt}$$

$$\left(\frac{1}{\mu}\right)E = \frac{dI}{dt} \tag{27}$$

The term $(1/\mu)E$ refers to a seemingly unfamiliar version of "displacement-electric" field, of inductive character, which exists in parallel to the familiar displacement-electric field version $D = \varepsilon E$ (of capacitive character). To distinguish between the two, we shall denote the inductive one by D^-, and the capacitive one by D^+. The latter involves ε (which refers to $+\Delta t/dx$) and engages in effects of capacitance which were considered above, while the former involves μ (which refers to $-\Delta t/dx$ and engages in effects of induction that we are considering here.

Since μ associates to a shift "backward" in time, its mediation involves negative energy, which is a non-classical entity, and should therefore have imaginary properties. As mentioned earlier, when an imaginary entity delivers outcome toward the real world (via interaction with another imaginary entity), that outcome should project to the real world through its negative reciprocal, as per (3). This is in fact the reason why the magnetic permeability appears in equations as a reciprocal $1/\mu$ (unlike the permittivity ε which is typically not reciprocated), while the negative sign is compensated by the fact that the relation describes a reaction process.

As discussed earlier, each of ε and μ is a complex entity (involves a real as well as an imaginary coordinate), and the same should therefore hold for both D^- and D^+. More particularly, the D^+ field's coordinates refer to (28) as considered earlier in section 3.5, while the D^- field's coordinates may similarly be described through (29) as follows:

$$D^+ = \varepsilon\left(E\cos\theta - iE\sin\theta\right) \tag{5) or (28}$$

$$\bar{D}^- = \mu\left(-\bar{E}\cos\theta + i\bar{E}\sin\theta\right) \tag{29}$$

On a point of attention, as the relation (29) involves an opposite shift in time $-\Delta t$ (contained within μ), it should be expected to have the imaginary term i next to the cosine part (instead of the sine part), and the permeability should come as a reciprocal $(1/\mu)$ instead of μ. Instead of that, for reasons of symmetry the expression (29) has been modified so as to account for the displacement in terms of opposite energy's point of reference. Due to that, the permeability is now expressed as a straight (not a reciprocal) term, while the imaginary term i gets to accompany the sine coordinate (instead of the cosine). Concurrently, the electric field is represented by its negative-energy variant $\overline{E}$ whose representation includes an upper bar above it and its units should involve a reciprocation of parameters. More on the essence of this field variant and its connection to a particle like the electron, shall be described in section 4.8.

Note that since the two coordinates of (29) are orthogonal, it should be possible for them to engage in distinct interactions. We shall here describe the imaginary coordinate of $\overline{D}^{-}$, which seems to engage in self-induction (while the real coordinate of $\overline{D}^{-}$ seems to have a particular engagement in the propagation of electromagnetic waves which shall be considered later). Due to its imaginary character, the negative-energy electric field $\overline{E}$, which could in short be referred to as "anti-electric" field, should not interact in the real world. However, this limitation is circumvented because it interacts in the form of a displacement-field version (through the co-involvement of the permeability term μ).

While the above discussion concerns the involvement of the negative-energy variant of the displacement-electric field in affecting reaction to a change in current, an orthogonal setting may involve the effect of induction in generating displacement-motion of charge (a displacement current I_d). This may likewise be loosely approximated via another, complementary reading of (26). In that relation, the term $d\ell$ concerns the circuit loop. Thus $d\ell$ represents a length dx, and in that sense we could express the left side of that relation as $\oint E \cdot dx$, as shown in (30). In such case, we may re-write the multiplication by dx as a division by $\left(1/dx\right)$ which is mathematically equivalent. Also, we shall more property denote the negative-energy variant of the electric field by the letter $\overline{E}$, and indicate that this changes with respect to imaginary space, where $\left(-1/dx\right)$ is represented as idx, as in (31). As this variant of the electric field applies through its displacement version (which deploys over the circuit loop), the field "lines" of this field version should project to the real world through inverse geometry, having loop-like shape (instead of radial-like of the conventional electric field), over the circuit loop. This constitutes the field of the electromotive potential.

$$\oint E \cdot dx = -L\frac{dI}{dt} \tag{30}$$

$$\frac{\overline{E}}{\frac{1}{dx}} = -L\frac{dI}{dt}$$

$$\frac{\overline{E}}{idx} = L\frac{dI}{dt} \tag{31}$$

$$\frac{\overline{E}}{idx} = \frac{d\Phi_B}{dt} \tag{32}$$

Recall that as mentioned earlier, such a reaction process should not be considered to react a change in current, but to rather react "the result" of what a change in current brings along. That is, it reacts a change in magnetic potential affected by an electric coil (or reacts the magnetic force that may arise if that magnetic potential interacts with another nearby magnetic potential). Actually, a magnetic force arises even internally upon the coil itself, as the magnetic field density in a coil is not evenly (co-axially) distributed, so a magnetic potential develops, pointing in the direction from more-dense lines (inside the coil) to less-dense magnetic field lines (outside the coil). So, a change in current through the coil changes the strength of this potential, and that needs to be counterbalanced too. (That principle actually also applies for any current-carrying wire even if it does not involve any coil, in the sense that any current-carrying wire itself eventually forms a closed circuit loop). In such case, a change in current changes the magnetic flux through that loop, and since it holds $\Phi_B = LI$, the relation (31) may be turned to (32), which refers to Lenz's law. Only here, in this particular paradigm the principle is applied in reverse order, as we described an opposite procedure where a change in current causes a change in flux (instead of the opposite way around).

When a change in current I is imposed on a coil or circuit loop, this brings a change in magnetic flux Φ_B through the circuit's cross-sectional area. And it's this change in flux that nature tends to react (instead of reacting the change in current which caused it). The change in flux comes along with a change in magnetic potential as described above, and this is what needs to be compensated. That compensation comes through the generation of the (reactive) phase shift (the lag in time of the current oscillation with respect to the voltage oscillation). That inductive shift is affected concurrently throughout the loop (therefore instantaneously, as explained earlier), affecting all elements of the loop at once, including the electric source. Through this way, the energy used in affecting a change in the magnetic potential of the coil is compensated by the fact that the inductive shift suppresses the efficiency of the electric source to deliver work.

(b) Inertia, as a Mechanical Counterpart of Induction

The inductive impedance has a mechanical counterpart in inertia, as the latter functions in a symmetric way, with the phase shift developing in space (instead of time). It concerns the shift in the curvature of the space metric with respect to the curvature of the time metric, as introduced earlier and illustrated through **Figure 1**. This symmetry is not by coincidence, and directly refers to the swapping between the parameters of time and space between the gravitational and electromagnetic interactions. We may refer to the shift in space as a space lag or space drag, and denote it as $-\Delta x$, where the Greek letter delta indicates displacement (in space), and the minus sign indicates its inductive-like (instead of capacitive-like) character. As explained previously, this phase shift exactly refers to the Higgs field that permeates spacetime and is responsible for causing the inertial properties of matter [5]. The particular reason why the Higgs field interacts in the form of a boson shall be possible to consider in sections 4 and 6, after certain material is introduced meanwhile. The term $-\Delta x$ concerns a measure of the "mechanical counterpart of inductance" (and involves a shift in space instead of time), and we already named it "mechano-inductance L_g", introduced through the relation (2). That could be measured in "meters of shift in space", as an alternative to measurement as an angle of phase shift. Mechano-inductance L_g is fundamentally different to the electric inductance L, since it deploys over space (instead of time). [A comparative list of notations is provided in Appendix]. This shift in space is not a classical physics attribute, and L_g is accounted for by a complex number, having a real as well as an imaginary coordinate. The quantity L_g is contained in the mechano-permeability μ_g which was introduced earlier through relation (20) and refers to phase shift of the form $-\Delta x/dt$ as shown in (33). Since L_g is accounted for by a complex number, so does the mechano-permittivity μ_g, which is also a complex number.

$$\mu_g = \frac{L_g}{dt} \rightarrow -\frac{\Delta x}{dt} \tag{33}$$

In this case, the inductive-like shift in space $-\Delta x$ broadly refers to the increased sideways proximity of the air particles as they swirl past the wing, causing a radial-like negative energy potential. This is compensated by the fact that the phase shift in space splits the energy spent in accelerating a material object in two orthogonal coordinates, a real and an imaginary. Only the real coordinate of energy does work in accelerating matter, while the imaginary coordinate causes an inefficiency, that we perceive as inertial impedance. Notice that this process has a strong parallel in electronics, in the way inductive impedance reacts the operation of electric engines (where it consumes part of the electric energy supplied, without delivering work). In the mechanical case, the imaginary coordinate (which arises due to the shift) suppresses energy retrieval from the source that powers the acceleration (for instance, an airplanes' turbines), decreasing the efficiency in providing the thrust. Such lessening of efficiency constitutes the "expense paid at the source", in return to affecting the gravitomagnetic potential (the wing's lift, for instance). Through that process, part of the energy is drained to the imaginary domain.

The phase shift between the curvatures in the metrics of Time and Space, which was described to refer to the Higgs field and is responsible for "dressing" matter with the property of inertia, appears to have a specific angle. The angle of phase shift that prevails over cosmic spacetime, turns out to match the Weinberg angle θ_w (known from the electroweak interaction), which has the value of $\theta_w = 30^\circ$. This value may be indirectly verified through a re-interpretation to older quantitative predictions, according to which, a particular surface exists outside a black hole's event horizon, at a distance of 1.5 times the radius of the black hole [4]. At either side of this surface the centrifugal force points in opposite direction, and light bends in the opposite direction. The new model now re-interprets this surface as a Space node (corresponding to point *f* of **Figure 1**). That the location of this nodal surface is at 1.5 the radius of the black hole (or, 50% of the radius away) may be interpreted as a phase shift of 30˚ (the 1/3 of this 1.5, or, the 1/3 of the orthogonal 90˚) which exactly corresponds to the Weinberg angle. Later, in section 5.3 we shall be discussing the reasoning behind the existence of the Weinberg angle, and why its particular value prevails. As we shall see, the particular value of this angle allows for a large number of physical properties to be in balance, from particle physics to astrophysics. For instance, in elementary particle physics, this angle appears to constitute the reason of existence of quarks, and may explain the specific value of quarks' charge as shall be discussed in section 4.10. This angle also appears to be responsible for the value of intrinsic spin being equal to ½, which refers to the sine of 30˚. While in astrophysics, this angle of phase shift addresses the reason of the abundance of matter over antimatter which shall be presented in section 5.2, and also, it complies with aspects of the theory behind black hole's ergospheres which shall be referred to in section 4.7 part (c). In this sense, the engagement in gravity and mechanics of a phase-shift angle equal to the Weinberg angle constitutes the grounds for bridging the gravitational interaction with the electroweak interaction. And by extend, the involvement of this phase angle allows for linking particles' wave nature to effects of relativity (to be addressed in section 4.6), linking in parallel the gravitational interaction to the Standard model.

We shall quantitatively treat inertia through the involvement of a reaction-field variant of the gravitational field, which we shall name "gravito-motive", in symmetry in the naming with the electromotive field, as they both operate under similar principles. We previously introduced a relation involving that field, which we copy here for convenience in (34). The term $\oint g \cdot d\ell_t$ refers to this particular variant of the gravitational field g. It concerns a displacement field version of the gravitational field, where the displacement develops over a loop in time $d\ell_t$. That loop in time may be understood to concern the loop (trail) in the curvature in time that a particle's gravitational field "line" describes, as is schematically represented through the waviness of the time curvature in **Figure 1**. (Recall that as the left and right ends of the hypothetical axis of this figure were explained to connect to each other into forming a loop, hence the same holds for the loop in time associated to a full trail of a gravitational field "line"). This holds despite the fact that only a part of the field "line" deploys in positive time, and the other part concerns negative time. Even though this loop seems immense in spatial terms, it concerns the parameter of time, so its spatial extent is rather irrelevant. While the gravitational field is a radial-like field, the displacement of a gravitational field "line" over this loop should be understood to take place in the direction of a particles' acceleration (riding that immense loop). The term L_g refers to the shift in space between the metrics of Space and Time, which rides over the loop of $d\ell_t$. This phase shift is possible to apply per any direction (of acceleration), so it generates impedance regardless the direction of acceleration of a material particle. Furthermore, as described earlier, the particle's momentum p is involved as per matter's wave nature where $p = h/\lambda \ (= h/x)$, where the Planck constant h has a fixed value, much like in electronics it holds $I = Q/t$ where an electron's charge Q has a fixed value too. And just like a change in electric current refers to $dI/dt = dQ/dt^2$, a change in momentum may be corresponded to

$dp/dx = dh/dx^2$, which refers to a change in the flow of quantized energy (h) through an area in space. Hence the representation of the change in momentum through a term like dp/dx, in analogy to dI/dt of the electromotive case.

$$\oint g \cdot d\ell_t = -L_g \frac{dg}{dx} \tag{2) or (34}$$

$$\oint g \left(\frac{d\ell_t}{-L_g} \right) = \frac{dp}{dx}$$

$$\oint g \left(\frac{1}{\mu_g} \right) = \frac{dp}{dx}$$

$$\left(\frac{1}{\mu_g} \right) g = \frac{dp}{dx} \tag{35}$$

The relation (34) may be loosely re-written in a way that may provide a more intuitive picture about the process taking place in impeding acceleration of matter. In particular, the term $-L_g$ may move to the left side of the equation to join the term $d\ell_t$. The term $d\ell_t$ in turn, can loosely measure in units of seconds, concerning seconds of shift throughout the whole loop in the curvature in time (the loop concerning fastness of time increasing up to a peak, then decreasing to zero, reaching a negative peak, and back to the particle). In this sense the term $\left(d\ell_t/-L_g\right)$ may be loosely represented as $\left(dt/-L_g\right)$ where that resembles the units of the reciprocal mechano-permeability $\left(1/\mu_g\right)$. Hence the relation takes the form (35), which specifies that a change in momentum dp/dx causes an inductive-like displacement of the gravitational field $\left(1/\mu_g\right)g$.

Note of the particular significance that inertia reacts a change in momentum (not a change in velocity alone). And it does this, as per the wave nature of matter (as per $p = h/\lambda$). This point shall be essential in a bridging between quantum theory and the theory of relativity, that will be addressed in section 4.6.

Note that the displacement shift L_g (corresponding to $-\Delta x$) is inductive-like (instead of capacitive-like), so it involves an inductive shift (drag) in space with respect to time. Such a shift backward in space is of opposite energy to a shift forward in space (that was involved in barrier penetration), and that should come along with imaginary attributes. According to the new model, an imaginary entity may project toward the real world (when it interacts with another imaginary entity) through its negative reciprocal, as explained earlier in relation to (3). This in fact, is the reason why the relation (35) uses the reciprocal of mechano-permeability $\left(1/\mu_g\right)$ (unlike the mechano-permittivity ε_g which is involved in the "capacitive displacement gravitational field" $g_d = \varepsilon_g g$, and is typically not-reciprocated). And since $\left(1/\mu_g\right)$ refers to a negative energy condition (a shift in negative space), it should interact with another imaginary entity so the two imaginary entities together could yield a real result of reaction (as per $i^2 = -1$). That second imaginary property refers to the negative-energy variant of the gravitational field, which is denoted with an upper bar $\overline{g}$, and may be referred to as negative gravitational field. Being an imaginary variant of g, it should apply toward the real world through its displacement-field version, and thus be subject to an inverse geometry with its field "lines" forming loops (instead of being radial-like and open ended), since the displacement of this field takes place over a cosmic loop (the hypothetical axis XX' of **Figure 1**). This field variant $\overline{g}_{d^-}$ is the one that mediates the gravito-motive potential, which reacts the change in momentum via the exertion of inertial impedance. Since the negative gravitational field is imaginary, it should not be expected to interact in the real world. But this limitation is circumvented since it interacts in the form of "displacement-field" (due to the co-involvement of the mechano-permeability term).

Conclusively, we may speak of two displacement gravitational field versions. The one engages in barrier penetration, where the displacement takes in the positive direction of space, and we may denote that by adding a positive sign at the right of g_{d^+}, as shown in relation (36). The other engages in inertial impedance, where the displacement takes in negative space, and we may denote that by adding a negative sign at the right of $\overline{g}_{d^-}$, as in relation (37).

$$g_{d^+} = \varepsilon_g g \tag{14) or (36}$$

$$\overline{g}_{d^-} = \mu_g \overline{g} \tag{37}$$

As explained earlier, each of ε_g and μ_g is complex, so it involves a real as well as an imaginary part. For same reason as explained through (29) either of these parts applies through a cosine or a sine coordinate. And by transferring the negation from the sine to the cosine term, allows to represent μ_g as a straight number instead of a reciprocal-number, just like the case was in the electronic counterpart. Furthermore, since the displacement gravitational field has two coordinates, either one should be possible to engage in distinct effects. The exertion of the inertial reaction potential involves the imaginary coordinate $\left(\overline{g}_{d^-}\right)\sin\theta_w$. With than being imaginary, it should in principle act at superluminal response. This is plausible, as the displacement (phase shift) $-\Delta x$ over the loop in time (of a gravitational field "line") applies *concurrently* throughout a cosmic loop (the whole trail of a gravitational field "line", including the real as well as the imaginary portion), just like when rotating a bicycle wheel all its elements rotate concurrently (in a sense, all together instantaneously). In fact, that form of instantaneity also relates to what holds in entanglement, as shall be pointed out in section 7.

That the displacement shift associated to inertia applies at *instantaneous* response (in conserving momentum) may be put in test by considering what would hold in a case of *angular* acceleration: When a material object is angularly accelerated to circulate, then for the "opposite force" to properly apply and conserve momentum, it should be affected instantaneously. For if a lapse existed, then action and reaction would point in different directions (due to the rotation that has taken place during the time lapse from action to reaction). To this date there seems to be no trace of such difference in direction of reaction, verifying (indirectly) that conservation of momentum (which is conveyed by the phase shift that causes inertia) applies at instantaneous fastness.

As per the above, the gravito-motive and electromotive cases apply in very symmetric ways, in opposing a change in momentum or in current correspondingly. In the case of inertia, the reaction potential (subject to the sine of the Weinberg angle) is less effective than the corresponding action force (subject to the cosine of the Weinberg angle), so a material object is able to accelerate.

3.8. Lenz's Law vs. Vortex Flow

We shall explore a broad analogy that exists between Lenz's law in electronics (referred to in relation (32)) and vortex flow in mechanics, and consider if a similar analogy may exist in a quantitative treatment of these two cases. According to Lenz's law, when a bar-magnet approaches or moves away from a metal ring or coil, a loop-like inductive current develops through the metal ring. In some analogy, when water drains through an orifice, a loop-like fluid flow of matter arises and forms a whirl. Despite the broad similarity, however, these two effects are subject to two key differences.

First, the mechanical version is direction degenerate (direction-indifferent), meaning that either direction of turn brings the needed counterbalancing effect (e.g. a centrifugal force, that reacts a centripetal Bernoulli-like pressure). As mentioned earlier, this holds since matter in the real world has only one sign, always positive (which is true since antimatter is also attractive, so that too constitutes a positive form of matter). If "negative-matter" (to be specified in section 4.7) was possible to reach form in the real world, then vortex-like effects (like the whirling of water) would be direction-specific, just like the magnetic field is direction-specific.

The second key difference, is that in the electronic case the loop-like inductive current is generated by an axial change in a *field's flux* (not a change in *charge flow*). While in the mechanical case the loop-like flow of matter is generated by an axial change in *matter flow* (not a change in a *field's flux*). The reason behind this difference appears to lie in the swapping of parameters of space and time that applies between the electric and gravitational interactions, while concurrently, either interaction behaves as imaginary with respect to the other. That puts into effect the need for negative-reciprocation in the parameters of time and space (in one of these two interactions). In such context, while the electric and magnetic fields relate to each other through the velocity term as shown in (38), the gravitational and gravitomagnetic fields relate to each other through the reciprocal of velocity, as shown in (39).

$$E = \left(\frac{dx}{dt}\right)B \quad \rightarrow \quad E = \upsilon B \tag{38}$$

$$g = \left(\frac{-\frac{1}{dx}}{-\frac{1}{dt}}\right)T \quad \rightarrow \quad g = \left(\frac{1}{\upsilon}\right)T \tag{39}$$

This inverses the relation between g and T with respect to velocity, so what holds is $T = \upsilon g$. In relation to that reciprocity, while Lenz's law $\left(\oint E \cdot d\ell = d\Phi_B / dt\right)$ is triggered by a change in magnetic flux, vortex flow is NOT triggered by an analogous change involving the gravitomagnetic flux through a symmetric relation of a form like (40). Instead of a flux, it involves a flow, where the area-like term dt^2 in (10) is swapped by its reciprocal. For same reason, the relation (40) seems to work in the opposite direction, meaning that vortex flow should be triggered by a change in gravitational flow Φ_g (instead of a change in Φ_T), through a relation of conceptual form like (41).

$$\oint g \cdot d\ell_t = \frac{\partial \Phi_T}{\partial x} \qquad [\text{not valid here}] \tag{40}$$

$$\oint T \cdot d\ell_t = \frac{\partial \Phi_g}{\partial x} \qquad [\text{conceptual}] \tag{41}$$

While the notion of gravitational *flux* was introduced in relation to the effect of barrier penetration, an example that concerns a change in gravitational *flow* is when matter accelerates to fall, since it gets to feel weightless (as in the example with astronauts' training in a parabolic flight, where they feel weightless). And it similarly applies when water starts draining through an orifice, where that resembles a change in gravitational flow, and this generates a gravitomagneto-motive, negative-energy potential, in respond to which matter gets to displace rotationally (loop-like). This particular potential may apply upon baryonic matter due to particularly negative-energy attributes of quarks which shall be discussed in sections 4 and 5.

On a side-note, a negative energy interaction similar to the one that triggers the vortex flow of matter, appears to lie behind the rotation of celestial bodies. Like the flow of charge induces a magnetic field around the wire, in the mechanical case the flow of matter comes along with a steady gravitomagnetic field. However, due to the orthogonality between matter and charge, the gravitomagnetic field has imaginary characteristics. When the gravitomagnetic field interacts with a particular "negative-matter" property which may be traced in baryonic matter (in atom's nuclei) that shall be introduced in section 4.10, then the gravitomagnetic field engages in a rotational (loop-like) classical "flow" (instead of flux), and that appears to be responsible for that rotation of celestial bodies. In that case, however, the interaction applies in reverse, since it is not a flow of matter that causes a field flux around it (as in the Bernoulli pressure around fluid flow). Instead, it is the propagation with respect to space, which needs to be counterbalanced by a rotation of matter (a particular trait of baryonic matter, which stems in the essence of quarks). It is very much like Lenz's law, applying in negative energy, over the gravitational interaction, and induces the rotation of planets (and appears to hold behind vortex rotation effects in general).

3.9. Raw Units of *B*, *H*, and Their Mechanical Counterparts

(a) Raw Units of *B* and *H*

The magnetic field may be considered to associate to, and to be accounted for, through "raw" units. To approximate that, we shall start with a reference to the magnetic field's relation to the electric field.

$$B = \left(\frac{1}{\upsilon}\right)E \tag{42}$$

We previously described how a swapping between parameters of time and space that applies between the electric and gravitational interactions, may lead to associating the electric field E to "raw" units of [sec/meters^2]. Multiplying those with the units of reciprocal velocity $(1/\upsilon)$ which refer to [sec/meters], it yields to units of [sec^2/meters^3]. These particular units may seem too unrealistic to account for "raw" units of B. However, we shall soon figure that these particular raw units do get to accomplish good matching to conventional equations. To put that in test, let's consider, for instance, if these particular units of [sec^2/meters^3] may be possible to reach any sort of matching to the conventional units of B being: 1Tesla = 1Volt·sec/m^2.

The "Volts" relate to the electric field through a formula that involves the separation between a capacitor's plates $\Delta V = Edx$. In such case, given the aforementioned raw units of the electric field, the units of voltage appear to corresponded to [sec/meters]. In a first reading this seems to make no actual sense, as it refers to the units of velocity subject to a swapping between the parameters of time and space. That however is not by coincidence. Consider that the same units resemble the ones of the electric permittivity which were referred to $\Delta t/dx$ [sec/meters] since Farads were associated to a measure of Δt. This may imply that the particular units of [sec/meters] may describe a potential, and we should keep that in mind as we shall get back to it later. Substituting these particular units of Volt into the expression of Tesla, it yields for the raw units of Tesla correspond to [sec/meters] [sec/meter^2] = [sec^2/meters^3] which matches the above-mentioned raw units of B. These particular raw units shall soon bring into surface essential information on how the magnetic force acts.

If that holds for the magnetic field, we shall next figure what holds for the units of the displacement magnetic field $H = (1/\mu)B$. The permeability term comes in units of [Henry/meter], so it involves inductance L, which was earlier stated to refer to a phase lag in time. That corresponds to a delay of $-\Delta t$, which may be measured in seconds (of displacement in time). In this sense, the units of the reciprocal permeability may refer to [meters/sec] which resemble the units of velocity, subject to the key difference that the seconds here refer to displacement in time, which is not an attribute of classical physics. By extend, the units of H correspond to [meters/sec] [sec^2/meters^3] = [sec/meters^2]. These units in fact, look similar to the raw units of the electric field. But again, they are not identical since in the case of H the seconds concern a phase shift in time Δt.

While a phase shift in time Δt (or in space Δx) may mathematically be more properly accounted for in degrees of angle, it might as well be expressed in terms of seconds (or meters correspondingly). For instance, the electric permittivity ε_0 which has been referred to $+\Delta t/dx$ and the magnetic permeability μ_0 which has been referred to $-\Delta t/dx$ could both be measured in [sec/meters], aside the positive-or-negative sign of the shift's direction in reference to the lead or lag in time that each involves. And it similarly holds with the units of displacement fields, like for instance the units of the displacement magnetic field H. Actually, as previously described, H may come in two variants: A capacitive one, for which it holds $H^{+}=(1/\varepsilon_0)B$, and an inductive one for which it holds $H^{-}=(1/\mu_0)B$. The units for both versions of H should accordingly refer to [m/sec][sec^2/m^3], which makes for [sec/m^2].

As per the above, the analogy between Δt and dt reflects on a similar analogy between the units of H and E. That analogy, also extends on the way the corresponding forces $F_H=qH^{+}$ and $F_E=qE$ apply. And further extends in that, both these forces apply through radial-like fields. Right next, we shall also figure that analogous conditions apply between the units of the gravitomagnetic and the displacement-gravitomagnetic fields. [A comparative list of notations is provided in Appendix].

(b) Raw Units of T and T_d, as Mechanical counterparts of B and H

Just like it holds with the raw units of the magnetic field, it similarly applies in mechanics for the raw units of the gravito-magnetic field T, subject to a swapping of parameters of time and space. As per (39) it holds $T=\upsilon g$, so the units of T should refer to [meters/sec] [meters/sec^2] = [meters^2/sec^3].

$$T_d=\frac{1}{\mu_g}T \qquad (20) \text{ or } (43)$$

$$\mu_g=\frac{L_g}{dt}\rightarrow-\frac{\Delta x}{dt}\rightarrow[\text{meters/sec}] \qquad (33) \text{ or } (44)$$

Regarding the displacement-gravitomagnetic field T_d, this arises through the relation (43), where the mechano-permeability μ_g corresponds to mechano-inductance L_g per time, which in turn refers to a shift in space with respect to time $(-\Delta x/dt)$, thus this shift could refer to units of [meters/sec]. Once again, Δx refers to a "shift in space" (which is different to conventional dx which measures with respect to conventional "stationary" space), and that is not an attribute of classical physics. In relation to this, the units of the displacement gravitomagnetic field refer to [sec/meters] [meters^2/sec^3] = [meters(of displacement)/sec^2], which holds for both the inductive-like or the capacitive-like displacement in space. Here again, the measure of a phase shift in meters (of displacement) comes as an alternative to a measurement in degrees of angle.

3.10. Magnetic vs. Bernoulli Potentials

(a) On the Magnetic Force

Existing theory of electromagnetism does not provide answers to questions like:

(i) What does a difference in density of magnetic field "lines" between adjacent regions (which drives the magnetic force) correspond to, in physical terms?

(ii) Why the magnetic field doesn't get "consumed" when it acts?

(iii) Why the expression of the magnetic force doesn't exhibit any sort of correlation to Maxwell's equations?

(iv) How does an opposite magnetic force affect upon an "other end", for momentum to be conserved?

The magnetic force is described through the relation (45). The raw units of the magnetic field were related to [sec^2/meters^3], but the particular powers involved in these units (squared and cubed) are not comparable to the usual powers involved in the units of other acceleration-providing fields (like the powers in the units of the gravitational field being [meters/sec^2] or the powers in the raw units of the electric field being [sec/meters^2]).

The reason behind this difference (in the powers of the units involved) relates to the fact that the magnetic field does not really affect a force solely on its own, unless the charge is moving. In relation to that, the corresponding force is not exactly a force of B, it is rather a force of $(\upsilon \times B)$ which includes the velocity. In this sense, this force could more appropriately be denoted as $F_{(\upsilon \times B)}$ instead of F_B, as in relation (46).

$$F_B = q(\upsilon \times B) \tag{45}$$

$$F_{(\upsilon \times B)} = q(\upsilon \times B) \tag{46}$$

$$F_E = qE \tag{47}$$

$$F_H = q(\mu B) \tag{48}$$

$$F_H = qH^+ \tag{49}$$

Notice the broad symmetry of Equation (46) to the equation of the electric force (47), with a critical difference between the two forces being that the magnetic force displaces the charge sideways without changing its kinetic energy, while instead, the electric force causes acceleration so it changes the charge's kinetic energy. The reason for that, is that the magnetic force concerns a "displacement force". Because of that, however, its action should associate to a displacement field. That in turn, implies that the field generating this force should involve a permeability or permittivity term.

Here, we need to recall that the raw units of the reciprocal of the magnetic permeability (or of the electric permittivity) correspond to $dx/\Delta t$, which resemble the ones of velocity dx/dt, subject to the condition that the parameter of time concerns a phase shift Δt. Therefore, the units of the term $(\upsilon \times B)$ resemble the units of (μB) which involve a sideways shift in time. Based on that, it is proposed that what drives the magnetic force is not the magnetic field itself, but its displacement field variant in negative reciprocal time. And that is what the sideways shift of the magnetic field lines (and the associated change in the density of the magnetic field lines) appear to represent. This concerns a "displacement-magnetic potential". So, what we call magnetic force appears to actually correspond a capacitive-like "*displacement-magnetic force*" F_H, as relation (49) indicates.

This notion additionally allows to explain why the magnetic field does not get consumed while it acts. It is because the magnetic field lines resemble equipotential lines/surfaces in negative reciprocal time, which may also be referred to as "imaginary time". When the magnetic field lines are deflected to the side (like when they are affected by an external magnetic field), they still only represent equipotential lines or surfaces. This is why they are not getting "consumed" in any way. It is the difference in density of the field lines that (provides the potential which) drives the magnetic force, and the magnetic force applies in nearly perpendicular direction to these equipotential surfaces, so it does not affect them.

The above notion may be translated in that, *the magnetic force is driven by a difference in the* "*fastness*" *of negative-reciprocal time* (*imaginary time*), which is represented by the difference in the density of the magnetic field lines. This comes in analogy to as the gravitational force corresponds to a difference in the fastness of positive time. Actually, while the magnetic field appears to associate to the curvature of *imaginary* time (negative-reciprocal time), an interaction from its own reference point (meaning the way the magnetic field perceives another magnetic or electric field) applies as a real entity. Consequently, the functioning of the magnetic force concerns a same kind of Doppler-like effect in time that was previously used to explain the way the gravitational force acts, only now, it concerns curvature in imaginary time. In that sense, while a moving charge is magnetically deflected (sideways shifted), this deflection gets to release and relax the potential attributed to the change in density of the magnetic field lines (which concerns the difference in imaginary time between adjacent points in space). This release in potential is what causes the moving charge to deflect sideways on its own.

Note that since the displacement-potential concerns imaginary time but deploys in the real world, that gets the associated curvature project to the real world through inverse geometry (radial-like instead of loop-like). This makes the magnetic displacement action associate to a capacitive-like potential (having radial-like field "lines", similar to those of the electric field). This geometry of field lines of H can be traced in the fact that, when a moving charge is deflected by a uniform external magnetic potential, the charge gets to move circular-like, consequently the magnetic potential acts radial-like (much like the centripetal force on a string that keeps a mechanical object in circular motion, is radial-like). This *capacitive* character may be indicated through a plus sign at the right of H, as shown in (49).

According to all the above, the magnetic action arises through a "*capacitive-like displacement magnetic field*", and not by the magnetic field itself. A relevant point of attention concerns what holds in terms of conservation of energy. In reaction to the capacitive shift, a counterbalancing process should be taking place for reasons of conservation of energy. That is taking place in the time domain, through a shift backward in time affected on the moving charge, which is accounted for through the effect of induction. To approximate the process for the case of a single charge requires additional concepts concerning the connection between a quantum particle and its fields, which shall be introduced in section 4. While, when the force is exerted upon an electric current carried by a wire (which involves a large number of charges) the process is well described in classical physics terms.

Furthermore, it is of particular interest to consider a corresponding case in a reverse way, meaning when charge is forced to move circularly because it passes through the turns of a coil (instead of being forced to deflect under the influence of an external magnetic field). In that case, the corresponding *deformation* of the magnetic field caused by the shape of the coil (where the density of magnetic field "lines" is changed), and that change in density yields a corresponding magnetic potential, and that is reacted via an inductive phase lag of the oscillation of current, backward in time $(-\Delta t)$ as considered previously. In fact, a similar phase lag should apply in the case of a DC current that deflects a charge, but that is not practical to trace since no alternation is involved.

The phase lag conveys inductive reaction to the other elements of the circuit, including the electric source, reducing its efficiency by splitting the energy supplied in two coordinates, a real and an imaginary, of which the imaginary does not deliver work. The shift in time is conveyed throughout the whole circuit loop concurrently, therefore instantaneously. As previously mentioned, a response at that fastness over that loop is feasible, for the same simple reason as, when a bicycle's wheel is rotated, all its elements rotate concurrently, at once. This feature of instantaneity however, is not an attribute of classical physics, and requires the use of imaginary numbers in order to account for, which concerns the imaginary coordinate of energy. This attribute of instantaneity is of great significance as it allows to provide the means for instantaneous responses, just like it holds with the reaction fields involved in entanglement (to be discussed in section 7). A corresponding method for modulation/demodulation upon this attribute of instantaneity has been worked upon by the lead author (C. Tsikoudas) but is beyond the scope of the present article.

In accordance to the above, when a charge is moving with conventional velocity $\upsilon = dx/dt$, it concurrently generates (radially) around it a displacement in time of the form $-\Delta t/dx$ (as perceived from the reference point of the electromagnetic interaction, so the imaginary term is absent), and that displacement is the one that corresponds to a magnetic potential. That potential is the one that interacts in causing the displacement of a moving charge, without changing its kinetic energy. The associated sideways shift (displacement) in the magnetic field "lines" is an effect of displacement in time, and that is counterbalanced by an orthogonal opposite shift in time (over the circuit loop) which we perceive in the form of the Voltage-Current lag which suppresses the efficiency of the source to deliver power. This similarly applies (in opposite direction) on the magnetic field lines of the external magnetic field (which deflects a moving charge). With respect to those, the corresponding sideways shift (in the opposite direction) is counterbalanced by an opposite shift in time which reduces the efficiency of charges in the corresponding external magnet's atoms and molecules to do work.

(b) Bernoulli Pressure, as a Mechanical Counterpart of a Magnetic Potential

Just like the motion of charge was described to generate a displacement in imaginary time around it, and that refers to the magnetic potential, an analogous condition appears to apply in mechanics. Here, the motion of matter (e.g. in fluid flow) goes along with displacement in space $\Delta x/dt$ around molecules, which corresponds to a potential. This refers to the gravito-magnetic potential which is responsible for the Bernoulli pressure around the flow of matter, and its field "lines" can be understood to concern "equipotential-pressure" lines/surfaces. As mentioned earlier, due to its negative energy, this potential is of short range, effective at the atomic-molecular scale. During fluid flow this potential may bring actual results in a larger range due to collective (transmissive) action which engages a large number of adjacent molecules. The reason why such collective action may not hold for particles in solid objects, is because molecules in solids have no adequate motional freedom, thus the gravito-magnetic force is not noticed during the motion of solid objects, even though it is still active there. In the other hand, an *opposite-energy* variant of the gravito-magnetic potential also exists, and that variant may engage in long range interactions, and that shall be discussed later in section 5.6, in reference to its influence on galaxy rotation curves.

A relation describing the gravito-magnetic force in long range interactions should have a form analogous to relation (50). In a comparison between (49) and (50), the term H^{+} has now been replaced by its mechanical counterpart $T_{d^{+}}$. That is, just like the magnetic force was explained to engage the displacement magnetic field H^{+} which involves a phase shift in time $1/\mu \quad (= dx/\Delta t)$, the gravito-magnetic force F_T similarly engages the displacement gravitomagnetic field $T_{d^{+}}$ which involves a phase shift in space $1/\mu_g \quad (= dt/\Delta x)$, as per relation (43).

$$F_T \propto \left(\frac{h/\lambda}{\upsilon}\right) T_{d^{+}} \tag{50}$$

Furthermore, much like the magnetic force is affected on charge $q \quad (= Idt)$ which for electrons is quantized at the value of −1e, the gravitomagnetic force is considered to be affected on matter which is quantized in units of energy referring to the Planck constant $h = p\lambda \quad (= pdx)$, rather than being affected on classical mechanical mass $m = E/c^2$ per se. The reason of such consideration comes in relation to a point that shall be introduced in section 4.3, where certain properties associated to mass (like inertial impedance) shall be discussed to exhibit a parallel to capacitance in electronics (like capacitive impedance) instead of exhibiting a parallel to charge. Therefore, the term $\left((h/\lambda)/\upsilon\right)$ which refers to matter (instead of mass) if preferred as a parallel to the charge in electronics.

The gravito-magnetic field lines are direction-degenerate (as either direction of turn works equally well), with the underlying reason for that being that only the positive sign of matter reaches stable form in our cosmic region (as both matter and antimatter constitute "positive matter", since they are both gravitationally attractive).

The gravito-magnetic potential is realized in the form of pressure, as in the case of the Bernoulli pressure introduced in section 2.4. The principle behind the way this potential functions, is analogous to, and refers to the Doppler-like effect of relativity that was described earlier. Just like that effect was discussed to work with gravity (referring to a difference in the fastness of passing time), or in the electric force (referring to a difference in stretching of imaginary space), or in the magnetic force (explained to the driven by a difference in fastness in imaginary time), the same factor similarly applies for the gravitomagnetic potential (in both its short range variant, as well as its long range variant which shall be elaborated later), which refers to a difference in the stretching of real space. In all of these cases, the acceleration (of matter or of charge correspondingly) is self-driven as the aforementioned Doppler-like effect of relativity relaxes and releases the corresponding potential (in this case, the curvature in real space associated to the gravitomagnetic potential) when the entity accelerates (in this case, deflects sideways).

In the paradigm involving the lift of an airplane's wing, the increased velocity of air above the wing goes along with a compression-like displacement of air molecules in the vertical direction. This compression translates to the gravito-magnetic field lines above the wing being denser than the gravitomagnetic field lines below the wing. And this difference constitutes a gravitomagnetic potential, which brings the lift force. It is of importance that the lift force tends to displace the wing sideways (e.g. upwards) without changing its kinetic energy (much like a moving charge is being displaced by a magnetic force without changing the kinetic energy of the charge). This corresponds to a capacitive-like potential, whose field "lines" are radial-like (resembling the centripetal force on a string that keeps a material object move circularly). Furthermore, in reaction to this lift (once again in analogy to the magnetic case described above), a back-drag force develops, which applies much like the inertial force does, dragging the wing (and airplane) backward. The way that such effect of impedance develops, is that the "deflection" of the wing upwards (lift) is counterbalanced by an orthogonal net phase shift $-\Delta x$ in the direction opposite to the airplane's acceleration. This shift splits the vector of energy spent for acceleration into two components, of which the imaginary component does not deliver work, while it consumes a portion of the energy (and fuel) used for thrust, suppressing the engine's efficiency. A point of significance is that, the angle (extend of the phase shift between the curvature in the metrics of time and space) in this paradigm depends on the strength of the lift (as per the curvature of the wing and use of flaps and slats), and not to the Weinberg angle θ_w that permeates spacetime, even though it is of similar nature to it.

3.11. Electromagnetic Wave Propagation per Real and Imaginary Coordinates

If we refer to Lenz's law (51), plug-in the magnetic flux term $\Phi_B = Bdx^2$, and rearrange terms, we reach the equation (52) which describes the propagation of an electromagnetic wave. That the one field (B) in this equation changes per

TIME, and the other field (E) changes per SPACE may be taken to imply that these two fields have counterbalancing roles in time and in space.

$$\oint E \cdot d\ell = \frac{d\Phi_B}{dt} \tag{51}$$

$$\frac{dE}{dx} = \frac{dB}{dt} \tag{52}$$

In relation to discussion over the previous sections, equations (51) and (52) describe orthogonal cases, of opposite energy. The latter involves conventional fields in positive energy (E and B), while the former involves reaction field variants, which concern negative energy as described earlier. That is traced, for instance, in that the electric field in (51) concerns a displacement field version which has loop-like field lines (instead of radial-like of the conventional electric field), while the magnetic field actually refers to a change in "flux" (not a change in "flow"), where the flux concerns "flow through imaginary space" $\Phi_B = B/idx^2$, as shown in relation (9). In relation to that, the fields involved in (51) and in (52) appear to concern orthogonal variants of E and B . That may actually allow for some misapprehension on the current understanding of how electromagnetic waves propagate, which we shall now comment upon.

Let us follow a similar process to the above, on Faraday's law expressed in the form (53), concerning a displacement current between a capacitor's plates. Plugging-in the electric flux $\Phi_E = Edx^2$ and rearranging terms, we reach a complementary relation describing the propagation of electromagnetic waves (54).

$$\left(\frac{1}{\mu_0}\right)\oint B \cdot d\ell = (\varepsilon_0)\frac{d\Phi_E}{dt} \tag{53}$$

$$\left(\frac{1}{\mu_0}\right)\frac{dB}{dx} = (\varepsilon_0)\frac{dE}{dt} \tag{54}$$

$$\left(\frac{1}{\mu_0}\right)\frac{dB}{-\frac{1}{dt}} = (\varepsilon_0)\frac{dE}{-\frac{1}{dx}} \tag{55}$$

One may notice that while in (52) the magnetic field changes per time dt , now in (54) it changes per space dx . A similar inversion holds for the electric field, which previously changed per space dx and now it changes per time dt . To explore what that inversion may imply, we shall exchange sides of the denominators of (54), so the same relation may now take the form of (55). The latter relation reveals a different aspect. While in (52) the magnetic field changes per "time", here in (55) it changes per "negative reciprocal time" which refers to "imaginary time" idt . And while in the former the magnetic field changes per "space", here in (55) it changes per "negative reciprocal space" which refers to "imaginary space" idx . For reasons of comparison we shall re-write these two equations, slightly modified. The (56) comes from (52) simply by swapping its left and right sides. And (57) corresponds to (56) by substituting the denominators $-(1/dt)$

and $-(1/dx)$ to the corresponding representations idt and idx.

$$\frac{dB}{dt}=\frac{dE}{dx} \tag{56}$$

$$\left(\frac{1}{\mu_0}\right)\frac{dB}{idt}=(\varepsilon_0)\frac{dE}{idx} \tag{57}$$

What this comparison reveals, is that these two equations, which jointly describe the propagation of an electromagnetic wave, actually describe the behavior of propagation of the wave in terms of opposite curvatures, as the space and time coordinates of either of these equations is imaginary with respect to the space and time coordinates of the other. And by extension, each of Lenz's law and Faraday's law (to which these two equations were associated to), likewise seems to each constitute an opposite energy variant of the other (with respect to real or imaginary coordinates of space and time).

That the denominators of (57) involve imaginary parameters of time and space, sets a requirement for the involvement of the permeability and the permittivity terms, and there is a particular reason behind that. As previously noted, the negative energy field variants $\overline{E}$ and $\overline{B}$ may not directly apply in the real world since they have imaginary essence. But they may do so through their displacement field versions (the versions involving ε or μ). Here, we have a similar alternation of fields, but in an opposite side of curvature. The conventional electric E and magnetic B fields may not directly apply in negative curvature (the imaginary space and imaginary time) since it is foreign to them, however they may do so through their displacement field versions, which necessitates the involvement of ε and μ, as per (57).

In a point of interest, considering that ε has been referred to $+\Delta t/dx$ and μ has been referred to $-\Delta t/dx$, the units of both correspond to [sec/meters], and the involvement of these terms in (57) applies like switching the units of its denominators so as to resemble the space and time dependences in (56). Moreover, the validity of the corresponding units for the ε and μ may be checked upon Equation (58) which calculates the speed of light.

$$c=(\varepsilon_0\mu_0)^{-\frac{1}{2}} \tag{58}$$

Since either of ε and μ refers to [sec/meters], the units of the right side of the equation make for [meters/sec] which matches the units of velocity at the left side of the equation. So the units fit, subject to the condition that the parameter of time refers to a "phase shift" in time. That reference to the shift in time, however, sets a preliminary hint that the propagation of light may involve a certain process taking place in the time domain.

That the involvement of ε and μ get the units of (57) seemingly associate to the space and time dependences (denominators) of (56), may imply that in both cases the alternation of B concerns *time* and the alternation of E concerns *space*. But in the other hand, the involvement of displacement in time $\pm\Delta t$

within ε and μ, as well as the involvement of imaginary space and imaginary time parameters in the denominators of (57) suggests that the current understanding of electromagnetic wave propagation in terms of classical physics does not provide the full picture:

The phase shifts in time involved within the terms ε_0 and μ_0 of equation (57) may imply that the propagation of light additionally involves an alternation forward-and-backward in time, along with every alternation between the electric and magnetic components. As we shall discuss ahead in section 6, this alternating displacement is actually what allows for radiation to exchange energy with quantum particles in changing their energy state. In fact, it is not simply the electric and magnetic fields that alternate between each other as per (56), it is rather their displacement field variants (the displacement magnetic and displacement electric fields) that are involved in the process of wave propagation, as per (57). Respectively, (57) may be re-written as follows.

$$\frac{dH}{idt} = \frac{dD}{idx} \tag{59}$$

Since the involvement of ε and μ gets the displacement magnetic and displacement electric fields displace forward and backward in time with respect to real space $(\pm\Delta t/dx)$, this means that each field alternation comes along with a corresponding shift in time, forward for the electric and backward for the magnetic, but both pointing toward the same direction, per every field alternation. This appears to concern the way an electromagnetic wave propagates, via repeated unidirectional displacements.

A next point to consider, is where do such phase shifts in time develop toward. Conventionally in electronics, an inductive (L) or capacitive (C) shift develops along a charge's direction of flow or acceleration within a circuit, as that holds, for instance, in a circuit involving a capacitor. In that case, while the electric flux changes, the associated displacement in time Δt causes the displacement current I_d through the capacitor. The electromagnetic waves, instead, are not emitted along the direction of acceleration of charge (since that is a non-radiative direction). They are emitted perpendicularly to the acceleration of charge (the radiative direction) since reaction generally arises orthogonally to the action, due to a real-to-imaginary relation between the two. Likewise, as per the orthogonality between time and space (either one being imaginary with respect to the other), the alternation in time of the electric field coordinate appears to be counterbalanced by an alternation in space of the magnetic field coordinate. The latter alternation in space, concerns the coordinate setting whereupon the Weinberg angle θ_w develops (as it concerns a shift in space). In that case, the repetitive phase shifts along the radiative direction result to the electromagnetic wave propagation. And as it shall be further discussed in section 6, the repetitive phase shift in *time* is what allows for the radiation to change the energy state of an electron, which concerns exchange of energy in terms of the electron's matter-related energy content (without any association to the electron's charge).

In section 4 we shall also consider the particular reason why the interaction between electromagnetic waves and electrons becomes quantized in the form of photons, where that will actually be discussed to apply for all bosons in general. As we shall see, a "photon" corresponds to only how a fermion's wave nature perceives an interaction with an electromagnetic wave, due to a Fourier-series effect in the time domain, which gets the involved fields interact in a form of beat, or a "quantum" of energy, which refers to the photon.

In section 6 we shall then further discuss how the present model extends toward the electroweak interaction. We shall also figure how the alternation of the displacement electric and the displacement magnetic fields along the radiative direction may have a complementary reading, when treated from an orthogonal perspective. Then, the repetitive phase shift may be treated with respect to space instead or time. While each of the displacement electric and displacement magnetic fields has a real as well as an imaginary coordinate, we shall discuss how the corresponding coordinates of D and H become involved in a wave's propagation, substituted by the displacement fields W_3 and B of the electroweak interaction, shifting over the Weinberg angle θ_w as per the description of the photon γ in the electroweak interaction, in Equation (60). A negative version of the fields should also concern effects like frustrated total internal reflection.

$$\gamma = \sin\theta_w W_3 + \cos\theta_w \mathrm{B} \tag{60}$$

Furthermore, just like an alternation in the imaginary coordinate of the displacement electric field may allow for the crossing of displacement-current I_d between the plates of capacitor, an analogous alternation of the corresponding displacement magnetic coordinate over the Weinberg angle will be discussed to allow for transfer of "displacement-momentum" p_d. That will address the reason why the Z^0 boson behaves as if it possesses effective mass. A similar process allows for the photon to become involved in the mediation of displacement-***negative***-momentum $\overline{p}_d$ which is of negative energy so it has imaginary properties, which are responsible for the photon behaving as a massless particle. That particular attribute, however, will be discussed to be responsible for the photon's ability to change the energy state of an absorbing electron. Also, in section 7 we shall consider that it is the magnetic coordinate of a photon that appears to engage in the effect of entanglement (which existing theory approaches and conjectures through context referring to quantum gravity).

3.12. Intrinsic Fields, in Exchange Forces and in the Exclusion Principle

We have previously described that it is feasible for negative field variants to interact in positive space or time, and it is feasible for positive field variants to interact in negative space or time metrics curvature, but that is possible only through their displacement-field variants, whose field "lines" have opposite geometry (due to the displacement, in time or space). This applies for the magnetic field as well. While the conventional magnetic field has loop-like field lines (e.g. as it develops around a current-carrying wire), it may engage in effects of negative energy through a displacement-magnetic field variant which has radial-like geometry. This field version may be traced, for instance, in particles' intrinsic spin properties, and we shall approximate that through a qualitative reference to a bar-magnet's magnetic field:

According to textbook theory, a bar-magnet's magnetic field comprises of two components. Namely, small surface currents, and particles' intrinsic spin. Surface currents concern microscopic atomic currents inside the magnet's material; these generally cancel out between neighboring atoms, but not at the surface, so they let a bar-magnet behave as if it had a small circular surface current flowing around it. That particular magnetic field variant resembles the magnetic field of a metal ring (or a coil). Such type of magnet behaves as having two "*hypothetical*" magnetic poles (north and south) located away from the metal ring (at either side of it), and its magnetic fields "lines" form closed loops.

The magnetic field attributed to particle's intrinsic spin, instead, has different characteristics. Observation of the shape of iron filings near a bar-magnet indicates that the magnet's field "lines" associate to *actual* magnetic poles (not hypothetical poles), each of which has field "lines" coming radially out (from the one pole), or in (to the other pole). In a case like that, it appears that what we observe is only a portion of the magnetic field "lines". Namely, we perceive the portion from the north until the south pole, which refers to a real actual field. But at the same time, we do not perceive a "return" portion of the field lines (e.g. from the south pole toward the north pole, in completing a loop). That we don't perceive that portion is not because this path lies behind the surface of the magnet (within the magnet's material). It is rather because this portion of the magnetic field lines is imaginary to classical perception, and is therefore hidden from direct view. If so, we need to figure how do these two variants of magnetic field (either with loop-like, or the intrinsic radial-like field "lines") arise differently:

We have previously described that, just like fluid flow creates a radial-like gravitomagnetic potential around it (which mediates the Bernoulli pressure), a flow of electric current similarly causes a radial-like magnetic potential around it. (The potential is radial-like, since it is normal to the magnetic field "lines"). Such a radial-like magnetic potential represents the difference in the "fastness" in imaginary time, while each magnetic field "line" (a loop around the wire) can be thought of to correspond to an equipotential line (or part of an equipotential surface). This pictures the "classical" magnetic field, like the one created by a flow of electric current in a wire, or a metal ring, or a coil.

But this picture does not apply for the magnetic field of an elementary particle, like an electron. In relation to material that shall be described right next in section 4, a quantum particle's wave function appears to describe an inverse type of oscillation. Instead of motion (e.g. of matter) with respect to time, we have an alternation in the fastness of passing time itself, which brings a resemblance of cyclic motion of matter *without* the latter actually moving and exhibiting classical angular momentum. That condition will be addressed to refer to an electron's mechanical-like spin, which causes a particle's intrinsic gravito-magnetic field, which is a mechanical field of negative energy. Likewise, it similarly holds with an alternation in the stretchiness of space, which brings a resemblance of cyclic motion of charge *without* exhibiting classical motion of charge. This condition appears to engage in producing the intrinsic magnetic field, which, due to the inverse way that it is produced, carries the characteristics of negative energy field variant.

Properties involving negative energy require imaginary numbers to account for. A negative energy field may interact with another imaginary entity so as to produce real result toward the classical world as per relation (3). In such case, the projection of an imaginary field or property toward the real world needs to become subject to a sine coordinate. And such a projection toward the classical world of positive time and positive space should be subject to the involvement of the Weinberg angle θ_w that applies between space and time. This means that the negative energy variant of the magnetic field should appear and interact toward the real-world subject to a sine coordinate of θ_w. This angle has the value of 30˚, and the sine of that value equals one-half, with that seemingly constituting the reason behind the specific value ½ of the intrinsic spin, and the associated magnetic moment of an elementary particle. The two possible (opposite) directions of cyclic waviness incorporated in a particle's wave function, provides for the corresponding two quantized magnetic spin states, of plus one-half and minus one-half. (This actually applies for both the magnetic, as well as the gravito-magnetic cases).

Due to its imaginary nature, the intrinsic magnetic field should apply at short range, as it should dump out quickly in the real world (same as the fields of evanescent wave modulation do damp out quickly). Furthermore, as the corresponding field is radial-like, every single particle (e.g. an electron) that carries this field variant does not behave as a North-South magnetic dipole. It rather resembles a "North-AntiNorth" dipole (for +½ spin), or a "South-AntiSouth" dipole (for −½ spin), in either of which cases we perceive only the one pole in the real world, with the other pole remaining hidden from direct classical perception since it has imaginary nature. This point shall be further elaborated, in section 5.4. Since the intrinsic magnetic field resembles a radial-like field, it looks much like a field of a monopole. The force between neighboring particles of opposite intrinsic-spin-related magnetic field is attractive, and that force concerns the "exchange interaction" which is responsible for keeping electrons together in chemical interactions, as in covalent bonds which pair electrons between atoms. Examples of such interaction concern bonds in organic compounds which typically involve Hydrogen, including the pairing of DNA.

This interaction also has a symmetric mechanical counterpart. That concerns the particle's intrinsic gravito-magnetic spin, associating to the electrons' waviness of matter (not charge), which also exhibits the value of spin ½ for same reason. The corresponding intrinsic-field version of the gravito-magnetic field also has radial-like field lines. In relation to material that will be discussed in sections 4.8 and 5.4, an electron behaves in a way that makes it resemble a "Gravitomagnetic-NegativeGravitomagnetic" dipole, of which we perceive only the one pole. And this again may come in two versions, of +1/2 spin resembling a "North-NegativeNorth" gravito-magnetic dipole, or −1/2 spin resembling a "South-NegativeSouth" gravito-magnetic dipole. Here again, we directly perceive only the one pole in the real world, while the other pole remains hidden from direct classical perception (as it has imaginary characteristics). In this mechanical version, the potential between identical particles of opposite spin is repulsive (instead of attractive), while same-spins exhibit a corresponding force of attractive nature, which could contribute to the Van der Walls forces.

On a note of significance, while both the intrinsic-magnetic as well as the intrinsic-gravitomagnetic field interactions are of short range in the real world (due to their negative energy), these particular fields may also engage in long range interactions too, under certain conditions. That is possible when either of them interacts with another entity of negative energy, so both this field and the other interacting entity have imaginary nature, so they perceive and interact between each other as real entities. One such example concerns one embodiment of Lenz's law, where a bar-magnet (whose magnetic field is mostly intrinsic) approaches a metal ring or coil, so there is change in magnetic flux (which is a measure with respect to imaginary space, as explained earlier). Since both the field and the measure of space are imaginary, this yields a classical-like interaction, at long (macroscopic) range, generating the inductive displacement current. By analogy, the intrinsic gravito-magnetic field is also plausible to apply at long range (even at celestial scale).

4. Matter/Charge Symmetries

4.1. On the Planck Constant & Imaginary Terms

An electron's wave function involves a real as well as an imaginary oscillating coordinate (61). Substituting the second derivative of space as well as the first derivative of time of that function to the Schrödinger equation, the latter takes the form of (62).

$$\Psi_{(x,t)} = \cos(kx-\omega t) + i\sin(kx-\omega t) \tag{61}$$

$$\begin{aligned}&\left[-\left(\frac{\hbar^2}{2m}\right)\left(-k^2\cos(kx-\omega t) - k^2 i\sin(kx-\omega t)\right)\right]\\&+\left[V_{(x,t)}\left(\cos(kx-\omega t)+i\sin(kx-\omega t)\right)\right]\\&=\left[\pm i\hbar\left(\omega\sin(kx-\omega t)-\omega i\cos(kx-\omega t)\right)\right]\end{aligned} \tag{62}$$

According to theory, for that equality to hold for all combinations of independent variables x and t, it is necessary that the coefficients of both the cosine terms and sine terms be zero [10]. To handle that, the cosine terms and the sine terms of (62) are put in separate equations:

$$\left[-\left(\frac{\hbar^2}{2m}\right)\left(-k^2\cos\left(kx-\omega t\right)\right)\right]+\left[V_0\cos\left(kx-\omega t\right)\right] \\ =\left[\pm i\hbar\left(-\omega\, i\cos\left(kx-\omega t\right)\right)\right] \tag{63}$$

$$\left[-\left(\frac{\hbar^2}{2m}\right)\left(-k^2 i\sin\left(kx-\omega t\right)\right)\right]+\left[V_0\, i\sin\left(kx-\omega t\right)\right] \\ =\left[\mp i\hbar\left(\omega\sin\left(kx-\omega t\right)\right)\right] \tag{64}$$

For the coefficients of both Equations (63) and (64) to add up to zero, it requires for the relations (65) and (66) to be satisfied at the same time. By dividing all the terms of (66) by i, the latter takes the equivalent form (67).

$$-\left(\frac{\hbar^2 k^2}{2m}\right)+V_0=\pm i\hbar\left(i\right)\omega \tag{65}$$

$$-\left(\frac{\hbar^2 k^2 i}{2m}\right)+i\, V_0=\mp i\hbar\omega \tag{66}$$

$$-\left(\frac{\hbar^2 k^2}{2m}\right)+V_0=\mp i\hbar\left(\frac{1}{i}\right)\omega \tag{67}$$

Equations (65) and (67) are satisfied concurrently only if $i=-1/i$. But this is already happening by definition as per (3). That these two relations are satisfied concurrently under this condition, provides the grounds, and allows for the present model to assume that imaginary entities may project toward the real world through their negative reciprocals. Let us see what this brings in interpreting (63) and (64).

The equation of Cosines (63) refers to properties of a particle that concern the real world. Same as in the original Schrödinger equation, the first bracket represents kinetic energy, the second bracket represents potential energy, and the right side of the equation represents total energy. The right side involves TWO imaginary terms, which turn it into real since $i^2=-1$, and that makes the complete equation of cosines to consist of real numbers. The equation of Sines (64) instead, is fully imaginary, since all its brackets include the i term. Existing theory brings no clues on what an imaginary entity represents, but we shall seek to bring up an insight into this. For a particle like an electron, Equation (64) may become involved in defining the particle's engagement in effects of reaction. In addition to that, however, these two equations may have an inverse reading: In relation to concepts that shall be introduced in sections 4.7 and 4.8, since the relation (64) is fully imaginary, it may refer to an exotic type of particle which may not take real form in our cosmic region, while it may reach ordinary form under conditions where the space metric acquires negative value. Such an exotic particle shall later be associated to a neutrino or an antineutrino. By same token, the equation of cosines (63) may be used in describing a neutrino's engagement in effects of reaction.

Even though all the terms of (63) are real, the fact that the right side of the equation has turned real due to the interaction of two imaginary terms, raises a question about the deeper role of each of these two imaginary terms:

(i) The first imaginary term, is the one next to the Plank constant h. This term arises because the Schrödinger equation relates a second derivative of space (which refers to the kinetic energy term at the left side of (63)) to a first derivative of time (referring to the total energy term at the right side of the equation). In this case, the "missing" second derivative of time translates to a ninety-degrees difference (orthogonality) between these two terms, just like an Imaginary coordinate axis exhibits a ninety-degree difference with respect to a Real coordinate axis. That this orthogonality comes along with the Planck constant, designates that the Plank constant itself should have imaginary attributes, so the two together (the orthogonality as well as the imaginary attributes of h) may yield a real outcome in the real world as per $i^2 = -1$, where that should associate to the particle's matter. The particular imaginary attributes of the Planck constant may be traced in its units, which come in [Joules·sec]. These units seem bizarre in a classical sense, since conventional energy should be measured "with respect to" time, instead of "times" time. It appears to turn out that due to the process of negative reciprocation, the Plank constant actually concerns energy flow "with respect to negative reciprocal time" −1/sec (instead of "with respect to time"), as shown in (68).

$$\text{Joules}\cdot\text{sec} = \frac{\text{Joules}}{\frac{1}{\text{sec}}} = \frac{\text{Joules}}{i\ \text{sec}} \tag{68}$$

Since the energy in the Planck constant associates to the particle's matter, not its charge, its energy content should concern an effect involving the parameter of time, just like gravity was also described to concern the curvature of time. And, since in the Schrödinger equation the Planck constant combines with a cycling term, this suggests that a quantum oscillator resembles an oscillation, or loop-like waviness of energy with respect to imaginary time *i*sec. Furthermore, the Planck constant is contained in the kinetic energy term of (62) at the power of 2. Here recall, that in (10) of section 3.5, we introduced the notion of gravitational flux $\Phi_g = g/idt^2$, which may transfer displacement momentum in barrier penetration. It now appears, that the cycling term next to the Plank constant indicates that the quantum oscillator resembles a waviness of displacement momentum $\left(p_d = \varepsilon_g\, \partial\Phi_g/\partial x\right)$, where that refers to motion without actual movement of real matter. In this case, that the waviness concerns an oscillation in the time domain, is what provides to the particle its probabilistic nature, as the particle is not living in single-valued "progression" of time. In this respect, the particle's matter essentially concerns an oscillation in non-unitary time, allowing it to pop-up and interact in a way that we ourselves (living in fixed fastness of macroscopic time) perceive to be probabilistic, without disobeying causality.

As we shall also consider ahead in section 4.5, the oscillation in the time domain is what gets a fermionic particle like the electron interact with electromagnetic radiation in a quantized way. The electron's wave function resembles living over a range of fastness of time and stretchiness of space, and that allows to concurrently satisfy multiple integer wavinesses (resonances) concerning the allowed energy states that an electron may occupy. And that is what permits the superposition of allowed states. The interaction of an electron's waviness of time and space with an electromagnetic wave in single-valued classical macroscopic time and space at our cosmic region (where these single-values of the time and space metrics refer to point e of **Figure 1**) gets an electromagnetic wave's fields "engage" in a specific "snapshot" of the electron's oscillating metrics. This corresponds to what is called a "collapse of the wave function" and "landing" to a definite state, where that refers to a measurement with respect to single-valued time and single-valued space. At such condition, the particle's probabilistic nature is reduced to single-valued time and space, corresponding to a specific state of the particle. In this way, classical physics and the particle nature of the particle refers to "catching" the oscillation of time and space metrics in a single-valued positive time metric and single-valued positive space metric. That the conventional formulas of physics do not describe the oscillation of time itself (and the oscillation of space as we shall see later), gets these formulas fall into the limitations of the uncertainty principle, which should be possible to suppress under conditions of coherency.

(ii) The second imaginary term (at the right side of the equation of Cosines) is the one next to the frequency ω. Apparently this term should be associated with the effect of waviness. Here we need to recall that the whole bracket of the right side of (63) arose from the imaginary portion of the wave function (61). This suggests that it should describe a counterbalancing process to the one described by the left side of (63) which arose from the real portion of the wave function (61). Provided it represents a counterbalancing condition, it should develop in an orthogonal direction, therefore radially to the particle. And due to the existence of the cyclic term that the right side of the equation contains, a waviness should deploy in a closed (loop-like) formation. In relation to certain additional concepts that shall be introduced right next in section 4.2, this whole term appears to have a particular association to the particle's gravitational field, which complies to a loop-like curvature in the time domain illustrated in **Figure 1**. Through that association, while a particle's internal essence is accounted for by relating the wave function's "second-space" to "first-time" derivatives, that becomes balanced out through an inverse relation involving the power of "first-space" (dx) to "second-time" (dt^2) parameters, where that refers to the units of the gravitational field dx/dt^2. The reasoning on how that arises is approximated right next.

4.2. Quantum Oscillator's Association to Gravity

A classical mechanical oscillator of a mass attached to a spring can be described by the relation (69), where f is the flexibility of the spring, and its reciprocal $(1/\mathrm{f}) = k$ equals its stiffness. A classical electronic oscillator of an alternating current in an LC circuit, may likewise be described by the relation (70). We shall now compare these equations to the real attributes of the quantum oscillator, which refer to the equation of cosines, re-written here for convenience in (71).

$$m\frac{d^2x}{dt^2} = -\left(\frac{1}{\mathrm{f}}\right)x \tag{69}$$

$$L\frac{d^2I(t)}{dt^2} = -\left(\frac{1}{C}\right)I(t) \tag{70}$$

$$\left[-\left(\frac{\hbar^2}{2m}\right)\left(-k^2\cos(kx-\omega t)\right)\right]+\left[V_0\cos(kx-\omega t)\right] = \left[\pm i\hbar\left(-\omega i\cos(kx-\omega t)\right)\right] \quad (63) \text{ or } (71)$$

The equations describing the two classical oscillators are symmetric to each other; the left sides of both associate to an alternating acceleration of matter-or-charge, thus to kinetic energy. The right sides also describe analogous properties, in the sense that both the flexibility of the spring or the capacitance of a capacitor associate to potential energy (needed for an oscillation to be made possible). The quantum oscillator (71) instead, has a different structure. The left bracket concerns a particle's kinetic energy, since the coefficient $(\hbar/2m)$ arises form $E=\frac{1}{2}m\upsilon^2$ by substituting the classical momentum term $p=m\upsilon$ to momentum as per the de Broglie wavelength $p=h/\lambda$. The middle bracket of (71) concerns potential energy which affects the particle externally (referring to the influence from its environment). And the right bracket concerns the total energy as it refers to the relation of total energy $E=h\nu$ and is therefore equal to the sum of the kinetic and potential energies. Furthermore, that the right side of the equation contains two imaginary terms, implies that the particle should have certain negative-energy characteristic associated with it.

We shall now permit ourselves to make a loose intervention. As the middle term V_0 of Equation (71) describes an external potential, that potential may affect the shape of the wave function, as well as the acceleration of the particle. We shall however explore the possibility that this potential does not constitute an essential intrinsic element of the raw quantum oscillator, required for the quantum oscillation to be in very existence. This holds for same reason that, a spring with a mass attached to it, does not require an external gravitational field in order to have the attached mass to be in oscillation. In fact, the potential term V_0 typically concerns an electric potential (instead of a gravitational, since the latter is by far weaker), while the electric interaction is foreign to the particle's own material essence itself. So that is much like having oranges and peaches in the same relation. We shall therefore consider taking this potential term V_0 out of the picture. Loosely speaking, as if the particle could supposedly be completely isolated at far outer space, hypothetically blocked from any external influence from all the rest of the universe.

A point that requires attention in this case, is that the kinetic energy term and the potential energy term (the two brackets at the left side of (71)) are supposed to have equal energies, since they have to counterbalance each other. Consequently, for waiving the potential energy term V_0 out of the equation, it requires to add a one-half mark (1/2) in front of the right side of this equation, in which case (71) becomes (72). The latter may be referred to as a "reduced equation of cosine terms", and the same concept may similarly apply for preparing a reduced equation of sine terms. The validness of the one-half value at the right side of (72) may be verified quantitatively through (73) which shows that the values of the kinetic energy term (at the left side of 72) and the reduced energy term (at the right side of 72) are equal.

$$\left[-\left(\frac{\hbar^2}{2m}\right)\left(-k^2\cos\left(kx-\omega t\right)\right)\right]=\frac{1}{2}\left[\pm i\hbar\left(-\omega i\cos\left(kx-\omega t\right)\right)\right] \tag{72}$$

$$\frac{\hbar^2 k^2}{2m}\to\frac{1}{2}m\upsilon^2\to\frac{1}{2}(m\upsilon)\upsilon\to\frac{1}{2}p\upsilon\to\frac{1}{2}\left(\frac{h}{\lambda}\right)(\lambda\nu)\to\frac{1}{2}h\nu \tag{73}$$

It also turns out, that now the right bracket of (72) does not describe total energy any more. It has only half the value of total energy (due to the 1/2 mark), and since the left side of the equation describes only kinetic energy, the right side should now concern potential energy only. Actually, we could very well waive the 1/2 marks from both the left and the right sides of (72), but we shall prefer to not do that, as in the next section we shall discuss on the existence of an additional 1/2 portion of energy for either side of the equation, where that would come in association to the particle's charge.

Since the right side of (72) originated from the imaginary portion of the wave function, that potential energy has imaginary origin. And that potential energy, now constitutes an essential prerequisite for the raw quantum oscillator to be in existence, and oscillate.

We now need to refer to the two imaginary terms that the right side of (72) involves, and explore what either one of them could account for, in a collective way. Each one of them should be associated with an oscillation in the metric of time, or the metric of space. In relation to what was described earlier, the units of the Planck constant h involve "negative reciprocal time", which corresponds to "imaginary time" as per (68), and the existence of this negative reciprocal applies as if the term translates in that the cyclic-ness described should not concern a waviness "with respect to" time, but a waviness "of time" itself (the metric of time itself). The imaginary term next to the frequency ω, in turn, should refer to a relevant oscillation in the metric of space. These two forms of oscillations need to co-exist for the whole right bracket to be real (as per $i^2=-1$). In addition to that, their product should describe potential energy, as the right side of Equation (72) was explained to now do. It turns out that this side of the equation (along with the 1/2 mark in front of it) appears to describe a waviness in the metric of time (as per the units of the Planck constant), as that deploys over space (as per the units of wavelength). That in turn, appears to refer to the particle's gravitational field, as that was described in Figure 1 to refer to the waviness of the metric of time over a loop at the cosmic scale, since the two ends of the figure's axis were explained to connect to each other in forming a loop.

Notice that what we've ended up having in (72), is a quantum oscillation relation which is symmetric to the relations of the classical oscillators. This is so as it involves a counterbalance between real kinetic energy (at the left side of the equation, concerning an oscillation in displacement gravitational flux), and potential energy which has imaginary origin (at the right side of the equation). In fact, it appears that it similarly holds for the classical oscillators (69) and (70) too, without noticing it, as their right sides involve a negative reciprocity of the capacitance $(1/C)$, or of the spring's flexibility $(1/\mathrm{f})$ terms, revealing that these terms arose in relation of imaginary attributes (which project to the real world through their negative reciprocals).

According to the above, each particle's own gravitational field appears to be accounted within the imaginary attributes of its wave function, as if this gravitational field constituted part of the particle's own essence (and not a consequence to the environment due to the particle's existence). Moreover, in such a way, the gravitational force affected upon a material particle appears to apply as if it tends to have this particle's own little contribution to a total gravitational field follow the same phase (in the waviness of the time metric) with all other particles in the its vicinity: That is, time moves faster and faster the further away from this particle, then beyond mid-distant outer space it starts moving slower and slower, and eventually turns negative, same as it was explained earlier to hold for celestial bodies. In this sense, the phase coherency in the waviness of a particle's own gravitational curvature could be understood to serve as a means for fermions to bunch up in-phase with the other particles' waviness. In other words, *gravity appears to concern the tendency for all particles' gravitational curvatures to come in-phase to each other*, and that allows them to bunch up in celestial formations, in order for their gravitational curvature in time to have coherent phase among each other (in some analogy to as bosons tend to bunch up coherently in beams).

Furthermore, in relation to concepts that shall be introduced in section 5.4, as a particle's gravitational field "lines" are radial-like, they tend to reach toward some opposite gravitational pole (nodal surface) very far away, which would serve as a time node, to which the gravitational field lines "dive" toward. But we shall elaborate on that later, when considering properties of monopoles-dipoles-multipoles at the large scale.

4.3. Quantum Nature of Charge

In section 3 we have described symmetries between the gravitational and the electric interactions, arising through a swapping of parameters of time and space. Their fields share symmetric geometries (e.g. the gravitational and the electric fields are radial-like), symmetric fluxes as in (8) and (10), symmetric representations of forces ($F = m\alpha$ and $F = qE$), even symmetric reaction potentials like (26) and (34). This provides a strong hint that such symmetries should extend (in a possible degree) over the essence of matter and charge. But then, why the Schrödinger equation doesn't make any prediction about the particle's charge? And, while matter exhibits wave-like properties, why does charge have to follow the trace of matter, and not exhibit wave-like properties of its own? This breaking in symmetry appears to hold because the Schrödinger equation relates a second derivative of space, to a first derivative of time. In relation to the discussion in section 4.1, the "missing" second derivative of time yields an oscillation in attributes of imaginary time. With those associating to time, that oscillation should rather concern the particle's matter only (not its charge).

But then, could there be a symmetric type of equation to possibly account for a waviness of charge? Under conditions, it appears that it could. That would be possible by devising an inverse type of relation, which would now relate a second derivative of TIME (instead of space), to a first derivative of SPACE (instead of time). But if this is so, a next question that arises, is what should the kinetic energy term, and what should the total energy term of such equation be like, so as to account for charge instead of matter, given the swapping of parameters of time and space that was introduced to hold between electronics and gravitation.

To help figuring that out, let us refer to the equation of cosine terms (63) that we came across earlier. As previously described, the left bracket involves the term $\hbar^2 k^2 / 2m$ which arose from the kinetic energy $\frac{1}{2} m\upsilon^2$. In this case we need to seek for an analogous condition concerning charge. This means that we should look for an entity that may take the role of mass, as well as for some property to take the role of velocity. In relation to what was discussed in previous sections, "mass" may be considered a property that "dresses" matter with *inertial impedance*. So, when energy is spent to accelerate matter, part of that energy is being consumed without doing work in accelerating it. In the case of charge, a corresponding analogy may be appropriately traced in capacitance. A consequence of *capacitive impedance*, is that when energy is spent to change a current, part of this energy is being consumed without doing work (in changing the current). We shall use this notion and shall try for "capacitance" to play a similar role in electronics, to the role that inertial mass does in mechanics.

As for what property of electronics could play the role that velocity does in mechanics, we should similarly look for a property that might be physically different to the conventional velocity that we are classically accustomed to. Since electronics has been discussed to be symmetric to mechanics via a swapping of the parameters of space and time, we could explore how such swapping could apply upon velocity. Since the electric interaction has been presented to be orthogonal to the gravitational, properties related to electronics should be imaginary with respect to properties related to mechanics, thus from the point of view of electronics the parameters of space and time should apply through their negative reciprocals. In relation to that, a velocity-related term we would be looking for could rather correspond to $\left((-1/dx)/(-1/dt)\right)$, which yields dt/dx, and refers to the unconventional units of [sec/meter]. Here recall that such type of units was previously associated to "voltage" (from the electromagnetic interaction's point of reference).

Due to this, we shall try the supposition that, in the context of electronics, voltage may assume a role similar to the one that velocity dx/dt does in mechanics. Despite how unrealistic this may seem, it turns out that such a supposition is not at all arbitrary:

Consider that, if the reciprocal of velocity dt/dx is perceived in the classical world to correspond to voltage, the same should also apply in reverse, with respect to negative energy. That is, what we perceive as conventional motion dx/dt, should be perceived as a potential from charge's point of view. And this appears to be indeed the case, and constitutes the reason why classical motion (dx/dt) of charge forms a potential around it, where that potential refers to a magnetic potential around a current. In that sense, the magnetic field (whose field lines were explained to correspond to equipotential lines/surfaces) arises in counterbalance to the flow of charge. In fact, such counterbalancing process applies in more universal sense, as it also applies upon the motion of matter, as in fluid flow, which forms a potential around it, where that potential refers to the gravitomagnetic potential that causes the Bernoulli negative pressure, as described previously.

As per the above, adopting capacitance (in place of mass) and voltage (in place of velocity), then the "Kinetic energy in relation to charge" could be approximated by a relation of the form $W = \frac{1}{2}CV^2$ (in place of $\frac{1}{2}m\upsilon^2$). This is of course a known relation which describes energy in the case of a capacitor. However, this particular expression does not seem appropriate to use in a complementary-to-Schrödinger equation, as it rather describes classical physics attributes which concern the particle-nature of charges (much like the term $\frac{1}{2}m\upsilon^2$ does in mechanics). While instead, we would rather need an expression referring to a "wave nature" of charge, in analogy to the kinetic energy term of $\hbar^2k^2/2m$ in mechanics. The term $\frac{1}{2}CV^2$ is appropriate to describe alternations of voltage in a circuit involving a capacitor, where it holds $C = Q/V$ and the value of capacitance C is constant. However, in the case of an elementary particle like the electron, it is the charge Q that has a constant (quantized) value, not the capacitance. Yet, it should still hold that $Q = CV$, in which case the product CV should stay constant, in analogy to as a particle's momentum $p = m\upsilon$ tends to keep constant in mechanics. (Actually, in such a comparison, it is not exactly the p, it is rather the $h = p\lambda = (m\lambda)\upsilon = (m/k)\upsilon$ where k is the wave number, that remains constant and quantized, and m/k can be considered to reflect something like "how much inertial mass" is "contained" per wave number k, in a similar sense to as capacitance reflects how much charge can be contained in a capacitor.

We are now in position to prepare a proper kinetic energy coefficient in relation to charge, according to a calculation like in (74). Notice how symmetric the term $(Q^2/2C)$ is to the kinetic energy coefficient $(h^2/2m)$ of quantum mechanics. Actually, here we have a replacement of the quantized value of h by another quantized value, the one concerning the electron's charge Q.

$$\left[-\frac{1}{2}C(\Delta V)^2\right]\to\left[-\frac{1}{2}\left(\frac{1}{C}\right)\left(C^2V^2\right)\right]\to\left[-\frac{1}{2}\left(\frac{1}{C}\right)Q^2\right]\to-\left(\frac{Q^2}{2C}\right) \tag{74}$$

With this on hand, we may now come back into formulating a Schrödinger-like equation of the general form [Kinetic energy + Potential energy = Total energy] in scheming an electron's "charge-wave". This may have the form shown in (75).

$$\left[-\left(\frac{Q^2}{2C}\right)\frac{\partial^2\Psi_{(x,t)}}{\partial t^2}\right]+\left[V_{(x,t)}\Psi_{(x,t)}\right]=\left[\pm iQ\frac{\partial\Psi_{(x,t)}}{\partial x}\right] \tag{75}$$

Regarding the potential term $V_{(x,t)}$ in the second bracket, this refers to externally acting fields, so it may differ per cosmic region, depending on the sign of progression of time and the sign of the stretchiness/contraction of space. For our own cosmic region, this term may be kept as is in quantum mechanics, especially considering that the external potential energy typically concerns the Coulomb potential in any way.

The "total energy" term at the right side of (75) becomes elucidated after we substitute the actual derivatives $\partial^2\Psi_{(x,t)}/\partial t^2$ and $\partial\Psi_{(x,t)}/\partial x$ into this equation. It then appears that this term relies on the representation of energy $W=Qk$, in symmetry to the relation $E=h\nu$ in quantum mechanics. Actually, the charge Q appears to be quantized for a similar reason to that the Planck constant is quantized in the case of matter. This reason being that, as the particle involves a waviness of the space metric, this applies as a superposition of charge waves of smaller and larger wavelengths of progressive amplitude, and that gets the particle's charge interact with external fields as of the quantized beat-like value of the electron's charge. In fact, an electron's charge-related wave function resembles living over a range of stretchiness of space, allowing it to engage in effects of non-locality without disobeying causality. Furthermore, in relation to material that shall be considered in section 6, just like an electron's wave function interacts with photons and may change the electron's energy state by a quantized amount of energy (which is matter-related), an analogous form of interaction involves the interaction of a particle's charge-related waviness, with fields of negative energy which ascribe to the $W^{\pm}$ s bosons (instead of photons). That lets the electron's charge-related wave function to exchange charge and "land" into different particle formation as per the electroweak interaction, as we shall discuss then. Furthermore, that the quantized value of an electron's charge equals 1e (instead of a 1/2 ground value that holds for h), appears to relate to that both positive as well as negative charge reaches stable particle form in the real world (unlike matter, where only "positive" matter reaches form in the real world, since both matter and antimatter constitute "positive" matter).

The relation (75) may be worked out in a similar way to as done in the original Schrödinger equation, by calculating and then substituting the corresponding derivatives of the wave Function (61), as shown through (76)-(78). Actually, the expression used for Ψ could come in variations, by swapping of the cosine and sine terms and the parameters of space and time in order to properly account for each different lepton (an electron or positron or neutrino or antineutrino) in each cosmic region. This is so, as the possible combinations of the signs of the time metric and the space metric, allow for 4 regions, as may be seen in **Figure 1** and shall be elaborated ahead in section 4.7.

$$\frac{\partial \Psi_{(x,t)}}{\partial x} = k\sin(kx-\omega t) + ki\cos(kx-\omega t) \tag{76}$$

$$\frac{\partial^2 \Psi_{(x,t)}}{\partial t^2} = -\omega^2\cos(kx-\omega t) - \omega^2 i\sin(kx-\omega t) \tag{77}$$

$$V_{(x,t)}\Psi_{(x,t)} = V_0\cos(kx-\omega t) + V_0 i\sin(kx-\omega t) \tag{78}$$

After plugging in these derivatives to (75), we may then separate the cosine and sine terms into two equations in a similar manner to as was done with (63) and (64). These may indicatively have as follows, depending on which variations of Ψ and V_0 are used in the calculations:

$$\begin{gathered}\left[-\left(\frac{Q^2}{2C}\right)\left(-\omega^2\cos(kx-\omega t)\right)\right] + \left[V_0\cos(kx-\omega t)\right] \\ = \left[\pm iQ\left(-ki\cos(kx-\omega t)\right)\right]\end{gathered} \tag{79}$$

$$\begin{gathered}\left[-\left(\frac{Q^2}{2C}\right)\left(-\omega^2 i\sin(kx-\omega t)\right)\right] + \left[V_0 i\sin(kx-\omega t)\right] \\ = \left[\mp iQ\left(k\sin(kx-\omega t)\right)\right]\end{gathered} \tag{80}$$

Similar to the case of the matter wave, for the coefficients of both (79) and (80) to add up to zero it requires that $i=-1/i$, but this is already happening by definition since for the imaginary term it holds $i^2=-1$. And same as we did for matter, we could then prepare "reduced equations" for the case of the waviness of charge, describing the "raw" quantum oscillator for charge. Once again, this can be done by taking out the V_0 term, and reducing the right side of the equation (which initially represented "total energy in relation to a particle's charge") by one-half. What we then get, has as follows:

$$\left[-\left(\frac{Q^2}{2C}\right)\left(-\omega^2\cos(kx-\omega t)\right)\right] = \frac{1}{2}\left[\pm iQ\left(-ki\cos(kx-\omega t)\right)\right] \tag{81}$$

$$\left[-\left(\frac{Q^2}{2C}\right)\left(-\omega^2 i\sin(kx-\omega t)\right)\right] = \frac{1}{2}\left[\mp iQ\left(k\sin(kx-\omega t)\right)\right] \tag{82}$$

For both (81) and (82), the left side involves the term $Q^2/2C$, and if we transfer here the ω^2 of the next term, then we get the kinetic energy coefficient to be $\left(Q^2\omega^2/2C\right)$. Furthermore, similarly to as was done in the Schrödinger equation where the wavelength λ was replaced by the wave number $k=2\pi/\lambda$, we may replace the frequency ω to its reciprocal "frequency number" which we may denote by the letter φ, where $\varphi=2\pi/\omega$. This concerns the number of cycles (or radians) per unit time (so it is something relevant to "period" instead of an ordinary "frequency"). It seems handy to use that, as the quantum context deals with reciprocals of space and/or time. So, when it comes to (81) and (82) we may substitute ω to $2\pi/\varphi$, and for reasons of convenience we may even use $\phi = \varphi/2\pi$, in which case the kinetic energy term now becomes $\left(Q^2/2C\phi^2\right)$.

Regarding the right side of both Equations (81) and (82), these involve the representation of energy $W = Qk$ in symmetry to $E = h\nu$ in quantum mechanics. And same as in the mechanical case, the right side of the reduced equations does not describe total energy any more, it now describes "potential energy concerning the waviness of charge" of the raw oscillator. As previously, we have added the 1/2 mark in front of it, since we waived the V_0 from the left side of the relation. At this point we may recall that when preparing the reduced equation of the quantum mechanical oscillator in (82), it was noted that the right side of that equation (which includes the 1/2 mark) accounted for an internal, imaginary, potential energy. It now appears that the remaining 1/2 of that energy (missing from equation (82)) could be associated with the 1/2 of the energy in relation to the particle's charge (the 1/2 of $W = Qk$ at the right side of (81)).

Furthermore, similar to as the right side of (72) was explained to associate to the gravitational field (the waviness in the curvature of time as that deploys over space), likewise the right side of (81) appears to associate to the particle's electric field. The same point could also be approximated through a loose and gross perspective, as follows: Since the waviness of charge arises by relating the wave function's *second-time* derivative to the *first-negative-space* derivative, that becomes balanced out by an inverse waviness involving the *first* power of time (dt) to the *second* power of negative-space $\left(d(-x)^2\right)$, where that reflects to the raw units of the electric field dt/dx^2 (as referred to in section 3.3). In that sense, the electric field should not be understood to concern a consequence to the environment due to the particle's existence. Instead, it should be understood to constitute part of the particle's formation (just like it was stated to be the case for a particle's gravitational field).

The waviness in the curvature of imaginary space which was associated to the essence of the electric field, appears to have its nodes match the nodes of the space curvature of **Figure 1**. In such case, the field "lines" of a particle's electric field should follow a waviness resembling the one of the Space Curvature of that figure (even though it should concern *imaginary* space). That is, imaginary space should be stretching more the further away from the particle, but only up to a range, and then beyond that range it should be contracting until reaching an opposite node at distant outer space. In relation to material that shall be presented in sections 4.7 and 4.8, after that node the electric field "lines" should continue a trail through a "return" portion (looping back to the particle) which has imaginary character. From that whole loop, we directly perceive the real (radial-like) portion of the electric field, while a portion of the imaginary part may engage in effects of reaction, which shall be elaborated later.

An analogy of interest, in reference to units involved, is that the energy $W = Qk$ is measured in Joules, charge Q is measured in Coulomb, and the wave number k is a measure of $1/dx$ since it associates to the reciprocal of wavelength (it describes the number of cycles-or-radians per unit space, so it refers to something like the "number of wavelengths over a specific distance"). And since it holds $Q = W/k$, the quantization of charge should come in units of Joule/(1/meters), which refers to [Joules·meters], in analogy to as the units of the Planck constant come in [Joules·seconds]. The difference between the two, being that time has been swapped to space. In other words, charge as per the wave nature can be thought of to concern energy with respect to imaginary space [Joules/(idx)], where the imaginary term accounts for a negative reciprocation on the basis that $i^2 = -1$ so $i = -1/i$. As for the negative sign, that comes along with the reciprocation, and this may be considered responsible for the electron charge being treated as "negative" charge (even though that sign might have been named arbitrarily in the first place). The negative sign may also be considered to associate (by similar reasoning) to the fact that charges of same charge sign *repel* each other while particles of matter of same sign *attract* each other.

Let us now focus on the reduced equation of sines (82). This is fully imaginary, since all its brackets include the *i* term. It appears that for a particle like an electron, this relation may become involved in accounting this particle's engagement in effects of reaction like those of the electromotive potential or the crossing of displacement-current through the plates of a capacitor as described previously. This is so, since effects of reaction typically involve negative energy field variants (through their displacement-field versions), which have imaginary essence, and should link to particle's imaginary part, which refers to the charge-related function (82). On a point of interest, due to the imaginary properties of (82) or of the reduced version of (64), these equations should also be considered to engage in interactions concerning entanglement.

Furthermore, in relation to concepts that shall be introduced in sections 4.7 and 4.8, Equations (81) and (82) may also have an inverse reading: Since the latter is fully imaginary, it may also be considered to describe a particle which may not take real form in our cosmic region, like a *neutrino* which resides in a cosmic region of negative space metric. That will later be considered to carry an imaginary variant of charge which we may here refer to as "anti-charge" (where that in turn, shall later be discussed to engage in the "neutral currents" of the electroweak interaction). For such particles within such regions, the equation of sines should apply as being an equation of real coordinates (from the reference point of these particles' habitat). And the equation of cosines (81) should correspondingly apply in terms of a neutrino's engagement in effects of reaction.

4.4. Quantum Nature of Spin

Electron spin is not an effect of classical physics, as in order to produce the measured magnetic moment, the surface of an elementary charged particle would have to be moving faster than the speed of light. The electron appears to be twice as effective in producing a magnetic moment as a classical charged body would do, as it has a spin g-factor of approximately two $(g_s \approx 2)$ with the deviation from the integer value being due to an anomalous magnetic moment correction [11]. The integer value of 2 may imply that an electron's spin should involve imaginary attributes, and these appear to refer to the negative energy variant of the magnetic field, discussed in section 3.12. This gets the electron's spin 1/2 comply with the spin g-factor of two, through the fact that the projection of such an imaginary property to the real world comes through the negative reciprocal of this value (as per $i = -1/i$), in this case 1/(1/2) = 2.

While spin is not accounted for in the conventional Schrödinger's equation, a similar methodology as of above may be used to approximate it. Like previously, we need to estimate a kinetic energy term and a potential energy term for preparing a reduced equation of Cosines and a reduced equation of Sines. Regarding the kinetic energy term, just like in the electric case in section 4.3 we used capacitance to take the role of mass, and we also used voltage to take the role of mechanical velocity, here we shall seek to devise a relevant kinetic energy term by (initially) parallelizing spin to a loop-like flow of current I through a coil. The flow of current through a coil gets the magnetic field "lines" being denser through the hole of the coil, and less dense outside the coil. This change in density creates a magnetic potential, which is reacted through the property of inductance that the coil exhibits and causes effects of impedance. In relation to that, we shall try for inductance L to take the role that inertial mass takes in mechanics, and shall use the current to resemble the role that velocity takes in mechanics. That may result to a kinetic energy term of the form $W = -\frac{1}{2}LI^2$. But, unlike the case of an electric circuit where the inductance $L = \Phi_B/I$ is constant and we have an alternation in current (and associated magnetic flux around it), in the case of an elementary particle like the electron, it is the magnetic flux Φ_B of the particle that appears to have a constant (quantized) value, while inductance applies as being effectively alternating. And since it should still hold $\Phi_B = LI$, the product LI should stay constant, just like a particle's momentum tends to keep constant in mechanics, or as the quantity CV stays constant, as a particle's charge $Q = CV$ has the quantized value of 1e as discussed earlier. However, while an actual electron does not involve a classical oscillation of current I in time, the alternation of time that the wave function was discussed to involve, resembles an oscillation of L instead, and the magnetic flux Φ_B applies in analogy to angular momentum. In that sense we may prepare a "kinetic energy" term for a Schrödinger-like relation, having the form of (83). And that in turn, may find its place in a reduced Schrödinger-like relation of a form (84).

$$\left[-\frac{1}{2}LI^2\right] \to \left[-\frac{1}{2}\left(\frac{1}{L}\right)\left(L^2I^2\right)\right] \to \left[-\frac{1}{2}\left(\frac{1}{L}\right)\Phi_B^2\right] \to -\left(\frac{\Phi_B^2}{2L}\right) \tag{83}$$

$$\left[-\left(\frac{\Phi_B^2}{2L}\right)\frac{\partial^2\Psi_{(x,t)}}{\partial t^2}\right] = \frac{1}{2}\left[\pm i\,\Phi_B\frac{\partial\Psi_{(x,t)}}{\partial x}\right] \tag{84}$$

Substituting the appropriate derivatives of space and time (depending on the type of lepton concerned), the constituent terms may be separated (same as previously) into two equations, one involving the cosine coordinates and another involving the sine coordinates. The one of these relations would describe the spin of an electron, and the other should refer to spin of a neutrino (when that resides within a cosmic region of negative space curvature, as per material that shall be discussed in section 4.7). The right side of either of these equations appears to relate to the negative-energy magnetic field (what we may here call "anti-magnetic" field) having radial-like field lines. Due to the negative energy, this field should apply through a displacement field variant, and should therefore act as a magnetomotive potential. Any displacement affected over the field "lines" of this potential should displace over both its real portion which is radial-like, as well as its imaginary portion which is hidden from direct classical perception. Furthermore, its projection toward the real world should involve a sine coordinate of the Weinberg angle $\left(\theta_w = 30^\circ\right)$, and this is why spin takes its value of $\sin 30^\circ = 1/2$, which lets it behave as if the particle has spin magnetic moment of the quantized value of 1/2. The corresponding potential engages in the pairing of electrons in covalent bonds, which therefore appears to concern a magnetomotive type of interaction.

The same basic principle should also apply for the mechanical version of intrinsic spin, which refers to the gravitomagnetic spin moment. And, in similar terms to as the electron's magnetic spin moment was related to the spin g-factor through the negative reciprocation as per 1/(1/2) = 2, analogous reasoning appears to apply behind the spin 2 in the gravitomagnetic case. Later, in section 6, which shall discuss how this property should also concern the spin of a particle like the graviton. A corresponding set of "reduced equations" of cosine and sine terms may be prepared, of which the spin interaction should concern the equation of sines, which is imaginary at both sides. Same as with the gravitational and electric fields considered earlier, here again the right side appears to relate to a negative gravitomagnetic field having radial-like field lines. Due to its negative energy, this field should apply in the real world through a displacement field variant, and therefore behave as a gravito-magneto-motive potential. Also, its projection toward the real world should act through a sine coordinate of the Weinberg angle $\left(\theta_w = 30^\circ\right)$, letting it behave as if the particle has spin gravitomagnetic moment of 1/2. This potential gets a particle (or a collection of particles) behave much like tiny gravitomagnet(s) of which only one pole is real, and the other is hidden behind, a concept that shall be elaborated in section 5.4. That also gets to attract particles of same spin gravito-magnetic moment of 1/2, and repel ones of opposite spin.

4.5. On Bosons vs. Fermions

To address why an electromagnetic wave interacts with an electron in the form of a photon, we shall refer to an effect of wave mechanics. According to Fourier analysis, if on top of a specific frequency we superimpose lower frequencies and higher frequencies of diminishing intense, we end up with a superposition which has the form of a beat-like pulse, or "wave packet". An analogous condition holds at the elementary particle scale, as a fermion's wave function concerns a sinusoidal-type of alternation in the fastness of passing time. Such sinusoidal values over the fastnesses of passing time gets the electron perceive an electromagnetic wave of a certain frequency as a collection of electromagnetic waves of higher and lower frequencies of diminishing intense concurrently. That appears to bring an equivalent Fourier-like effect in the time-domain, which addresses why an electromagnetic wave interacts with a quantum particle as a wave-packet of energy, which refers to a boson (e.g. a photon).

A similar process accounts for the quantization of energy of a *fermion*, like an electron. A Fourier-series involves the superposition of integer (resonant) values concerning the allowed energy states of the electron. As the energy comprising the quantum particle has imaginary attributes (where that can also be traced in the reciprocal of time involved in the units of the Planck constant), the quantum oscillation needs to project to the real world through a sine coordinate of the Weinberg angle. This results to a Fourier-series which refers to a "Central Cardinal Sine Function" [12]. That is responsible for giving to a particle like an electron (as per the particle's wave nature) the properties of a fermion.

Since the exchange of energy of fermions is quantized due to a Fourier-series effect, the particle-like nature of radiation (in the form of photons) only corresponds to how a fermion perceives an electromagnetic wave, as the electron's essence involves non-single value of time fastness. When the interaction takes place with respect to single-valued macroscopic time fastness (referring to the value of the time/space metrics corresponding to point e of **Figure 1**), this gets the particle's superposition of states "land" to a specific energy state. The same reasoning behind the quantized exchange of energy should apply for the particle-like nature of all bosons.

While such a Fourier-series effect may address why an electromagnetic wave interacts with a quantum particle as a wave-packet of energy, it does not provide any intuitive clues on how it is possible for the resonant process of absorption or emission of a photon to change an electron's energy state. To seek for clues on that, we shall consider that an electromagnetic wave propagates as per the relation (85), which is more compactly expressed in (86). It is essential that these relations involve the permeability μ and the permittivity ε terms, which in turn involve inductance L and capacitance C, where those concern a phase shift in time $-\Delta t$ and $+\Delta t$ respectively. As discussed in section 3.11, during transmission of an electromagnetic wave the alternation between the displacement-electric and displacement-magnetic components comes along with an alternation in the shift in time $\pm\Delta t$. That alternating shift in time over space appears to constitute the means of the wave's step-by-step propagation, while at the same time it appears to also constitute the matching point for the exchange of energy of the electromagnetic wave with a particle like an electron, as the particle's matter-related essence also refers to an alternation in time as discussed in section 4.1.

$$\frac{\left(\frac{1}{\mu_0}\right)dB}{-\frac{1}{dt}} = \frac{(\varepsilon_0)dE}{-\frac{1}{dx}} \qquad (55) \text{ or } (85)$$

$$\frac{dH}{idt} = \frac{dD}{idx} \qquad (59) \text{ or } (86)$$

Recall that an electron's wave function arises by relating a second derivative of space to a first derivative of time. The "missing" second derivative of time gets the quantum oscillator refer to an oscillating shift in time. More particularly, the cycling term next to the Plank constant indicates that the quantum oscillator resembles a waviness of displacement momentum $\left(p_d = \varepsilon_g \, \partial\Phi_g / \partial x\right)$. And since that involves the (previously introduced notion of) gravitational flux, that makes it involve an oscillation in the time domain. The corresponding energy in that oscillation associates to the particle's matter (not the charge). In this case, the frequency matching between the alternation of the shift in time of the electromagnetic wave and the alternation of the shift in time associated to the electron's change of energy state, serves as the matching frequency for the resonant exchange of energy (emission or absorption) of the photon.

That the alternating shift $\pm\Delta t$ concerns the parameter of *time* is key for the exchange of energy to affect the electron's energy content in terms of matter (not charge). After the introduction of certain additional concepts in section 6, we shall provide additional insights on how a photon may particularly affect the electron's energy content in terms of matter. That shall be facilitated via a comparison between the nature of the photon and that of the Z^0 boson. As an early indication, a field coordinate of the Z^0 will be explained to transmit displacement-momentum (a mechanical counterpart of a "displacement-current" of electronics), and that lets this particle illusively appear as if it carried actual mass, while that may be referred to as "pseudo-mass". By symmetry, a similar process allows for the displacement-magnetic field coordinate of a photon to transmit displacement-*negative*-momentum $\overline{p}_d$ which is of opposite energy. That attribute appears to be responsible for the photon's ability to add or retrieve energy and change the energy state of an electron (and in this sense change its energy content in terms of matter). However, due to the *negative*-energy involved in that displacement process, which exhibits imaginary character in the real world, the photon behaves as a massless particle.

By extend, in symmetry to as a photon may change the energy content of the electron in terms of matter, we shall also consider that an analogous alternation of a phase shift in *space* allows for an exchange the energy in terms of charge. This shall be considered to allow for the exchange of $W^{\pm}$ bosons to affect the charge of particles produced through the Weak interaction.

We shall now purposely permit to ourselves a loose conceptual approximation on how a fermion physically differs from a boson. This is only meant as a supplementary, intuitive stepping stone to the nature of quantum particles. It may be provided through two different ways of "reading" the relation (85):

- The first way is the conventional one, where this equation describes an alternation of the displacement magnetic $(1/\mu_0)dB$ and displacement electric $(\varepsilon_0)dE$ components. Here, the amplitudes of B and E alternate, while the permeability and permittivity terms have fixed values (of phase shift in time). This condition ascribes to a Boson.
- The second way of reading (85) is completely hypothetical. We may imagine that the same equation may supposedly describe an inverse condition, concerning an alternation in the phase shift (displacement) in time, as if the equation described the alternation in the values of μ and ε, by keeping the electric and magnetic fields steady. This condition may serve as a loose conceptual approximation on what nearly-ascribes to a fermion.

This obviously concerns an oversimplification, considering that in an actual wave function, the Planck constant in the kinetic term has a power of two. And on top of that, a more complete representation of a fermion would additionally require a complementary alternation of phase shifts in space, so as to cover the particle's properties in relation to charge. That could actually lead toward formulation of classical-like equations describing the essence of a particle. Unlike Faraday's law which assumes alternating E, B and steady L, C, these classical-like equations should rather exhibit alternating L, C, L_g, C_g and steady E, B, g, T fields. The former ones would be treated as fields, and should also come in displacement-field versions L_d, C_d, L_{g_d}, C_{g_d}, involving real as well as imaginary coordinates. And unlike the conventional permittivity and permeability terms referring to $\varepsilon = C/dx$ and $\mu = L/dx$, similar terms should have an analogous form, conceptually like $\varepsilon_Q = E/idx$, $\mu_Q = B/idx$, $\varepsilon_h = g/idt$, $\mu_h = T/idt$, where the subscripts "Q" and "h" are meant to indicate versions referring to charge and matter correspondingly. Associated phase shifts of orthogonal angle could refer to the different leptons. Such notion on angles of phase shift shall be elucidated in sections 4.8 and 4.10 ahead. Actually, in relation to material that shall be discussed in section 4.10, fractional shifts involving the Weinberg angle or its multiple (equal to one-third or two-thirds of the orthogonal 90˚) shall be presented to ascribe to quarks.

On a note of significance, in contrast to the assertion that the electromagnetic and gravitational interactions are independent, it appears that either one requires the co-existence of the other, for reasons of energy balancing. This shall be further supported during the sections ahead, where we shall particularly address how a "negative-gravitational" type of field and an "anti-charge" type of field may enter the picture, ascribing to neutrinos. In this respect, the natural need for co-existence of matter and charge (in either positive or negative energy variants) within a fermion, may be treated as an "interaction" which we may refer to as a "chargo-matter" or "electro-gravitational" interaction, whose mediators are simply, the fermions.

According to concepts we have been considering this far, interactions involve extensive symmetries through a swapping between the parameters of time and space. And all those involve a waviness, as well as a loop-ness in time and space. That actually addresses issues of dimensioning that shall be discussed in section 7. The extensive symmetry between effects of time and space, also allow to quantitatively approximate numerous effects or properties through measures of energy, space, and time only. For instance:

Joules/second = units of Power (rate of doing work)

Joules/meter = units of Force (measure of action)

Joules * second = Joules/(1/second) = Joules/i second

= units of the Planck constant, ref. to quantization of matter

Joules * meter = Joules/(1/meter) = Joules/i meters

= referring to quantization of charge, as discussed in section 4.3.

Matter's quantum/length = momentum $\left(p = h/x\right)$
Charge (quantized)/time = current $\left(I = Q/t\right)$

4.6. Relativity of Momentum & of Electric Current

(a) Relativity in reference to momentum (not mass)

Momentum equals mass times velocity, but it also equals the Planck constant divided by the particle's wavelength, as per (87). In accordance to that relation, a particle that moves at certain velocity has a specific wavelength, while when it moves faster it has a shorter wavelength since h is constant, so when p increases λ should decrease.

$$p = m\upsilon = \frac{h}{\lambda} \tag{87}$$

When a particle moves at a relativistic velocity, the quantized value of h still remains constant, while the wavelength λ gets space-contracted as per the Lorentz term. This makes the particle's wavelength even shorter and this corresponds to the particle's momentum being subject to a relativistic increase. In this sense, it is the *momentum* as per the wave nature $\left(h/\lambda\right)$ that takes a primary role in this effect of relativity, not mass alone. (Much like the uncertainty principle also addresses momentum, not mass alone). While instead, in terms of the classical physics perception of momentum $\left(m\upsilon\right)$, the velocity is measured externally with certainty, and because of that we illusively attribute the relativistic change solely to mass, which may work well numerically but seems not exactly proper as the deeper effect appears to concern momentum.

The same general notion may also apply on matter's gravitational behavior and matter's inertial properties. In relation to the gravitational behavior described in section 2.1, acceleration develops due to a Doppler-like effect in time, by relaxing and releasing the gravitational potential attributed to the curvature in the metric of time. We used the example with the accelerating rocket-ship, where time "moves" slightly faster in the front part than in the rear part by a factor of

$\left(1+gd/c^2\right)$, where g is the acceleration and d is the distance between the two clocks [1]. But that factor is only good for a non-relativistic velocity, where the term υ^2/c^2 tends to zero. In a relativistic case, the difference between the clocks at the front and the rear of the accelerating object is also subject to the Lorentz term $1/\sqrt{1-\upsilon^2/c^2}$, whose presence yields a larger difference. This larger difference corresponds to a larger force, and that provides the illusion of a relativistic increase in mass.

As for the inertial behavior of matter, that was explained to impede a change in a particle's momentum (not mass alone), through the non-relativistic relation (34). Under relativistic conditions the Lorentz term $1/\sqrt{1-\upsilon^2/c^2}$ becomes involved again and increases respectively the inertial impedance, so its involvement applies as a "worsen coefficient of performance" in changing the particle's momentum p (by some analogy to as a bad coefficient of performance in electric engines increases energy consumption). This is done by increasing the imaginary coordinate of energy spent for acceleration at the expense of the real coordinate. This implies that any external potential becomes less effective in accelerating the relativistic moving particle. Since this corresponds to an increase in inertial impedance in accelerating matter, once again it is illusively interpreted as a relativistic increase in the particle's mass.

Note that the increase of the imaginary component of energy spent to accelerate a particle resembles an increase in the Weinberg angle (for the relativistic moving particle). Such change in that angle actually applies concurrently to all particles constituting a macroscopic relativistically moving object. And since it applies for all the particles of that object together, they do *not* feel the change in this angle in interaction among themselves (which could otherwise affect their properties and stability).

(b) Relativity in reference to particles' charge (in electric current)

Considering that the above holds for matter, symmetry would require for an analogous effect of relativity to apply on charge. According to existing theory, when a charged particle moves at a relativistic velocity, there is no relativistic increase on charge. While this statement is not wrong, it does not provide the full picture.

When a current-carrying wire accelerates to a relativistic velocity, its charge does not increase, but the wire's length gets contracted [13]. This contraction brings a higher density of charges, since the length of the current-carrying wire is now space-contracted while it still carries the same charge. This is equivalent to the (contracted) wire now carrying more current. This relativistic increase in current is analogous to the relativistic increase in a particle's momentum (due to the relativistic contraction of its wavelength), and that makes the effect of relativity in electronics to be symmetric to the effect of relativity in mechanics.

This symmetry may also be approached in terms of curvature in time. For charge Q that flows in the form of current I, it holds $I=Q/t$ (just like for matter it holds $p=h/\lambda$). In a relativistic context the quantized value of the charge Q of an elementary particle like an electron remains constant, but time t gets time-dilated, and that decrease brings the equivalent of a relativistic increase in current I. (This is just like in the mechanical case the quantized value of h remains constant but λ gets space-contracted so the momentum p increases). Furthermore, time dilation similarly applies in increasing the electromotive potential which would impede the change in current. The conventional Equation (26) which describes this potential is only good for non-relativistic cases, while under relativistic conditions the Lorentz factor has to be added upon, which affects a relativistic increase in impedance.

As per the above, the laws of relativity should be considered to apply symmetrically for both matter and for charge. In either case, length or/and time becomes contracted or dilated by the Lorentz factor of $1/\sqrt{1-\upsilon^2/c^2}$, so what changes is the *charge density* or the *effective density of matter* as per the particle's wave nature, and that yields a relativistic increase in current and momentum correspondingly. Such notion serves in bridging quantum nature (wave nature of matter and charge) with the theory of relativity. Note that in both cases, the relativistic increase applies only toward the direction of motion, since the velocity in the transverse direction is zero hence there is no relativistic effect there. This comes to support the requirement of 3 dimensions of time (just like the 3 dimensions of space), which was introduced in section 3.5(b) and shall be further referred to in section 7(c).

4.7. Association of the 4 Leptons to the Signs of the Time & Space Metrics

Figure 1 schematically illustrates that the time metric and the space metric may also take negative values over large regions at the cosmic scale. We shall now explore what consequences this brings on the nature of elementary particles inhibiting each of these regions. We shall focus only on leptons, as hadrons are composed of quarks which constitute a more complex case which shall be addressed later, in section 4.10. Since we are dealing with two metrics (time and space) and each of them may have two signs (positive and negative), there are four possible combinations of parameters:

(i) Positive Space & Positive time (The Electron)

This refers to the cosmic region between points *b* and *f* of Figure 1, which identifies to the part of the universe that we live in. In this region, an electron's matter wave may be obtained through the Schrödinger equation which relates a second derivative of space $\left(\partial^2\Psi/\partial x^2\right)$ to a first derivative of time $\left(\partial\Psi/\partial t\right)$. As introduced in section 4.3, a corresponding waviness in relation to this particle's charge may be approximated through a Schrödinger-like equation that relates a second derivative of time to a first derivative of space. Speaking of leptons, this type of cosmic region constitutes stable habitat for electrons. Antiparticles like the Positron are unstable in this region, in relation to the Feynman-Stückelberg interpretation which associates antiparticles to (living in) the negative direction of time

[2]. According to the new model, the negative direction of time concerns an opposite sign of energy. And when a positron is created in a region where time moves in the positive direction, then the abundance of electrons in its vicinity makes the positron vulnerable in finding an electron of same energy in positive time, and annihilate together. Furthermore, neutrinos and antineutrinos may not reach particle form in positive space curvature, as shall be discussed shortly.

(ii) Positive Space & Negative time (The Positron)

This refers to the cosmic region between points *a* and *b* of **Figure 1**, where the time metric has negative values, while the space metric is still positive. In compliance to the above-mentioned Feynman-Stückelberg interpretation [2] [14], the new model proposes that such kind of cosmic regions constitute stable habitat for antimatter particles, like the positron. Atomic and molecular formations in that region should therefore consist of antimatter (e.g. having their nuclei surrounded by positrons instead of electrons). Other than that, interactions should be just like the ones in our own cosmic region, where causality applies ordinarily (but in a world made of antiparticles).

In this region, a particle's matter wave may be obtained through the Schrödinger equation which relates a second derivative of space $\left(\partial^2\Psi/\partial x^2\right)$ to a first derivative of NEGATIVE time $\left(\partial\Psi/\partial(-t)\right)$, with that describing the positron. In terms of gravity, antimatter may be considered forced to accelerate as per $dx/d(-t)^2$, instead of the "conventional" gravitational acceleration dx/dt^2. But since these two terms are equivalent $\left[dx/d(-t)^2\right]=\left[dx/dt^2\right]$, antimatter particles respond the "usual" way to an external gravitational field, and are gravitationally attractive just like conventional matter is. Furthermore, it similarly applies for the inertial properties of antimatter, since a change in momentum of antimatter is resisted in the same way to as a change in momentum of conventional matter (re. relation (34)).

In accordance to what was described in section 4.3 in reference to a particle's charge, the positrons charge should be approximated through a Schrödinger-like equation that relates a second derivative of NEGATIVE time $\left(\partial^2\Psi/\partial(-t)^2\right)$ to a first derivative of space $\left(\partial\Psi/\partial x\right)$. At this point we may recall that in section 3.3 we introduced the "raw" units of an electron's electric field to refer to [sec/meter^2]. In the case of a positron, the negative direction of time would have the corresponding raw units refer to [(−sec)/meter^2]. Here the negative sign accounts for an electric force pointing in the opposite direction, and this complies to the charge of the positron being opposite to that of the electron.

In that cosmic region (between points *a* and *b* of **Figure 1**) the electrons should be unstable and should have short half-life, for same reason as positrons are unstable and have short half-life in our own classical region (between points *b* and *f* of **Figure 1**). The reason is that the curvature of negative passing time applies as an opposite sign of energy (and respective potential), and two entities formed in opposite energies have the natural tendency to cancel out their potentials. If an electron gets created in a region of negative time (between points *a* and *b* of **Figure**

1), the abundance of positrons in its vicinity makes the electron vulnerable to find a match with a positron of same energy in negative time, and annihilate together. Furthermore, in this cosmic region neutrinos and antineutrinos are still unable to reach particle form, because space curvature is positive.

Cosmic regions of negative time and positive space may have any size ranging from extremely large, to extremely small. Large cosmic regions should exist at various spots the distant universe, as will be described in section 5.1. A small region may concern even a single positron, which behaves much like a small island of negative time among positive time we live in. The large regions are stable as their particles are not in immediate proximity to electrons so as to interact and annihilate together. In section 5.2 we shall also address the reason why there is less antimatter than matter in the universe.

(iii) Negative Space & Positive time (The Antineutrino)

This refers to the cosmic region between points *f* and *g* of **Figure 1**. Such regions should be understood to exist outside a black hole's event horizon, at the left of point *g* (as point *f* refers to a surface outside the black hole, at either side of which certain effects are predicted to have their forces pointing in opposite direction) [4]. In such a region *f*-*g*, a particle's matter wave may be obtained through the Schrödinger equation relating a second derivative of NEGATIVE space to a first derivative of positive time. This applies as if the equation of Cosines (63) were imaginary and the equation of Sines (64) were Real, and that describes "imaginary" matter. In such conditions of negative space and positive time, it is not feasible for conventional matter to reach particle-form, for same reason that neutrinos may not reach conventional particle form in our classical region of positive space. We shall translate the notion of imaginary matter to refer to "*negative matter*", which is fundamentally different to antimatter (since antimatter constitutes "positive" form of matter). Existing theory often associates negative matter to anti-particles [15]. In the contrary, the new model identifies negative matter as the matter of neutrinos and antineutrinos, where that may take actual form only in the negative metric of space, and associates such sign of matter to the negative solutions to the relativistic Dirac equation (instead of associating those solutions to antimatter particles). According to this notion, the negative energy solutions of the Dirac equation should refer to neutrinos and antineutrinos, not to antimatter particles like the positrons (as per current practice).

Conditions prevailing at the particular region between points *f* and *g* of **Figure 1** may also find partial match to existing theory concerning the existence of an ergosphere outside a rotating black hole [16]. Existing theory predicts a frame dragging effect to take place in that region, according to which, objects within that sphere should appear to move faster than the speed of light to an external observer. While such velocity is not plausible for conventional matter, this limitation may be overcome if the space metric has negative value, in which case the particles that reach particle-like form within this region are the "antineutrinos", as the present model suggests. These particles should have the cosine coordinates of its wave function being imaginary and the sine coordinates being real (with respect to our point of view), and this inversion ascribes to a particle that should interact superluminally within the corresponding cosmic region. While instead, the antineutrinos and neutrinos should exhibit imaginary essence in our own cosmic region (of positive metric curvature), which does not allow them to take ordinary form and interact gravitationally with conventional matter, neither to exhibit inertia, thus they appear to us as being massless.

In alignment to the above, any notion of "time travel" or even "plain travel" of conventional matter through that region of negative space is non-feasible, since conventional matter may not take form. And if conventional matter was created in that region during a high-energy interaction, it would almost instantly decay.

Similarly to as it holds for matter, it should likewise apply for charge. In relation to what was described in section 4.3, the particles of such region should have a form of charge which may be approximated through a Schrödinger-like equation that relates a second derivative of positive time to a first derivative of NEGATIVE space. That refers to an unconventional type of "imaginary" charge. For particles that reside *within* this region (stable antineutrinos, and short-lived neutrinos), this type of charge should behave same as ordinary charge does in our own cosmic region. With respect to our own perception however (of the real world of positive time and positive space), such charge may not take actual form. We shall refer to that type of imaginary charge as "*anti-charge*", and assign it as being the "charge" of antineutrinos. Neutrinos in turn, have opposite sign of "anti-charge", as they reach stable form in regions of opposite direction of time, to those of the antineutrinos. We shall elaborate on the electric-like field of such "anti-charge", which shall be referred to as "anti-electric field" in the next section (and along with that, in the corresponding "negative-gravitational" field of such particles). The introduction of these fields has implications to the theory of the Weak Interaction, which shall be described in section 6. Among else, it arises that "anti-charge" appears to mediate the "neutral currents" of the electroweak interaction. The introduction of these fields also has implications in astrophysics, which shall be discussed in section 5.

<u>(iv) Negative Space & Negative Time (The Neutrino)</u>

This refers to the cosmic region to the right of point *g* until the left of point *a* of **Figure 1**, considering that the figure's axis forms a hypothetical loop. Such type of regions should be understood to exist at the far distant universe, or behind a black hole's event horizon, as per the loop-ness through negative space which shall be elaborated in section 5.1. In this cosmic region, a particle's matter wave may be accounted through the Schrödinger equation relating a second derivative of NEGATIVE space to a first derivative of NEGATIVE time. That condition refers to "imaginary" matter (negative matter) that comes along with opposite so-called "anti-charge" to that of antineutrinos (due to the change in the metric of time). It therefore refers to the matter-essence of "neutrinos", which should reach stable form within this region. Neutrinos should be considered negative-energy particles (a sort of "negative-matter monopoles") that may appear and interact in our real classical world only in very limiting cases of interaction at the border of the velocity of light. Actually, while the negative metric of space gets neutrinos to travel superluminally within their region of cosmic habitat, they would not be able to interact with conventional matter unless they slightly cross the border from negative-to-positive energy (in order to interact in positive metric curvature). This is the reason why only left-handed neutrinos are found to interact in our cosmic region, due to their marginally lower energy which allows them to interact in the classical side of the universe. In the next section we shall introduce how the gravitational-like and electric-like fields of neutrinos associate to the weak interaction. Since these fields are of negative energy, they should also damp out quickly in positive space, and become evanescent in close range within the classical region (much like electromagnetic waves in evanescent modulation damp out quickly in the real world).

Same as previously, neutrinos' "imaginary charge" may be approximated through a Schrödinger-like equation that relates a second derivative of NEGATIVE time to a first derivative of NEGATIVE space. That refers to the above-mentioned "anti-charge", which has unconventional properties. Particles that reside at that cosmic region (the neutrinos) should interact with each other in the same way as electrons interact with each other in our own classical cosmic region. However, with respect to our own perception (in the real world of positive space) such charge may not take actual form, and constitutes "imaginary" charge, for similar reason that neutrinos' negative matter may not take actual form in out classical region of positive space. We shall refer to the imaginary charge of neutrinos as "*negative anti-charge*" type, which concerns opposite sign of "anti-charge" to that of antineutrinos. That again, has implications in the theory of the Weak Interaction as this type of charge mediates the so-called "neutral currents" of the electroweak interaction.

While that particular cosmic region constitutes natural habitat for neutrinos, antineutrinos should also be possible to take particle form there but with short half-life, for same reason that positrons have short half-life in our own classical region. In the other hand, while negative space constitutes natural habitat for neutrinos and antineutrinos, it is not feasible for conventional matter (e.g. electrons) to take actual particle form in that region (for same reason that neutrinos may not take actual form in out classical region of positive space). Obviously, this condition also prohibits any possibility of travel of conventional matter in that region too, since it should instantly decay.

Same as previously discussed, a cosmic region of negative space and negative time may either be very large (e.g. of cosmic scale), or as small as a tiny local spot (e.g. housing a neutrino). In either case cause-and-effect conditions apply regularly upon the particles of the region. Yet, this is done solely with respect to the negative direction of time (without "positive" time being involved in parallel for purposes of observational measurement). It is just that only neutrinos are stable in that region, and would be surrounding atoms' nuclei (similar to as electrons do in our own cosmic region). Furthermore, if an antineutrino is created in that region, it should soon interact with a neutrino to annihilate together.

4.8. Lepton's Fields, of Positive & Negative Metric

(a) Gravitational Field of Positive & Negative Matter

In section 2.2 we described that each gravitational field "line" of a material object (either a celestial body or a microscopic particle) forms a hypothetical loop. The portion of the loop referring to the curvature of positive time (over positive space) corresponds to what we directly perceive of an object's gravitational field, while the portion of the loop describing negative curvature of time (over negative space) is not directly perceivable as it has imaginary character. Then, in section 4.7 we introduced the notion of "negative matter", where that should have a gravitational field associated with it. We may look into that through **Figure 3**.

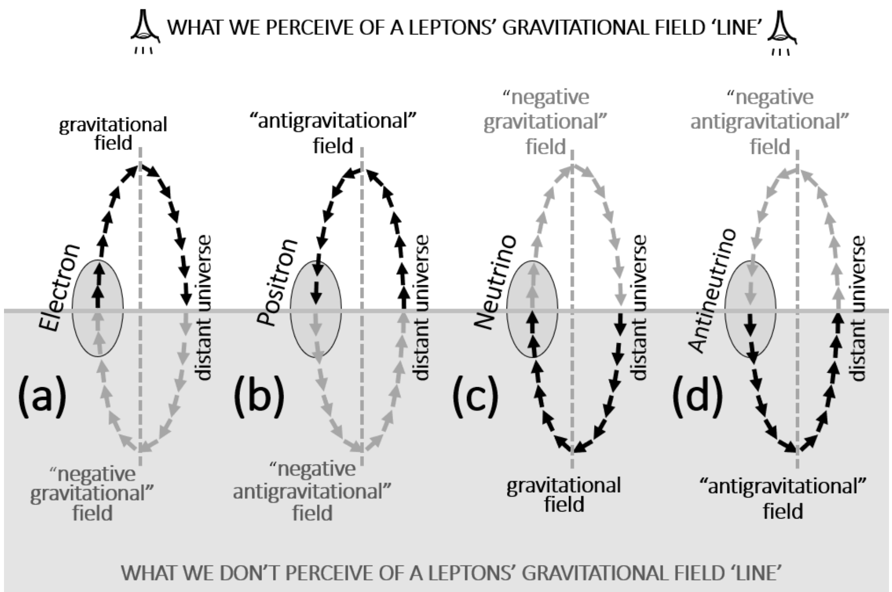

Figure 3. Positive time metric portion (black arrows) and negative time metric portion (grey arrows) of a single gravitational field "line" of an electron (a) and the other leptons (b), (c), (d), from a hypothetical "side-view".

This figure schematically depicts a hypothetical "side-view" of a gravitational field line (e.g. representing the trail of curvature of time) of each of the four leptons, the electron (figure's part a), the positron (part b), neutrino (part c), and antineutrino (part d). The shape and size of each particle drawn is only schematic, and does not have any sort of reference to shape or size of an actual particle. Let us comment on the gravitational field of each of the leptons, as follows.

<u>The electron:</u>

The illustrated gravitational field "line" of an electron (part a) is meant to follow the curvature of the metric of time. The further away from the particle time moves faster and faster, and this is represented by the black arrows pointing upward.

Then, after a certain range in mid-distant universe time starts passing slower and slower, and this is represented by the black arrows pointing downward. At some point at the very distant universe the field line reaches a node, beyond which the time moves in the negative direction, and that is represented by the respective grey arrows which let the field "line" continue through the negative time portion until completing the hypothetical loop back to the particle. The portion drawn in grey color has non-classical nature (with an exception near the nodes but that will be addressed in section 4.9), and that restricts it from direct classical perception. A point of attention is that the nature of this negative field portion resembles the gravitational field that the neutrino (part c) exhibits toward the real world, since the neutrino possesses "negative matter" which may not take actual form in the classical world.

The existence of the lower portion of the field loop (grey arrows), also implies the existence of an imaginary "negative-matter" pole of the electron, hidden under (behind) the electron's real matter pole. Since this pole is imaginary, it does not have conventional physical essence, however, we should treat it as a "hidden" pole, and not as a "non-existing" pole, the reason being that under certain conditions the imaginary pole may interact with other imaginary field portions, so that the two imaginary entities may yield a negative real result, as we shall consider in the next section. According to that notion, even though with respect to the real world the electron appears to be a gravitational monopole, it actually corresponds to a hypothetical dipole, of which we directly perceive only the real (positive matter) pole. This is the reason why the electrons (and other leptons) are schematically drawn elliptical in Figure 3, so as to graphically represent the notion that the electron has two poles, the real one (upper part of the schematic ellipse) and the imaginary (lower part of it).

Furthermore, as the figure indicates, the gravitational field "line" extends all the way toward the distant universe, until it reaches a point where time turns from positive to negative (where arrows turn from black to grey). In relation to material that shall be presented in section 5.1, that nodal point at the distant universe behaves as an "opposite" gravitational pole (not shown in the figure), which shall later be described to have an association to an opposite gravitational monopole. In relation to this notion, a vertical dashed line has been drawn in the figure, to split the gravitational field loop into two halves, of which the left half allocates to the electron, and the right half allocates to that opposite distant pole (to be clarified more specifically, ahead).

The positron:

It similarly holds for the other leptons. In the case of the positron (part (b) of Figure 3), a similar loop is drawn to illustrate the same form of hypothetical "side-view". The upper half of this loop represents the portion of a gravitational field "line" which is real (black arrows). Here the arrows are shown to point in opposite direction (anticlockwise), where that is only meant to graphically represent the opposite direction of time that applies for antimatter particles (in alignment with the aforementioned Feynman-Stückelberg interpretation).

The lower portion of the loop is again in grey color as it has non-classical nature which makes it hidden from direct classical perception. Here again, this field portion resembles the nature of the gravitational field that an antineutrino exhibits toward the real world (part (d) in the same figure). And that imaginary portion of the field line implies the existence of an imaginary pole hidden "behind" the real pole of the positron.

Furthermore, in relation to material that shall be presented in section 5.1, the nodal point at the distant universe where arrows turn from black to grey shall be described to resemble an opposite gravitational pole (not shown in the figure). Hence, the drawn vertical dashed line is meant to allocate the gravitational field loop into two halves, of which the left half ascribes to the positron and the right half to the distant pole (and particle) correspondingly.

<u>The neutrino:</u>

Just like the positron resembles an electron in negative direction of time, the neutrino resembles an electron of the negative space metric. Such condition provides to the neutrino imaginary characteristics, which prohibit it from taking particle-like form in the real world. It does however take particle-like form in cosmic regions where the space metric (as well as the time metric) have negative values, like to the left of *a* and to the right of *g* of **Figure 1**, within which it behaves much like an electron does in our own cosmic region, as described in the previous section.

In terms of gravitational field, the inversion of the parameter of space gets the "negative-gravitational" field of a neutrino to be imaginary to the real world. This is why the upper part of gravitational loop in part (c) of **Figure 3** is illustrated in grey arrows, instead of black. Same as previously, a neutrino may be understood to form a hypothetical dipole. The pole which projects toward the classical world is imaginary (upper part of the schematic ellipse), and the pole which projects toward negative space curvature is the real pole. This implies that in the cosmic regions of negative space metric (referring to the negative antinode of the Space curvature of **Figure 1**) neutrinos reach actual particle-like form, and attract each other gravitationally, same as electrons (and positrons) do in our real world. Furthermore, the particular node at distant universe where arrows turn from grey to black, resembles an opposite gravitational pole (not shown).

<u>The antineutrino:</u>

Likewise, the antineutrino is same as a neutrino but refers to (living in) opposite direction of time. This is graphically represented by the field arrows drawn to point in the opposite direction. In this sense, it resembles a "positron of negative space metric". This condition provides to the antineutrino imaginary characteristics which prohibit it from taking particle-like form in the real world. It does however take particle-like form in cosmic regions where the space metric has negative values, like in regions between points *f* and *g* of **Figure 1**.

In terms of gravitational field, the inversion of sign of the parameter of space gets the gravitational field of a neutrino to be "imaginary" in the Real world. This is why the upper part of the gravitational field "line" (in part (d) of Figure 3) is illustrated in grey arrows, instead of black. The "negative-gravitational" field of the antineutrino is real in cosmic regions of negative space metric, this is why the lower part of the figure is illustrated with black arrows, instead of grey (as the inversion of the parameter of space turns the field to real). Same as previously, an antineutrino may be understood to form a hypothetical dipole, of which the pole which projects toward the classical world is imaginary (upper part of the ellipse), and the pole which projects toward the negative space metric is the real pole. This also implies that in cosmic regions of negative space metric, antineutrinos have actual particle-like form, and attract each other gravitationally, same as positrons and electrons do in our real world. Antineutrinos also attract neutrinos gravitationally, just like electrons gravitationally attract positrons, since they are both made of same sign of matter (both negative). Furthermore, the node at the distant universe where arrows turn from grey to black resembles an opposite gravitational pole (not shown), as shall be elaborated later, in section 5.

(b) Electric Field of Charge & "Anti-Charge"

Similar conditions to those of the gravitational field, apply for the electric field as illustrated in Figure 4. The field arrows here represent the curvature in the metric of imaginary space (instead of the curvature in the metric of real time of the gravitational case).

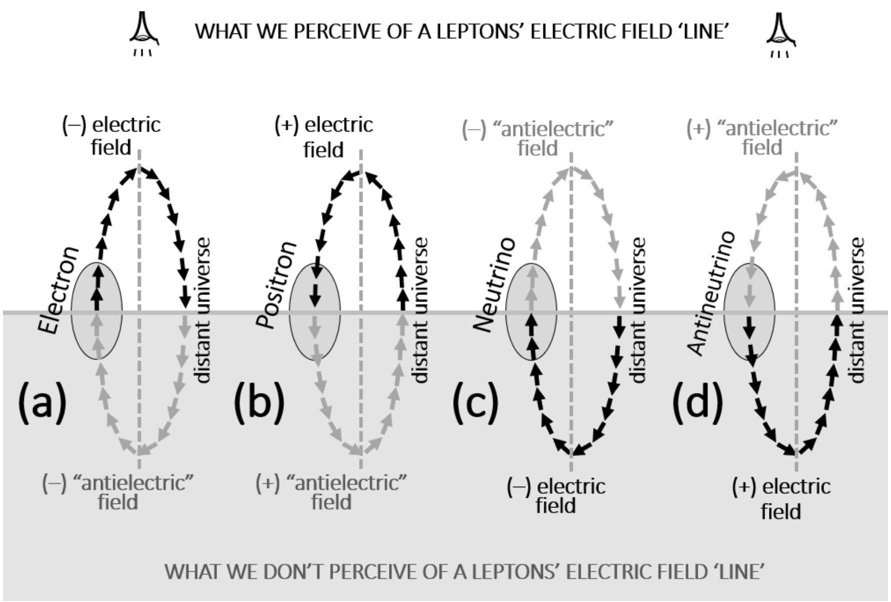

Figure 4. Positive metric portion (black arrows) and negative metric portion (grey arrows) of an electric field "line" of an electron (a) and the other leptons (b), (c), (d), from a hypothetical "side view".

<u>The electron:</u>

In reference to the electron (part (a) of Figure 4), the upper half of the field's loop depicts the real portion of the electric field, which extends radial-like (much like the gravitational field does in Figure 3). The lower part of the field's loop, in turn, depicts the imaginary portion of the electric field (grey lines) which refers to what we have referred to as an "anti-electric field" (in place of the "negative-gravitational field" of the gravitational case). This again implies that the electron is a hypothetical electric dipole, of which we directly perceive only the real pole (schematically represented by the upper part of the drawn particle). The lower pole (graphically represented as the lower part of the drawn particle) is correspondingly a "negative anti-charge" pole, hidden under the real pole. And similarly applies for the electric field of the other three leptons:

The positron:

The positron (part (b) of **Figure 4**) corresponds to a hypothetical dipole of which the real pole (upper part of the drawn particle) ascribes to this particle's positive electric field (black arrows). The opposite direction of arrows (anticlockwise) is meant to graphically indicate the opposite direction of time (in alignment with the Feynman-Stückelberg interpretation) which associates to this particle's essence. The imaginary pole (lower part of the drawn particle) ascribes to the imaginary positive "anti-electric" type of field (grey arrows). The electric force properties of the positron are similar to those of the electron, meaning that two positrons repel each other, while a positron and an electron attract each other. Furthermore, positrons (same as the electrons) may not reach form in regions of negative space metric (just like neutrinos may not reach form in the world of positive space metric where we live in).

The neutrino:

The neutrino (part (c) of **Figure 4**) is a particle that may reach form only in regions of negative space metric. This particle corresponds to a hypothetical dipole, of which the classical-world's pole (upper part of the drawn particle) has imaginary essence, which means that it may not reach actual particle form in positive space. This pole exhibits an "anti-electric" type of field (grey arrows), which is also imaginary. The real portion (lower part of the drawn particle) exhibits toward space of negative metric, and has a "negative anti-electric" type of field (black arrows) which takes form only in cosmic regions of negative space. Regarding the electric force properties of a neutrino, these depend on the cosmic region where the particle resides (as it also holds for the other leptons too). For a neutrino residing in a cosmic region of negative space metric, electric forces are similar to those of the electron in the positive space metric, meaning that two neutrinos repel each other, while a neutrino and an antineutrino attract each other. Neutrinos' electric properties appear imaginary with respect to the electric properties of electrons and positrons, so they hardly interact with these particle, except in limiting conditions that shall be described below.

The antineutrino:

The anti-neutrino (part (d) of **Figure 4**) also concerns a particle that may take form only in regions of negative space metric. Such a particle corresponds to a hypothetical dipole of which the classical world's portion (upper part of the drawn particle) exhibits an "anti-electric" type of field (grey arrows), while the other portion (lower part of the ellipse) exhibits a real positive electric field (black arrows). Regarding the electric forces of an antineutrino, these depend on the cosmic region where the particle resides (as it also holds for the other leptons too). For an antineutrino residing in a cosmic region of negative space metric, the electric forces are similar to those of an electron in our region, so two neutrinos repel each other, while a neutrino and an antineutrino attract each other. Antineutrinos' electric properties appear imaginary with respect to the electric properties of electrons and positrons, so they hardly interact under ordinary conditions.

As per the above, the following assumptions can be made:

(i) All leptons possess matter, either of positive sign (the electron and the positron) or negative sign (the neutrino and the antineutrino). For the latter two, the matter pole is imaginary with respect to the classical world, this is why neutrinos and antineutrinos do not exhibit properties associated to mass, either gravitational or inertial. Likewise, all leptons possess charge, either conventional charge (the electron and the positron) or what we referred to as "anti-charge" (the neutrino and the antineutrino). For the latter two, the charge's pole is imaginary with respect to the classical world, so they do not exhibit the properties associated to charge (like electric or electromotive). An exception holds for negative-energy reaction potentials that may leak energy toward the real world, as shall be discussed ahead.

(ii) According to what was described in previous sections, the gravitational field refers to the curvature of the metric of time, and the electric field refers to the curvature of imaginary space. It was also stated that time and space are orthogonal entities, meaning that either one is imaginary with respect to the other. This orthogonality brings an associated orthogonality in terms of which fields we may directly perceive in the real world:

In the classical world we directly perceive positive matter and positive antimatter (e.g. electrons and positrons), but we do not perceive negative matter and negative antimatter (e.g. neutrinos and antineutrinos). While instead, in terms of charge we directly perceive an orthogonal combination, namely, we directly perceive negative and positive charge (e.g. electrons and positrons), but we not perceive negative and positive "anti-charge" (e.g. neutrinos and antineutrinos).

(iii) A point of significance is that, just like the flow of charge, or a change in electric field generates a magnetic field, and just like fluid flow of matter or a change in effective gravitational field generates a "gravitomagnetic field", it similarly holds with respect to the flow of so-called "anti-charge" or a corresponding change in "anti-electric" field, as these conditions generate an "anti-magnetic" type of field. For cosmic regions constituting each particle's stable habitat, the "anti-magnetic" field should obey very symmetric relations to the ones described by Maxwell's equations. As for the classical world we live, such "anti-magnetic" field appears to interact with the imaginary portions of a lepton's wave function, and produce real reaction potentials, as the negative magneto-motive and gravito-motive potentials which were described earlier. Examples concern the potential that powers the operation of the electric battery (described earlier in section 3.6(a)) as well the potential that powers exergonic bio-chemical reactions which power life (described in section 3.6(b)). After an introduction of certain additional concepts, in section 5.6 we shall also address how the negative-gravitomagnetic field causes a long-range force that plays a key role in galaxies' rotation curves, shedding much light in relation to the notion of dark matter.

(iv) The "anti-electric" field $\overline{E}$, the "anti-magnetic" field $\overline{B}$, the "negative gravitational" field $\overline{g}$, and the "negative gravitomagnetic" field $\overline{T}$ in their displacement-field versions appear to have particular association to the field components of the weak interaction, which shall be discussed in section 6.

(v) That all the leptons possess matter as well as charge (either in positive or in negative energy), also applies for quarks, as shall be considered in section 4.10, and that allows to generalize this statement for all fermions. That fermions possess both matter and charge is actually needed for reasons of energy balancing, as matter concerns an effect of time and charge concerns an effect of imaginary space, so either one is imaginary with respect to the other. This co-existence, not only allows for the corresponding energies in the time and space domain to counterbalance each other, it also allows for all fermions (of positive and negative energy) to be in co-existence in the universe without a prerequisite of an initial supply of energy (e.g. from some external source, or from some other universe). Therefore, in contrast to the conventional assertion that the gravitational and electric properties do not interact with each other, it now appears that the two interactions need to co-exist and are tightly correlated to each other. As previously mentioned, that allows to even speak of a "gravito-electric" (or, "mattero-charge") interaction, whose mediators are the fermions.

4.9. Phase Shifts in Reaction Potentials

Figure 3 and **Figure 4** have been illustrating either the gravitational field OR the electric field. The former refers to the curvature of time, while the latter refers to the curvature of imaginary space. Other than the fact that either of these two fields holds imaginary with respect to the other, the question of "what is imaginary" also concerns the reference viewpoint: For instance, with respect to the world of mechanics the electric field corresponds to a curvature of "imaginary space", while with respect to the point of view of electronics, it corresponds to a curvature of "real space" (not imaginary space). On top of this, while any field "line" (e.g. a gravitational OR an electric one) follows its trail in forming a hypothetical loop, this trail appears to pass through change of sign of both the metrics of Time as well as Space (e.g. as the trail follows along the loop-like axis XX' of **Figure 1**). To cope with that, we shall here be speaking of "plain" (e.g. not imaginary) time and space.

If we were to draw a schematic trail of a field line's hypothetical loop, and incorporate the change of signs of both the time and the space metrics in the same 2-dimensional figure, we would need to involve two axes, at an angle to each other.

This is so, as (in relation to the illustration of Figure 1) the nodal points of time do not match the nodal points of space, due to the phase shift between the curvatures of time and space (earlier described to refer to the Higgs field that permeates spacetime). So, throughout the hypothetical (loop-like) trail of a generic field "line", the axis referring to space and the axis referring to time should have an angle between them, of value matching the Weinberg angle of 30°. That is schematically depicted in Figure 5, which illustrates a field "line" (loop of drawn arrows) that passes through areas where both space and time are positive, (arc b - f), or only space is positive (arc a - b), or only time is positive (arc f - g), or both space and time are negative (arc g - a). Also, since this particular field line drawn here is generic (purposely not specifying if it concerns a gravitational or an electric field), the "arrows" are only schematic without a tight particular meaning. Actually, instead of all arrows having the same direction (either all clockwise or counterclockwise), an alternative depictional option has been chosen here, where the arrows have a specific direction (inclination) from the particle until almost halfway to distant universe, and an opposite direction (inclination) from there, until the very distant universe. This is nothing more than a different representational option.

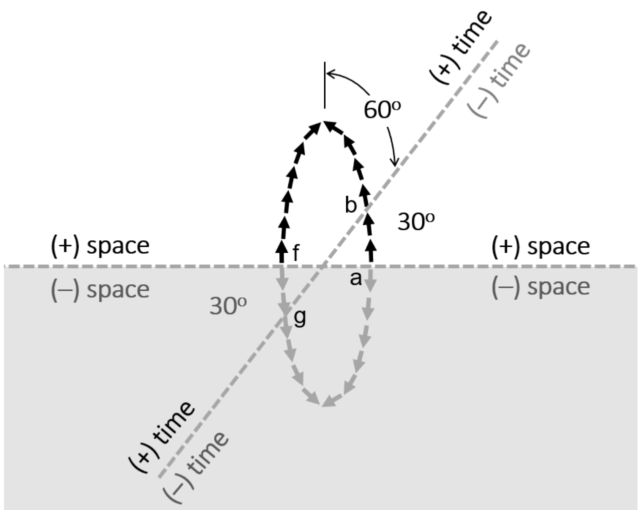

Figure 5. Generic field "line" (loop of black and grey arrows), passing from areas of positive and negative values of the Time and Space metrics, where the Time and Space metrics have a phase shift between them, of 30 degrees.

In relation to what was described earlier, we may not directly perceive a field portion through negative space (shaded area in Figure 5), as that portion has imaginary characteristics. A point of significance in relation to what was discussed in section 3, however, is that the non-perceivable field portions are possible to interact with the imaginary portion of a fermion's wave function, and yield a real negative outcome as per the relation $i^2 = -1$. In fact, it appears that the displacement-field variants of the imaginary field portions are extensively involved in our everyday life in the form of reaction potentials, through inductive-born and capacitive-born effects. For instance, they constitute the field variants which were described (in section 3) to be involved in inertial impedance, in the electromotive impedance, in vortex fluid flow, and in Lenz's law, while it similarly applies with the fields involved in the powering of the electric battery, or the powering of exergonic bio-chemical reactions. As these effects involve field portions that reside in opposite energy in each case, they appear to engage through their displacement-field versions which apply through a sine (or cosine) coordinate of a phase angle. For the quantum mechanical, and certain classical mechanical cases, that angle typically concerns the Weinberg angle.

Furthermore, in the gravitational interaction the phase shift develops in space, while in the electric interaction the phase shift develops in time. In both interactions, the phase shift may be of either inductive, or capacitive character, with a corresponding displacement potential being generated in each case. The existence of a phase shift in the gravitational interaction, and more particularly the deep symmetry of that to the electromagnetic interaction, allow to address the inner-working of a large number of mechanical effects, from the very small to the very large scales. This includes the interactions described in section 3, as well as effects at astrophysics scale which shall be described in section 5, addressing points like the abundance of matter over antimatter, spiral galaxy rotation curves, and more.

4.10. On the Nature of Quarks

So far, we have discussed the proposal that leptons (like the electron) have a real portion (referring to equations (63) and (79)) and an imaginary portion (referring to equations (64) and (80)). In association to those, we may consider the electron to constitute a hypothetical dipole, of which only the one pole has real essence, while the other is a virtual pole that does not take real form. And, due to the existence of the phase shift between the curvatures of time and space at the cosmic scale, the negative energy fields of the virtual pole were explained that is possible to engage (as coordinates) in effects of reaction as per the relation $i^2 = -1$.

It turns out that the phase shift between the curvatures of the metric of time and the metric of space also allows for an additional form of oscillation, involving the Weinberg angle (30º) in a different way. In particular, this phase shift of time curvature (with respect to space curvature) allows for an oscillation in time which "dives" into negative curvature by that angle. And the same phase shift from the reference point of space curvature (with respect to time curvature) allows for an oscillation in space that dives into negative curvature by that angle too. In such case, 1/3 of the particle (referring to 30˚ out of the orthogonal 90˚) resides in the positive space metric, and 2/3 resides in the negative space metric. The corresponding particle is no longer behaving as a lepton, and appears to obtain the properties of a quasi-particle, which corresponds to a quark. The fractional properties of such quasi-particles do not meet the requirements for reaching particle-like form on their own. They may however reach stable form if they combine with other quasi-particles, in a way that allows them to collectively satisfy basic quantization criteria.

Not any angle of phase shift can allow formation of particles of this type. It appears that the conditions of resonance which may reach stability refer to the Weinberg angle of 30˚ (being equal to one third of the orthogonal 90º) or the angle of 60˚ (which equals 90˚ minus the Weinberg angle). When such an angle of phase shift is affected on the particle's charge, a same degree of phase shift should deploy over space in affecting the fermion's electric field. As in section 4.3 we associated the right side of a particle's reduced equations (81) to a particle's electric field, here the phase shift appears to apply upon the particle's electric field "lines", shifting them by the Weinberg angle along the radial direction (the direction of the field's "graphical arrows"). Notice an analogy to the voltage-current phase shift in electric circuit oscillations, but now developing over space, and in the radial direction, since a particle's electric field is radial-like. Such radial-like phase shift (displacement) of the fermion's electric field is fixed (not oscillatory), since the fermion's electric field is fixed.

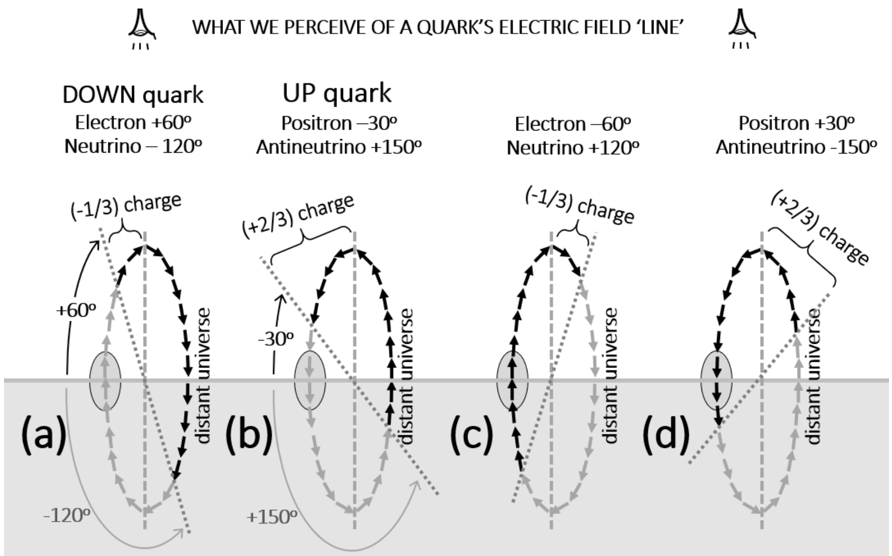

Figure 6. A phase-shift of a particles' electric field (black arrows) along the field "arrows" by ±30˚ or ±60˚ resembles transforming a lepton to a Down quark (a) or an Up quark (b) correspondingly, while other phase-shift angles may be considered (c), (d).

Since the particle's electric field is phase-shifted radially in space, this brings the consequence of a portion of the particle's electric field to become imaginary, and concurrently a part of the particle's so-called "anti-electric" field portion (associating to the particle's corresponding hidden "anti-charge" pole) to displace toward the real side of the world. This lets only a fraction of the particle's (phase-shifted-forward) electric field to project to (and be able to exert forces in) the classical world, while the remaining portion has become imaginary. The particle to which this fractional electric field (and charge) ascribes, refers to a quark.

The described phase shift applies on both electric and magnetic properties of a particle, but it is more apparent in radial-like fields like the electric, or the intrinsic magnetic, as the field "arrows" have been phase-shifted radially outward/away or inward, by a fixed amount. The concept of the shift (fixed displacement) on an electric field "line" is schematically illustrated in **Figure 6**. Note that the same basic characteristics described here for the electric field, should apply for the gravitational field as well. However, in that case there are additional effects of impedance that affect the particle's inertial properties, which shall be noted below.

As previously described, the portion of an electric field line which ascribes to a particle concerns the part at the left of the vertical dashed line. And from that, only the upper half (the upper-left quadrant) projects to the classical world of positive space, while the lower part (the lower-left quadrant) may reach real projection only in cosmic regions where the space metric has negative values.

In part (a) of **Figure 6**, the black arrows (which represent the electric field of negative charge) are now schematically shown to be phase-shifted clockwise (forward) by ($90^\circ - 30^\circ =$) 60°, leaving only 1/3 of the real electric field effective (black arrows at the upper-left quadrant), ascribing to a value of charge equal to $Q = -(1/3)\mathrm{e}$. This is so, since only 1/3 of the black lines are visible from "above", which represents the portion perceived in the real classical world. While the remaining grey arrows at that quadrant represent the so-called "anti-charge" which the particle should also possess (and concerns an imaginary field variant, so it does not constitute ordinary charge with respect to the real world). Notice also, that the same formation may alternatively arise by a counterclockwise (backward) phase shift of a neutrino by minus 120º. The resulting particle formation may be characterized to refer to 1/3 of an electron (black arrows) and 2/3 of a neutrino (grey arrows) at the upper left quadrant. Since only a net charge of value −1/3 e has real essence (while the remaining portion concerns −2/3 of "anti-charge" which is imaginary to the classical world), the corresponding particle refers to as a down quark.

Likewise, in part (b) of **Figure 6** the positive electric field "arrows" relate to those of a positron that have been phase-shifted clockwise (backwards) by –30º, leaving only 2/3 of the field active (black arrows at the upper-left quadrant), ascribing to a value of charge +2/3 e. The rest of the arrows (grey arrows at that quadrant) correspond to "anti-charge" (which is imaginary). Notice that the same formation may alternatively arise by a counterclockwise (forward) shift of an antineutrino by +150˚. The resulting particle formation in these cases can be characterized to refer to 2/3 of a positron (black arrows), and 1/3 of an antineutrino (grey arrows). This carries a net charge of value +2/3, and corresponds to an up quark.

Note that alternative formations of same value of net charge (either –1/3 or +2/3) may also arise as shown in the parts (c) and (d) of **Figure 6**. However, in these formations the partial real electric field (black arrows) seems to lie at the upper-right quadrant (at the right side of the vertical dashed hypothetical line). That appears to ascribe to the field of the "other pole" (toward the distant universe), so in a first reading such formations may not refer to a conventional quark of our classical universe. However, they could engage in effects of opposite energy, as per the field portions at the lower-left quadrant in their depiction. Such portions might also engage in interactions that play a role in the confinement of quarks into stable composite particle formations, that shall be referred to ahead.

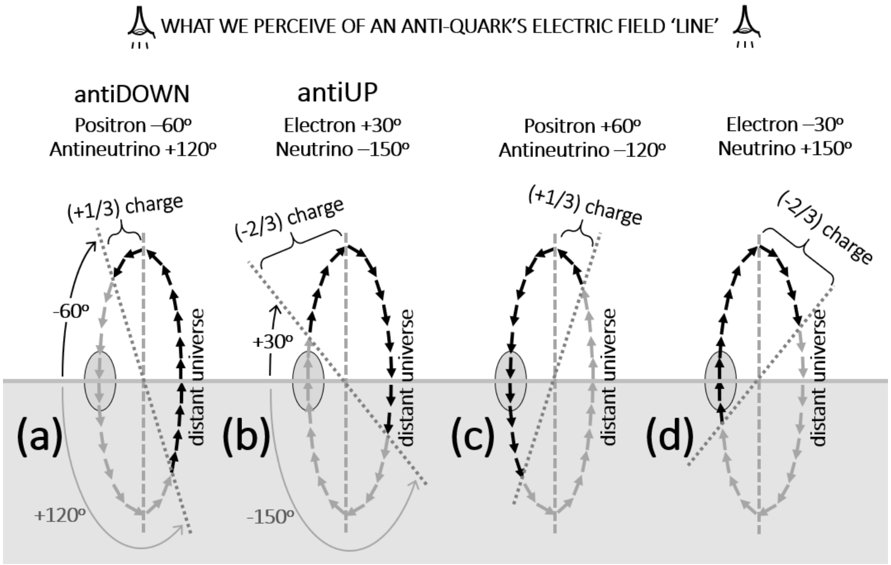

Figure 7. Relevant schematic representations concerning an anti-down quark (a), an anti-up quark (b), and other phase-shift angle considerations (c), (d), from a hypothetical "side view".

Similar type of phase shifts may allow for the existence of quarks of opposite charge, which would therefore be referred to as "antiquarks", as illustrated in Figure 7. For instance, a positron whose electric field is shifted backward (clockwise) by 60˚ or an antineutrino shifted forward (counter-clockwise) by 120˚ would refer to a particle of charge equal to +1/3 e, as shown in part (a) of Figure 7. Likewise, an electron whose electric field is shifted forward (clockwise) by 30˚ or a neutrino shifted backward (counterclockwise) by 150˚ would refer to a particle of charge −2/3 e, as shown in the depiction at the part (b) of the same figure. Here again, alternative formations of same value of net charge may arise (of either +1/3 or −2/3) as shown in the parts (c) and (d) of Figure 7. But in these formations the partial real electric field (black arrows) seems to lie at the upper-right quadrant (to-the-right of the vertical dashed hypothetical line). So that again appears to ascribe to the field of the "other pole" (toward the distant universe) thus in a first reading such formations may not constitute conventional quarks in our classical universe, however such particle should still interact in effects of opposite energy through the field portions at the lower-left quadrant of their depiction.

The existence of quarks in a particle-like assembly (form) is subject to conditions of quantization as well as avoidance of annihilation, as follows:

Quantization: Since quarks partially dive into negative energy, their fractional properties may not meet certain quantization criteria on their own, and this prohibits their existence in nature as isolated particles. Such criteria seem to be similar to those of leptons, and may only be met by quarks collectively if they combine with each other.

For a lepton like an electron, energy is quantized as per the Planck constant h, however due to the phase shift of the metric of time with respect to the metric of space, the corresponding energy needs to project to the real world through a sine coordinate of the Weinberg angle. Since $\sin 30^\circ = 1/2$, the value of an electron's lower energy state refers to $\frac{1}{2}h$. Recall that the quantization of energy was previously attributed to a Fourier-series effect affected in the time domain. In the case of the electron, such a Fourier-series concerns the superposition of integer values that allowed energy states of the electron have. As the corresponding oscillations are imaginary to the real word, they project toward the real world through a sine coordinate of the Weinberg angle. This gets such a Fourier-series to refer to the "Central Cardinal Sine Function", giving to the electron the properties of a fermion as noted in section 4.5. In terms of an electron's charge, the quantized value of energy similarly comes through a Fourier series attributed to a sinusoidal-like waviness in the curvature of imaginary space, to which charge was referred to correspond in section 4.3. But since that oscillation already concerns the metric of space, it should not need to project on positive space through a coefficient of 1/2. Hence, the quantized value of charge equals the integer value of ±1e.

Quarks instead, have charge values of ±1/3 e or ±2/3 e, which are non-integer values. Nature provides a way to overcome this limitation when combining more than one quarks together, as it holds in the formation constituting a proton or a neutron. According to theory, a proton is composed of two "up" quarks (symbol "u") each having charge +2/3, and one "down" quark (symbol "d") having charge −1/3. So the proton corresponds to a "uud" particle, of charge 2/3 + 2/3 − 1/3 = +1e, which in this way may satisfy the integer-charge requirement. Likewise, a neutron is composed of one "up" quark and two "down" quarks, making up for a "udd" of charge 2/3 − 1/3 − 1/3 = 0. Similar conditions to those of quarks apply for antiquarks. In particular, the antidown, antistrange, and antibottom, have a value +1/3 e. A point of interest is that since the "anti-" quarks are supposed to have opposite charge, one could put in consideration if the up, charm, and top quarks are in-a-way "antiparticles", since they carry "positive" charge (of +2/3e). However, such consideration may be void as the distinction between regular quarks and "antiquarks" should rather refer to which ones ascribe to the classical side of the world.

According to all the above, each quark refers to 1/3 of one lepton of positive energy and 2/3 of another lepton of negative energy, or vice versa. Therefore, a quantitative description of the quantum oscillator concerning a quark, should concern a linear combination of Equations (63) and (64) with regard to matter (or their reduced versions like (72)), as well as a linear combination of (79) and (80) with regard to charge (or their reduced versions like (81) and (82)). Actually, each of those components seems to have engagement in the strong interaction, as shall be considered ahead in section 7.

With regard to its energy in terms of matter, a quark similarly dives partially into negative energy, and its gravitational field should be subject to an analogous phase shift as the one described for the electric field. That the quarks, when combining into baryons, have by far larger mass than an electron, may be attributed in part due to a different-than-the Weinberg angle inductive-like phase shift that quarks' nature should involve (to be referred to in section 7), and in another part, as it involves the contribution of the gluons, which seem to exhibit impedance characteristics through a symmetric process to the one that the Z^0 shall be discussed to exhibit an effective mass (to be discussed in section 6).

Avoiding annihilation: While electrons and positrons may reach particle form in the positive space metric, and neutrinos and antineutrinos may reach particle form in the negative space metric, quarks appear to live in both the positive and negative metrics concurrently. The part in the positive space metric is crucial to their existence in the real world via combining with other quarks, while the part of the negative space metric is likely to have its field components contribute to the strong interaction. A question that arises, is why protons (which carry positive charge) are stable particles, while positrons (which also carry positive charge, and are truly elementary particles) are not stable in our own cosmic region, since they quickly annihilate.

The reason that this is happening appears to be that the positrons live under negative energy in time (in alignment with the Feynman-Stückelberg interpretation discussed earlier), so the cosmic region where they should reach stable form corresponds to the region between points *a* and *b* of **Figure 1**. As discussed earlier in this section, when a positron is created in our own cosmic region (between points *b* and *c* of that figure), it is vulnerable to match the energy of its quantum oscillation in time with same energy of opposite sign (of an electron), and annihilate together. In the other hand, quarks have a portion to concern conventional matter and another portion to concern negative matter (which ascribes to neutrinos, not positrons). That does not only involve an inversion in the sign of time (as it holds for antimatter) it additionally involves and inversion in space (as that holds for the negative matter of neutrinos). These two inversions of sign together, bring that portion of the quark back to positive energy, and that removes grounds for annihilation to take place. Instead, it allows for fields from either sign of the space metric engage in interactions toward the opposite metric. To translate that to a loose electronic analogy, interaction between quarks appears to apply as supposedly having Lenz's law and Faraday's law taking place concurrently, through the fractional fields coordinates of quarks. The portion of quarks in positive energy have their gravitomagnetic potential act at very short range (since it quickly becomes evanescent in the real world). This prohibits quarks from interacting with quarks that lie further away (like in neighboring composite particles), and this limits their range of interaction to stay between the quarks of the same composite particle. In the contrary, the portion of quarks in negative energy seems to engage in long-range interactions, with implications in astrophysics which shall be addressed in section 5.6.

5. Implications in Astrophysics

5.1. Cosmic Regions & Their Particle Inhabitants

In Figure 1 we described that the curvatures of the Time metric and the Space metric follow a characteristic waviness at the cosmic scale, which involves values in the positive metric as well as in the negative metric. Even though that schematic representation in that figure has a simplified form, it clearly illustrates the waviness of space and time curvatures, as well as a loop-ness associated with it, considering that the right end of the hypothetical horizontal axis was discussed to loop back to re-attach at the left end. This model is obviously an oversimplification, as the actual universe rather looks as a sea of waves with larger and smaller antinodes. It does however explain the core concept behind what holds at the cosmic scale. The same notion is illustrated here in Figure 8, part (a). The positive and negative combinations of Time and Space curvatures allow for the existence of 4 cosmic regions:

Region *b*-*f*, housing electrons: The type of region between points *b* and *f* refers to places where both time and space have positive values, like in the classical world we live in. According to what was described in section 4.7, leptons that may reach stable form in such region concern the ones possessing conventional (positive) matter, which refers to electrons. Celestial bodies in this region comprise of conventional atoms and molecules whose nuclei are surrounded by electrons. In our celestial neighborhood (referring to point *e* of the figure), the inclination of the time curvature gets the gravitational force attract celestial formations toward a black hole, in the direction referring to points *d*→*f*. In the other hand, celestial bodies located at the far distant universe (for example in a region near point *c*) are subject to an opposite inclination of the time curvature, and that results to these bodies being attracted outward and away in the direction *d*→*b*, with that seemingly constituting the key reason of the observed accelerated expansion of the universe, without a requirement for dark-energy or a cosmological constant. That the observations suggest the expansion is "accelerated", is because the closer to point *b* (coming from point c) the steeper the slope of the time metric curvature as may be seen in Figure 8, part (a).

Region *a*-*b*, housing positrons: The type of region between points *a* and *b* refers to any regions or spots in the cosmic waviness where the time metric has negative values, while the space metric still has positive values. According to the present model, a place where time passes in the negative direction has nothing to do with interactions progressing as in a "motion picture run backward". It corresponds to a place where interactions follow causality, while negative time simply allows for *antiparticles* (like the positron) to reach stable form. This also implies that celestial bodies in such region are made of atoms and molecules whose nuclei are surrounded by positrons (instead of electrons).

A corresponding cosmic region may not house celestial bodies made of conventional atoms and molecules involving electrons, as these particles would have short half-life and would disintegrate. In terms of gravity, antimatter is attractive to matter (as antimatter constitutes "positive" form of matter), so material (or celestial) objects in such region should attract each other. However, due to the opposite inclination of time curvature in that region, celestial bodies should be attracted in the direction referring to points $a \to b$. Such celestial bodies should look much like conventional celestial bodies do. They should be traced in astrophysical observations indicating gravitational attraction in that direction due to the opposite inclination of curvature. Furthermore, due to such curvature, light coming from those bodies is predicted to have opposite index of refraction, in fact, corresponding indication of celestial objects constituted of antimatter is documented to exist, on the basis of such property of light having a negative index of refraction, observed via telescopes with concave lenses [17]-[18].

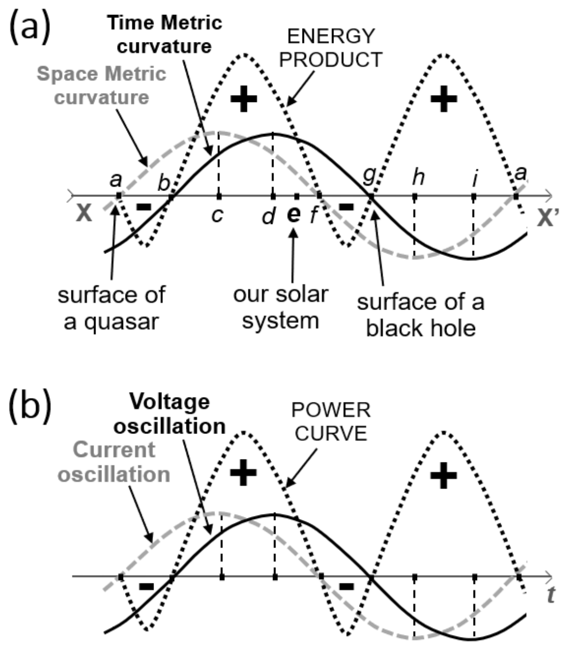

Figure 8. Waviness of energy/power, exhibiting large positive antinodes and small negative antinodes, in electronics (b) and in gravity/mechanics at the cosmic scale (a).

On a side-note, other than the large regions where time passes in the negative direction, it is also possible for very small spots of negative time to form within our classical region. For instance, when a positron comes into existence in our own cosmic region through a particle-antiparticle pair production, it constitutes (all by itself) a small spot of negative energy in time; like a miniscule *a*-*b* region or tiny "island" of negative time, within our cosmic region of positive time metric. When the region is that small, however, then the surrounding area of positive time applies as an opposite potential that does not constitute a favorable place for such an antimatter particle to maintain in existence, as discussed earlier.

Region *g*-*a*, housing neutrinos: The type of region between points *g* and *a* refers to spots in the cosmic waviness where both the space and the time metrics have negative values. According to what was described earlier, such spots should constitute natural habitat for neutrinos, where these leptons should reach conventional particle-like form (same as electrons do in our own cosmic region). Antineutrinos should also be possible to reach particle form there, but they would have short half-life as they would quickly annihilate (same as positrons do in our classical world). In such region, electrons and positrons should exhibit imaginary attributes so they should not reach particle form at all (just like neutrinos do not reach conventional particle form in our own classical habitat). Celestial bodies of such region have to be made of atoms and molecules whose nuclei are surrounded by neutrinos (instead of electrons), behaving as electrons do in our region, possessing negative "anti-charge" type which behaves as conventional charge with respect to their own region of negative space metric, and exhibits a conventional-like negative electric field as depicted in **Figure 4**, part (c), LOWER half. Quarks in that region should also have a portion in negative and a portion in positive energy, forming corresponding baryons. (The particular values of baryon's "anti-charge" shall be addressed later, in **Table 1**).

Neutrinos in that region should electrically repel each other since they have same "anti-charge" type (just like electrons repel each other in our cosmic region). In terms of gravity, these particles refer to "negative matter", and possess negative gravitational field type, which also behaves as a conventional field with respect to the negative space metric as depicted in **Figure 3**, part (c), LOWER half. And they should be attracted to any other negative matter particles (e.g. neutrinos or antineutrinos) in that region. According to the present model negative matter (like neutrinos) is repulsive to conventional positive matter (like electrons), however these two signs of matter do not co-exist in conventional particle-like form in nature, since the region of each one's habitat does not conventionally allow for the other to reach particle-like form. Exceptions apply at marginal relativistic conditions along the involvement of the weak interaction, like during supernova explosions which shall be discussed in section 5.3.

Celestial bodies that match these characteristics should exist at the distant universe, and their surface should be associated to point *a* as that is "viewed" from its right side (re. **Figure 8**, part a). These regions seem to correspond to distant celestial objects of unconventional characteristics, like the quasars. In such sense the surface (event horizon) of quasars appears to correspond to point *a* of **Figure 8** (as viewed from its right side). Notice that inside quasars, neutrinos and antineutrinos should behave like electrons and positrons do in our region, while outside those regions neutrinos and antineutrinos exhibit imaginary essence.

Such celestial formations constitute habitat for "negative matter", which should repel away conventional matter, as was referred to in section 2.1 (condition 3). However, conventional (positive) matter may only exist outside these celestial formations (to the right of point a), since positive matter may not reach particle form inside them, as already explained. Celestial formations of negative matter should exist in regions of the universe where observations reveal repulsive gravitational effects, especially in cases which repel away celestial content at seemingly superluminal velocity [19]-[20]-[21]. Current theory attributes such velocity to illusive effects of relativity that develop close to the line of sight. However, superluminal velocity should constitute an ordinary feat for particles of negative matter (e.g. neutrinos), as per their imaginary attributes.

Region *f-g*, housing antineutrinos: The type of region between points *f* and *g* refers to cosmic spots where the space metric has negative values, so particles in that region should possess negative matter and "anti-charge". And, since the time metric has positive values, these particles' "anti-charge" should have "positive" sign. In relation to what was described earlier, such spots should constitute natural habitat for anti-neutrinos, which should reach stable particle-like form in that region. Neutrinos should also be possible to reach particle form in that region, but would have short half-life as they would soon annihilate (like positrons do in our classical world). In such a place, electrons and positrons should exhibit imaginary attributes so they should not reach particle-like form (like it holds for neutrinos in our own classical habitat). Celestial bodies of such region have to be made of atoms and molecules whose nuclei are composed of negative matter baryon variants (whose "anti-charge" values are addressed later, in **Table 1**) and are surrounded by antineutrinos (instead of electrons).

Anti-neutrinos in that region should electrically repel each other (like electrons repel each other in our cosmic region). In terms of gravity, these particles refer to "negative matter", which is attracted to other negative matter (antineutrinos, or neutrinos) in that region. Here again, negative matter is repulsive to conventional matter, however these two signs of matter do not co-exist in nature, since the region of each one's habitat does not allow the other to reach particle form (with an exception in marginal relativistic cases involving the weak interaction, like in supernova explosions which shall be addressed in section 5.5). Celestial bodies that match these conditions should reside in regions like rotating black holes' ergospheres, or in transitional high-energy celestial explosions.

The above description on what holds in all of these cosmic regions leads to a definite assumption that "time travel" (or any travel) of conventional material objects (e.g. rockets or observers) is not feasible in the metrics of negative time or negative space, as their matter will disintegrate, either quickly (where time runs negative) or almost instantly (where the space metric has negative values). However, tunneling interactions which involve negative-energy displacement-field variants are possible, as in the effect of entanglement which shall be referred to in section 7(d).

5.2. Reason of Abundance of Matter over Antimatter

Existing theory does not explain the abundance of matter over antimatter. It turns out that this may be figured through a parallel to the theory of LC circuits in electronics. The part (b) of **Figure 8** illustrates an oscillation of voltage (black curve), an associated oscillation of current (dashed grey curve), and the power curve (doted curve) which concerns the product of voltage times the current. When the oscillations of voltage and current are subject to a phase shift between them, either inductive or capacitive, then power exhibits oscillatory behavior, as depicted in the dotted power curve. During the time the oscillations of voltage and current have both positive or both negative value the power is positive, while during the time that either one of the voltage or current is positive and the other is negative, the power is negative. Provided that the voltage-current phase shift is less than 45º, then the power curve exhibits larger positive and smaller negative parts (antinodes).

It similarly applies in gravity/mechanics. As discussed earlier, the curvature in any metric concerns a potential, for instance the curvature in the metric of time refers to a gravitational potential, while the curvature in the metric of space refers to a negative gravitomagnetic potential (to be discussed in section 5.4) while in section 5.5 this curvature shall also be associated to an "anti-electric" type of potential. Likewise, the curvature in the metric of imaginary space refers to an electric potential (a voltage). The energy product of space and time curvatures, depicted by the dotted curve in **Figure 8** part (a), has a deep symmetry to the power curve in electronics. This symmetry is not by coincidence, and concerns the symmetry between the electric and gravitational interactions presented in this manuscript. Just like the oscillation in voltage brings an oscillation in current, the waviness in the metric of time (e.g. the gravitational potential) brings along motion (change in momentum), where that generates a gravito-magnetic potential, whose density associates to the curvature of space. And while in electronics an inductive or capacitive phase shift concerns a shift backward or forward in time, in the gravitational/mechanical case the phase shift corresponds to a shift in space, as illustrated in **Figure 1**.

In electronics, when the power curve has positive values (which happens when the oscillations of voltage and current have both positive or both negative values) energy is transferred from the capacitor to the inductor. While, when the power curve has negative values (when either one of the voltage or current is positive and the other is negative), this means that energy is transferred from the inductor back to the capacitor. In the gravitational/mechanical case instead, the phase shift between the wavinesses of the time and the space metrics deploys over space. In such case, instead of an alternation in the flow of energy in time (which holds in electronics), in gravity/mechanics there is a change in energy accumulation in different forms of matter (matter or antimatter, of positive or negative matter-sign) with respect to the spatial waviness at the cosmic scale. More particularly, when the energy product of the time and space curvatures has positive values (which happens when both curvatures have positive, or both have negative values) this condition refers to energy accumulation (existence of particles) of positive energy product, like electrons (when in positive space) or neutrinos (when in negative space) [22]. While, when the energy product of the time and space curvatures has negative values (which happens when either curvature has positive values and the other has negative values) this condition refers to existence of particles like the positron (when in positive space) or the anti-neutrino (when in negative space).

Since the phase shift between the curvatures of Time and Space corresponds to the Weinberg angle 30˚ which is less than 45˚, this has the result that the positive antinodes have larger area than the negative antinodes. That in turn, signifies accumulation of more energy in the form of matter (atomic formations where nuclei are surrounded by electrons, conglomerating in conventional celestial bodies) than in the form of antimatter (atomic formations involving positrons, conglomerating in celestial formations of anti-matter), and that explains the abundance of matter over antimatter in the classical universe. By extend, the same condition also signifies the accumulation of more energy in the form of negative matter (atomic formations involving neutrinos, conglomerating in quasars) than in the form of negative antimatter (formations involving antineutrinos) in the parts of the cosmos where the space metric has negative values.

The above model predicts the existence of cosmic regions where celestial bodies are composed of antimatter particles. These regions and celestial bodies should be significantly lesser than those housing conventional celestial bodies, because the Weinberg angle is less than 45˚. Regions with such celestial bodies composed of antimatter shouldn't appear much different than regions of conventional positive matter that we have all around us. And they should be ordinarily visible in the sky. Indication or evidence of celestial objects of antimatter is already available and relies on the prediction that light from that region should have a negative index of refraction, so it would be possible to observe by telescopes with concave lenses [17]-[18] [23]. By same reasoning, there should also be more quasars in the universe (which are composed of negative matter) that celestial formations composed of negative antimatter.

5.3. Cause of the Weinberg Angle

Just like in electronics the positive values of the power curve concern transfer of energy from the capacitor to the inductor, and the negative values of the power curve concern transfer of energy from the inductor to the capacitor, a somewhat similar process takes place in the context of mechanics, and concerns energy transfer in effects of action and reaction between opposite metrics.

In the theory of electronics, an inductive phase shift (a lag in time) of the current oscillation with respect to the voltage oscillation arises due to an inductive "load". The concept of a "load" is more clear in the theory of operation of AC electric engines. Electric engines have coils, which turn the rotors via the magnetic force. In reaction to such force, a voltage-current phase shift in time develops, which transfers instantaneously a reaction to the electric powerline and suppresses the efficiency in delivering work as explained in section 3.7. Such shift in the oscillation of current is met in industrial facilities where electric motors exert forces in delivering motion. A similar inductive shift is affected by the coils even in the absence of mechanical action caused by a magnetic force. This is so as coils get charges to move cyclically, and that bends their magnetic field, making the magnetic field "lines" denser inside the coil and less dense outside of it. That difference in density corresponds to a potential, and that potential is reacted through displacement-electric action mediated by the electromotive potential as explained in section 3.8. That effect of reaction generates an inductive phase shift between the oscillations of voltage and current, which is conveyed instantaneously to the electric source and all other circuit elements. That shift again splits energy in two coordinates, a real and an imaginary, of which the imaginary consumes energy without delivering work, therefore suppressing the efficiency of the source. A similar process takes place in the case of a capacitive phase shift. That shift is conventionally treated as a phase lead of the current oscillation with respect to the voltage oscillation, while it may seem more rational to treat it as a phase lag of the voltage oscillation with respect to the current oscillation. In summary, it turns out that forces (like the magnetic and its associated potential) are causing a phase shift, which in turn generates reaction potentials which involve negative energy displacement-field variants.

A symmetric process applies in gravity-mechanics, and associates to the inductive-like phase shift in the metric of Space with respect to the metric of Time as illustrated in **Figure 1**, or in **Figure 8** part (a). As per the swapping of parameters of time and space between the gravitational and the electromagnetic interactions, here the phase shift develops over space (instead of over time which was the case in electronics), and arises in reaction to forces that apply in all cosmic regions illustrated in **Figure 1** or in **Figure 8** part (a), including the sum of mechanical and quantum mechanical forces (like the gravitomagnetic and its associated potential), at all scales. Their existence, from small scale like the atomic, to medium scale as in vortex flow, to large scale like in galaxy rotation (to be discussed in section 5.5), is responsible for the development of the reaction phase shift between the curvatures of time and space, which has been previously described to associate to the Higgs field that permeates spacetime at the cosmic scale. This shift is responsible for the existence of negative energy effects of reaction, like the inductive-like impedance which dresses matter with inertia (in symmetry to inductive impedance in electronics).

According to the new model, the value of the phase angle between the curvatures of Space and Time (referring to the Higgs filed) corresponds to 30˚ (the 1/3 of 90˚) which equals the Weinberg angle. As described in section 3.7(b), the particular value in terms of degrees of angle may be indirectly verified through older quantitative predictions [4] of the existence of a surface outside a black hole's event horizon, at a distance of 1.5 times the radius of the black hole, at either side of which surface, the centrifugal force points in opposite directions. The new theory re-interprets this surface as a Space node (point f in **Figure 1**). The location of this nodal surface at 1.5 the radius of the black hole (or 50% of the radius away) is also re-interpreted as a phase shift of 30˚ (the 1/3 of the orthogonal 90˚) which matches the Weinberg angle.

This specific angle is crucial since it brings stability between particles and interactions. If that angle had a different value, it would not be possible for quarks to exhibit the charge of (±1/3)e or (±2/3)e as explained in section 4.10, so as to be able to combine with each other in forming stable nuclei. And leptons like the electron would not have the quantized value of spin 1/2 (where 1/2 refers to the Sine of 30˚), which is key in electron pairing as in the functioning of chemical bonds (e.g. in organic compounds) as described in section 3.12. So, it is this angle that lets particles reach into formations, and by extend it lets matter and charge co-exist in a way that the energy in either one nulls the energy of the other, so nature may exist without need for any external supply of energy (e.g. from some another universe). In fact, according to these concepts, this model does not require a big bang, as energy may have always been there in a sea of waviness, where energy involved in effects of space nulls energy involved in effects of time, while the curvature of the Time and Space metrics at the cosmic scale also accommodates the observed expansion of the universe. In fact, matter in existence rotating in celestial formations seems to be of as much abundance as required for forces in nature to get the (inductive-shift-like) Weinberg angle to have the particular value.

An interesting question is whether it's the cosmic waviness of the metrics that dictates the housing of particles per region, or if it is the particles that dictate the waviness. It turns out that since either of these two affects the other, they could only go together concurrently, and in balance. After all, that is what allows for the total positive and the total negative energy in the cosmos to sum up to null, making it plausible for the cosmos to exist without any need for external supply of energy, and without the need for the existence of a "cosmological constant".

5.4. Fields/Poles at Large Scale

In section 2.2 we considered that a gravitational field concerns the curvature of the metric of time, as schematically illustrated through the curvature of the Time metric in Figure 1 (or in Figure 8, part a). This means that a single gravitational field "line" of a celestial body (or of a single elementary particle constituent of that celestial body), follows a trace of time passing faster and faster the further away from the body, while after some distant point the slope changes and time starts passing slower and slower, until reaching a node beyond which time turns negative. That however doesn't specify what exactly holds at that distant nodal point/surface where time changes sign.

Should this model imply that there exists some form of immense sphere (like an event horizon) far out at the very distant universe, which corresponds to a nodal point b of Figure 1, beyond which time passes negative? And if so, would distant galaxies be gravitationally attracted "radially outward and away" in the direction $d \rightarrow b$ toward that immense spherical-like surface causing the observed accelerated expansion of the universe? And supposedly that holds for a distant surface which refers to point *b* of **Figure 1**, should there be another, even larger cosmic spherical-like surface that corresponds to the nodal point a, beyond which the metric of space also turns negative?

It turns out that this whole picture may only serve as a rough, initial approximation. A radial-like field "line" indeed follows the way toward the distant universe, at some distant point the slope of its inherent curvature changes sign, and eventually reaches a cosmic range where it "dives" in to an opposite-signed metric of time or of space respectively through a nodal surface (event horizon). The other side of a node in Time constitutes an ordinary habitat for antimatter or an ordinary habitat for negative matter respectively for the other side of a node in Space. Furthermore, the more the contents of any such region, the more stable this region would be, as otherwise the existence of very little contents would have their antiparticles being more vulnerable to engage in annihilation effects. Indication or evidence of celestial objects constituted of antimatter is reported to exist, relying on the prediction that light from that region should have a negative index of refraction, which is observed via telescopes with concave lenses [17] [18] [23]. Likewise, a considerable number of celestial regions of negative matter should exist toward all directions throughout the universe, which may apply as "negative matter poles" whereupon gravitational field "lines" of material particles on earth would eventually "land" upon. These therefore play a role, as if an "opposite pole" to each gravitational monopole on earth is spread away toward negative matter existing out in the universe (referring to point *a* of **Figure 8** part (a)). According to this notion, therefore, the "other end" of "all field lines" of a particle's gravitational field "coming out" of earth does not reach to a specific immense nodal sphere at the very distant universe. Instead, they may reach up and "land" to different celestial regions at different depths (distances) away from earth.

This new notion requires to re-affirm how the universe is subject to an accelerated expansion due to an outward gravitational force. It seems that the far more abundant matter (conventional matter) in the universe, with respect to the lesser amount of anti-matter (as discussed in section 5.2), allows for the dominance of opposite inclination of the curvature of the Time metric to reach far away toward most directions in distant outer space. The lesser amount of antimatter in the universe may conglomerate in celestial spots/regions at various distance and directions, giving to the cosmic fabric of Time curvature the shape of a "sea of waves". Yet, the far larger amount of (conventional) matter in the universe sufficiently allows for the overall curvature of Time to reach deep toward the very distant universe, with the associated gravitational field attracting celestial matter outward and away, in what we perceive as the accelerated expansion of the universe.

The above concept does not apply under the same exact way for electric field lines. While in our cosmic region we directly perceive only positive matter (since both matter and antimatter constitute "positive" sign of matter), we perceive both signs of charge, positive AND negative. Celestial objects in our cosmic region typically have an almost equal amount of negative charge (in their electrons) and positive charge (in their protons), so they are electrically neutral. This grossly implies (for reasons of intuition only) that all electric flux coming "out of" electrons equals the electric flux reaching into protons. In relation to that, a celestial body like earth does not exhibit a net charge, whose electric field "lines" would have otherwise needed to go all the way toward a distant celestial body comprised of antimatter. And likewise, a celestial body supposedly made of antimatter would similarly have the electric flux that "comes out" of its atoms' positrons to end up to the anti-protons composing their nuclei, so such celestial bodies should be neutral too.

There is however, a different way that the electric interaction mimics the gravitational at the celestial scale, in the sense that the net electric properties at the scale of a planet or a star do not cancel out. That relates to the electric properties of quarks. As explained previously, each quark resembles being much like 1/3 of an electron and 2/3 of a neutrino or vice versa. This means that each quark should carry both charge as well as what we described as "anti-charge" as previously discussed. A proton comprises of one "up" and two "down" quarks, so in this sense it is a udd particle, thus the total charge it carries corresponds to −1/3 +2/3 +2/3 = +1e. But at the same time, the proton carries "anti-charge". The amount of such "anti-charge" that each of its quarks carries can be estimated through reference to **Figure 6**, by the grey arrows contained in the upper-left quadrant of each quark drawn. From there, it arises that each proton carries "anti-charge" of −2/3 + 1/3 + 1/3 = 0. This tells that the electrons and the protons completely balance out their electric potentials, since (other than balancing-out their negative and positive charges) they possess no other net potential in carrying any "anti-charge". However, a different condition holds for the neutrons of the nuclei. A neutron is a uud particle. So it carries a net charge of −1/3 − 1/3 + 2/3 = 0, meaning that it is electrically neutral. But at the same time, the neutron carries "anti-charge" of −1/3 + 2/3 + 2/3 = +1 $\overline{e}$. This tells that *each neutron constitutes an "anti-charge" monopole*. Considering that in a celestial body like earth the nuclei of atoms have neutrons (and not antineutrons), this implies that earth (and in this respect, any other conventional celestial body in our cosmic neighborhood too) constitute "anti-charge" monopoles. In that sense, the "anti-electric" field lines of a celestial body like earth, go all the way "radially away" until finding a node on some other celestial body at the distant universe (much like the gravitational field lines were described to do).

This is a point of significance, as we had previously described that the electric field associates to the curvature of negative reciprocal space (imaginary space). It now appears, that the "anti"-electric field directly associates to the curvature of positive space. In other words, just like the curvature of the metric of time around a celestial body directly associates to its gravitational field, *the curvature of space around a celestial body directly associates to this body's "anti-electric" field* (which is a negative energy field so it does not yield direct force on conventional charges). According to that description, earth corresponds to an "anti-electric" monopole. And in relation to that, the closer to earth, the more contracted space is. By same token, the further away from earth the more stretched-out space becomes, but only up to a certain range, and then space starts to become more and more contracted again as we reach toward a quasar. It is the same type of effect that we previously described for the curvature of time, now applying for the curvature of space.

In such case, an "anti-electric" field "line" of a celestial body like earth (or of any of the neutrons existing in such celestial body) should go all the way toward the distant universe, and eventually "dive" to an event horizon corresponding to point *a* of **Figure 1**. In accordance to what was described in section 5.1, point *a* corresponds to an event horizon of a quasar. In that sense, the "anti-electric" field lines of neutrons on earth go all the way until reaching quasars that exist around the universe (at different directions and radial distances from earth).

Note that in relation to what was described with respect to **Figure 4**, a neutron's "anti-electric" field lines are of similar nature to those of the neutrino (part (c) of that figure), and should be understood to refer only to the portion extending from the particle itself until mid-distant universe (re. upper-left quadrant of the grey arrows in that depiction), while the remaining portion of the field lines (from mid-distant range until a quasar) refer to the "other pole" (e.g. a particle at the outer edge of the quasar, re. upper-right quadrant). Behind the quasar's "event horizon" the "anti-electric" field line turns to a classical electric field line, following its trail to complete a full loop.

We shall now focus on a different topic, addressing why certain fields may come in monopoles (like gravitational or electric monopoles), while other fields may not, like the classical magnetic field which comes from an un-splittable dipole. When a magnet is cut into two pieces, it instantly turns into two smaller magnets, each one having a north and a south pole. This happens as the magnetic property refers to the direction of spin magnetic moment of electrons involved, which may easily change. In fact, it requires less energy for half of the magnet's electrons to flip spin (and become an "opposite magnetic pole" so as to have the total magnetic potential balanced-out) than to stay unchanged. And that gets half of the electrons of the cut bar-magnet to quickly flip spin, and create a new magnetic dipole. This condition should apply until reaching down to the individual electron level, where an electron could either be spin up, or spin down (so it can not resemble a conventional magnet having a north and a south pole). But still, even just two electrons of opposite spin, tend to pair up (with that constituting a process of chemical bonding). The lesser energy required for flipping is what gets magnets to always have two poles.

In the contrary, other radial-like fields, like the electric or the gravitational, appear to form monopoles. This is so, as it is not feasible energy-wise for half the electrons of a charged object to flip their charge sign (e.g. turn themselves into positrons), and even more, it is not feasible for half the electrons of a material object to flip along the sign of their matter to negative (turning themselves to neutrinos) so as to create a matter-dipole. But in the other hand, in relation to what was described above, monopoles may not exist in nature solely on their own, unless an "other end" of their field "lines" exists and "lands" on an opposite pole. Either if that other pole is very far away (as it holds for the gravitational or for the "anti-electric" field which may reach to different celestial formations), or if its near-by (as it holds for the electric field of electrons, which may reach into nearby protons). In either of such cases, if these *opposite* poles where not in existence, it wouldn't be possible for particles (e.g. electrons as monopoles) to exist in nature solely on their own. In other words, electrons would not be possible to be in existence if there were no positive charge of equal amount in existence anywhere else in the universe, for their electric field "lines" to "land" upon (and actually follow the field loop through an imaginary portion). And so it holds for all fields, of all fermions. Therefore, the notion of gravitational and electric "monopoles" is somewhat illusive, as it refers to only a part of the full picture. In that sense, even an isolated electron should not be considered a monopole in the strictest sense, as it concerns one pole whose "other pole" is spread away to other particles around.

5.5. Supernova vs. Pulsar Transitions

(a) Core-Collapse Supernova

Like the values of inductance and capacitance in the elements of an LC electronic circuit define the frequency and damping of an oscillation of current, a corresponding analogy applies in gravity/mechanics. Here, the values of the inductive-like phase shift between the Space and Time metrics (the Weinberg angle), and the capacitive-like potentials (like the gravitational, or the long-range gravitomagnetic) may influence the frequency and damping of celestial effects like the death and birth of stars. Actually, while such celestial effects evolve, matter of celestial bodies is not subject to a static value of the metrics of time and space. For instance, when a star burns its fuel and starts to collapse, the gravitational force on the star's matter progressively intensifies, and that condition refers to the value of the time metric shifting in the direction $d \rightarrow f$ (getting closer and closer to point f) of **Figure 8** part (a), where the stiffer slope of the time curvature refers to stronger gravitational action.

We shall start with a reference to how existing theory explains the process that takes place in a typical, core-collapse supernova. According to it, when the star has no more fuel to cause outward thermal pressure, the core contracts and eventually reaches the electron degeneracy pressure. Further compaction is forbidden due to the exclusion principle, which prohibits electrons from occupying identical energy states. But if the mass of the star exceeds the Chandrasekhar limit, the electron degeneracy may not support the gravitational pressure, and an extremely powerful implosion of the core takes place. The core heats up and gamma rays are produced, which brings nucleons to an excited state that results to knocking neutrons away. Protons absorb inner atomic electrons and change into neutrons by emitting an electron neutrino via inversed beta-decay. Some of the neutrinos are absorbed by the outer layers of the star and get the supernova explosion to start [24]-[26]. Thermal energy is shed by release of neutrinos through neutrino-antineutrino pairs. The collapse is reacted due to neutron degeneracy, which causes the implosion to re-bounce outward through a shock wave which causes the supernova explosion. Depending on the mass of the star, that may produce elements heavier than iron, while the remnants of the core form a neutron star or a black hole. The generation of neutrinos by a supernova has been observed in the case of Supernova 1987A [27] [28], verifying that the core-collapse model is basically correct. However, the particular roles of particles, instabilities, and fields in the supernova explosion are not clearly understood.

As proposed above, while the star collapses under its own gravity and the gravitational action intensifies, the prevailing value of the time metric shifts in the direction $d \to f$, getting ever closer to point f which is a space-nodal point. When point f is almost reached, that associates to the limiting condition that the Pauli exclusion principle gets into effect. If the mass of the star exceeds the Chandrasekhar limit, the electron degeneracy may not support the gravitational pressure, and that condition refers to crossing over point f (toward the right of it), breaking the critical limit set by the Pauli exclusion principle. That in turn, refers to passing into negative values of the space metric. Negative space is imaginary to conventional matter, which means that conventional matter (like the electrons) may not reach particle form, and has to transform its energy into negative matter (like neutrinos and/or antineutrinos). This is why the particular inverse beta-decay takes place, which absorbs inner atomic electrons and emit neutrinos. (Actually, through the same interaction protons turn to neutrons, but we shall comment on that in separate).

Under ordinary (not transitioning, hi-energy) conditions, positive and negative matter (e.g. electrons and neutrinos) may not co-exist (reach particle form) at the same region, as neither of them may inhabit space of opposite sign of metric. What this tells, is that in positive space the electrons reach form and exhibit conventional gravitational field, while neutrinos do not exhibit gravitational field since their own "negative gravitational" field is imaginary (damps out at really short range) toward the conventional world of positive space. Likewise, neutrinos exhibit gravitational field and forces only in negative space metric, where the electron's gravitational field is imaginary. During the transitional process that corresponds to the crossing over point f, however, particles of negative matter as well as of positive matter may be in existence (reach particle form, each of them in their own space-curvature habitat) while in extremely close proximity. That proximity, is actually within the limited range of action of their (opposite-energy's) gravitational fields (which have therefore not damped out there). As considered in section 3.1, matter of opposite signs gravitationally repel each other (the opposite to what holds for charges of opposite signs, which attract each other). The corresponding gravitational repulsion between adjacent electrons and (particle-like) neutrinos gets to start a burst of the star's contents. This burst expels particles both outwards (in an explosion toward space curvature of positive sign) as well as inwards (in an implosion toward space curvature of negative sign). In the outward direction (concerning space metric of positive value) neutrinos should instantaneously exhibit imaginary gravitational properties, and electrons exhibit real gravitational properties. While in the inward direction (concerning space metric of negative value), the opposite holds, meaning that neutrinos should instantaneously exhibit real gravitational properties and electrons should instantaneously exhibit imaginary gravitational properties. In that case, it is the gravitational field of electrons in positive space (constituting positive matter) and the gravitational field of neutrinos in negative space (constituting negative matter) that are in close proximity that causes the repulsion which ignites the supernova explosion. And this seems to constitute the way that neutrinos transfer energy to the star and produce the shock wave that causes the Type II supernova explosion.

The process that takes place on particle's nuclei is not exactly the same. The transitioning of baryons from positive to negative energy should involve the fields of "anti-charge" and negative matter, which in section 6 shall be associated to the weak interaction. We shall here focus on quarks' charge only (not electrons' charge). Existing theory describes that protons have charge of +1e, and neutrons have zero charge. But that does not provide a full picture, as it does not take into consideration that quarks additionally exhibit negative matter and "anti-charge", as shown in the upper-left quadrants of the drawings of **Figure 6** and **Figure 7**. As shown in **Table 1**, a proton (which is an udd particle) possesses charge that adds up to +1e, but also has "anti-charge" which nets out to zero. A neutron, in turn (which is an uud particle), has its charge add up to zero, however it is not exactly a neutral particle, as concurrently it carries $+1\,\overline{e}$ of "anti-charge", which we do not directly perceive as it is a negative energy field, therefore imaginary to us.

On a side-note, it should not be forgotten that the "anti-charge" portions of nucleons also associate to corresponding "anti-magnetic" fields, which engage in opposite energy processes that leak energy toward the classical world. As for instance, in powering the electric battery, described in section 3.6, and similarly for negative gravitomagnetic fields which apply on exergonic reactions.

Table 1. Nucleon charge and "anti-charge" values.

PARTICLE	CHARGE TYPE	CHARGE VALUE
Proton	Charge: "Anticharge":	$-1/3 + 2/3 + 2/3 = +1e$ $-2/3 + 1/3 + 1/3 = 0$
Neutron	Charge: "Anticharge":	$-1/3 - 1/3 + 2/3 = 0$ $-1/3 + 2/3 + 2/3 = +1\,\overline{e}$
AntiProton	Charge: "Anticharge":	$+1/3 - 2/3 - 2/3 = -1e$ $+2/3 - 1/3 - 1/3 = 0$
AntiNeutron	Charge: "Anticharge":	$+1/3 + 1/3 - 2/3 = 0$ $+1/3 - 2/3 - 2/3 = -1\,\overline{e}$

It similarly applies with the charge and "anti-charge" of anti-baryons, as the table also depicts. Notice however, a point that differentiates baryons from leptons. In the case of leptons, we needed 4 separate particles to account for all field versions, namely the electron (negative charge), the positron (positive charge), the neutrino (negative "anti-charge"), and the anti-neutrino (positive "anti-charge"). For baryons instead, we have the proton (positive charge), the anti-proton (negative charge), but we do not exactly need a "negative proton" (since that is already embodied in the neutron which has charge $+1\overline{e}$), neither we exactly need a "negative anti-proton" (as that is already embodied in the anti-neutron, since that has charge $-1\overline{e}$).

It turns out that during a supernova explosion, interactions lead to the creation of neutrons and neutrinos, both of which carry "anti-charge". As "anti-charge" is imaginary to positive curvature, we perceive these particles to be neutral, however, with respect to negative space curvature that exists at the right of point *f* (at the inner core of the supernova) particles in that region exhibit negative matter and "anti-charge", which lets *neutrons and anti-neutrinos behave much like protons and electrons do in our classical region*. In fact, while with respect to the classical world the inner core of a supernova might seem as a remnant, it should constitute normal habitat for negative matter, with negative atoms and negative molecules reaching regular form. In the region between points *f*-*g* the atom-like formations should be surrounded by anti-neutrinos (behaving as electrons do in our cosmic neighborhood), while the nuclei should constitute of antineutrons (which have "anti-charge" of $-1\overline{e}$) instead of protons, and anti-protons (having $0\overline{e}$) instead of neutrons.

A point open to consideration relates to the existing theory's prediction that a supernova explosion develops in two stages, the first when electron degeneracy is overcome and an implosion takes place, and the second when the collapse is re-acted by neutron degeneracy, which causes the implosion to re-bounce outward through a shock wave which causes the supernova explosion. This may relate to the condition that, when space curvature flips from positive to negative metric, electrons may no longer reach particle-form so they should almost instantaneously transition to neutrinos and antineutrinos. While instead, the quarks (which compose nucleons) partially engage in both positive and negative space metric curvatures, as explained in section 4.10. That allows for both positive as well as negative space metrics to provide habitat for these quasiparticles, so they need not instantaneously transition, but they may sustain a wider time gap until balancing out in forming antiprotons and antineutrons. This allowance of time may contribute a reason why the neutrons seemingly engage at a secondary stage during the supernova explosion.

(b) Pulsars

Existing understanding of the way pulsars emit radiation is not complete [29]-[30]. It now appears that the process that applies in a pulsar is inverse to the one that applies for core-collapse supernovae. As described above, the gravitational mechanism behind a core-collapse supernova relates to a shifting of the prevailing value of the time metric in the direction $d \to f$ (in Figure 8, part a) and eventually crossing above point *f* into negative metric curvature of space. But another analogous process is also possible, concerning attraction based on an opposite inclination of curvature. Other than the inversion of space metric taking place at point *f* of Figure 8 part (a), another similar inversion takes place at point *a* of the same figure, so we shall explore what process may be taking place in relation to that point. As described in section 2.2, the slope of the curvature of time in the region between points *d*-*b* forces distant celestial bodies to accelerate in the direction $d \to b$ (with that force being responsible for the accelerated expansion of the universe). That in turn, implies that celestial bodies residing in the neighborhood of point *b* should attract matter, much like a conventional black hole does in our cosmic neighborhood. There is however, a key difference between these two cases, since a conventional black hole (point *g*) has a space-nodal surface (point *f*) developing *outside* the black hole, while in the distant universe a black-hole-like celestial object (point *b*) has a space nodal surface (point *a*) developing *inside* the body (since point a is positioned to the left of point *b*). That constitutes a significant difference, because when a distant star that resides in the neighborhood of point *b* collapses by its own gravity in the direction $c \to b$, particles do NOT cross a space-nodal region (like point *a*) so as to have atomic electrons interact with protons and turn to neutrons (via inversed beta-decay) that drives a supernova explosion via gravitational repulsion. Actually, even celestial antimatter that exists behind the event horizon at point *b* should still be attracted in the direction $a \to b$ (and not $b \to a$). So it avoids passing through the space-nodal region *a* and cause a supernova explosion.

It turns out that instead of positive matter (either antimatter or conventional matter) being attracted in the direction $b \to a$, we have a case where negative matter (like neutrinos in particle-like form) are attracted toward point *a* from its left side, in the direction $I \to b$. In such case, the flip in space metric that takes place at point a should result to an inverse type of supernova explosion. Here, once the nodal point a is overpassed (from left to right, in Figure 8 part (a)) and space curvature charges sign, protons should transition to neutrons (exhibiting "anti-charge" $+1\overline{e}$), and neutrons should transition to protons (exhibiting $0\overline{e}$). Once again here, the remnant that resides in the region *a*-*b*, is not exactly a neutron star. Its contents should comprise of atom-like (and corresponding molecule-like) formations, where the nucleus should contain neutrons (exhibiting $+1\overline{e}$) in place of protons, and protons (exhibiting $0\overline{e}$) in place of neutrons. And these nuclei should be surrounded by neutrinos, behaving much like electrons do in our cosmic neighborhood (due to the opposite sign of space metric).

This case seems to concern what holds for pulsars. As the remnant concerns a negative form of matter (imaginary with respect to our cosmic region), it should rotate at superluminal fastness, so as to comply to its imaginary attributes. Such type of superluminal motion has been documented [31]. In this case, negative matter and "anti-charge" should interact though its negative-gravitational and "anti-electric" fields as discussed earlier in section 3.6. The "anti-electric" field, along with its associated "anti-magnetic" field has to obey symmetric laws to those of the Maxwell equations. However, conditions of negative space metric get the emission process take place in an inverse way. Namely, while in conventional electronics the acceleration of charge causes the emission of radiation radial-like (normal to the direction of acceleration), in the case of pulsars we should have exactly the opposite. The radial-like centripetal acceleration of "anti-charge" emits radiation along the magnetic axis (instead of emitting astrophysical jets). This concern the inverse-type of mechanism that generates the strong beam that pulsars exhibit, coming out of their "antimagnetic" poles. And at the same time, their negative matter essence is responsible for their ultrafast rotation.

In relation to concepts that shall be introduced in section 6 concerning the Z^0 boson, it is very likely that supernova or pulsar remnants may emit Z^0 bosons toward their negative energy cosmic region *f-g* and/or *a-b* correspondingly, behaving like photons do in own cosmic region. Also, photons in those regions should behave like Z^0 bosons do in our own neighborhood.

5.6. Galaxy Rotation Curves & Negative Matter

So far, we discussed that the electric and the gravitational fields have negative-energy variants, which have imaginary properties, and may interact with the imaginary (negative-energy) portion of particles in mediating effects of reaction. The same condition holds for the opposite-energy magnetic and gravitomagnetic counterparts of these fields, also in symmetry to Maxwell's equations. In section 2.4 we described that the gravitomagnetic field is already a negative energy field, so it damps out quickly in the real world. There is however, a particular condition where that field would not act as an imaginary field, in which case it could interact in long range. This may happen when the gravitomagnetic field (which has imaginary nature) applies upon the imaginary properties of matter's wave nature. Then, the negative matter and the gravitomagnetic field should both appear and interact in real with respect to each other, so they could apply at long range. Let us see what effects could that have on galaxy rotation, and how.

According to Kepler's Second Law which accounts for the orbital motion of the planets in our solar system, it would be expected that the larger the distance from the center of a galaxy, the rotational velocities of stars should decrease, similar to as it holds for the planets of our Solar System. This is based on the law of conservation of angular momentum $L = rm\upsilon$, where r is the radius of rotation and $m\upsilon$ is the linear momentum. According to that relation, if the radius of rotation is reduced by one-half, the rotational velocity should double in order for angular momentum to be conserved, same as it holds for an ice skater that pulls their hands in and spins faster. This also applies on the rotation of planets in our solar system. In the contrary, in a far larger scale the observations of galaxy rotations reveal that the rotation of spiral galaxies remains flat as the distance from the center increases, which means that the rotational velocity of stars is not getting lower the further away from the galactic center [32] [33].

According to calculations, this discrepancy could be resolved if the gravitational force experienced by a star in the outer regions of a galaxy was proportional to the square of its centripetal acceleration (as opposed to the centripetal acceleration itself, like in Newton's second law), or alternatively, *if the gravitational force came to vary inversely with radius* (r) as opposed to (r^2) as per Newton's law of gravity [34]. In relation to that, galaxy rotation could be possible to explain without the need for dark matter, if some other attractive force of proportional strength would apply on top of the gravitational, where that new force would vary with respect to "reciprocal" radius $(1/r)$, meaning that it would be stronger the further away from the center of the galaxy. In such way the total attraction force, including both the gravitational and that other force, would vary (approximately) with respect to $(r^2)(1/r) = r$. To explore such possibility, we need to figure: (i) what could the nature and origin of such other force be, and (ii) why it applies at the galaxy scale but not at the (smaller) solar-system scale.

Since the waviness in the time metric (illustrated in **Figure 1**) is described to concern gravity, one could question if the waviness in the curvature of positive space metric could possibly account for an additional (real) force. If so, such an effect of space would also need to provide an answer to (ii) as of why would that force act at galaxy scale, but not at the smaller-sized solar system scale, where Kepler's law applies.

We shall start with addressing this latter point. A candidate explanation appears to concern the phase shift between the time and space curvatures of **Figure 1**. At a relatively small celestial scale, like that of our planetary system, the radius of revolution of planets around our sun is far smaller than the spatial extend of the phase shift between the space and time curvatures depicted in **Figure 1**. This is more obvious when this shift is measured in terms of length (and not in terms of degrees of angle which refers to the Weinberg angle). Because of that, at the scale of our planetary system, there is almost no influence of such a phase shift arising in relation to our *sun*. So that practically leaves only for the phase shift due to our mother galaxy's *black hole* to be in effect, where that is relatively flat in the range of our celestial neighbourhood. Therefore, that leaves only for gravity to be the main force that keeps our solar system together. This is why Kepler's second law applies, where the force varies with respect to the square of the radius. At galaxy scale instead, the radius of a galaxy is far larger than the spatial extent of the Weinberg shift, and space goes through a node at point *f* of **Figure 1**. In this case, it is the curvature of positive space outside that nodal surface that acquires significance, and if that may relate to some appropriate potential, then the combined attraction at galaxy scale (due to gravity and due to such potential) could get Kepler's law be no-more valid on its own, as a different balancing would apply, where the rotational velocity of stars does not decrease the further away from the galactic center.

To further support the above supposition, we need to specify what type of curvature effect could constitute the origin and nature of a corresponding potential. If it were a space-curvature-related potential and force, applying in symmetry to the gravitational time-curvature-related force, then its action (from the applicable range onwards) should rather vary inversely with the square of the radius $\left(r^2\right)$. But that option does not match the existing observations which reveal that spiral galaxy rotation tends to remain flat as the distance from the galaxy center increases. This calls to look for some other possibility for this potential's origin. In that case, another possibility is to consider if it could concern a *gravitomagnetic*-related force [35]. For that case, the phase shift between time and space curvatures would still explain why that potential applies at galaxy scale and not at solar system scale.

In relation to what was described in section 3.10, the gravitomagnetic field "lines" correspond to equipotential lines of a radial-like potential, which comprises of a space shift referring to $-\Delta x/dt$. (That is in close analogy to as the magnetic field lines correspond to equipotential lines/surfaces of a radial-like potential comprising of a time shift $-\Delta t/dx$). A significant difference between the magnetic and gravito-magnetic field's cases, however, is that the former has the characteristics of a real field so it may apply at long range, while the gravitomagnetic field T has the characteristics of an imaginary field (of negative energy), so it quickly damps out and becomes evanescent in the real world, thus it has short range of action as explained earlier.

But let us suppose that the gravitomagnetic interaction could also take place in conditions of opposite energy, by applying in relation to particles' imaginary portion (associating to negative matter), like the one that all quarks partially involve, and neutrinos were also described to be made of. That could have the interaction of two imaginary entities to bring a real result, in which case such interaction: (i) could have long range of action, and (ii) due to its imaginary origin it would project to the real world with respect to reciprocal conditions (per $1/dx$ instead of per dx) as explained earlier through the relation (3). A way that such condition could apply, is if the (imaginary) gravitomagnetic field could interact with motional flow of negative form of matter. We therefore need to explore if such an inverse type of interaction could apply through some way between imaginary entities, and generate a capacitive-like attractive potential that would account for the missing attractive force (which raised the need to hypothesize the existence of dark matter in the first place).

For a negative gravitomagnetic field to be generated at a galaxy scale, it should relate to a flow of particles of negative matter, so that flow would create around it a radial-like potential $-\Delta x/dt$ (a space-dragging potential), similar to as it holds with the Bernoulli pressure around a fluid flow, now applicable at the large scale (**Figure 9**, part a). At first, there seems to be no observational evidence of such flow to be taking place at galaxy scale, for making this an actual scenario. (Neither an alternative, and rather remote, hypothesis, of the motion of a whole galaxy through vacant space could make for such a type of scenario).

What appears to make a realistic case, concerns the flow of particles toward opposite directions, like at both sides of an accretion disk, in a mirror-like way as shown in Figure 9, part (b). Such an alternative could generate a radial-like, space differential $-\Delta x/dt$ [35]. This is actually how the curvature in the metric of space becomes involved. Here, the flow of particles toward opposite directions does not raise any obstacle since the gravitomagnetic field is direction-degenerate. In fact, such kind of mirrored flow of particles and energy complies to the observed process of astrophysical jets developing at both sides of accretion disks.

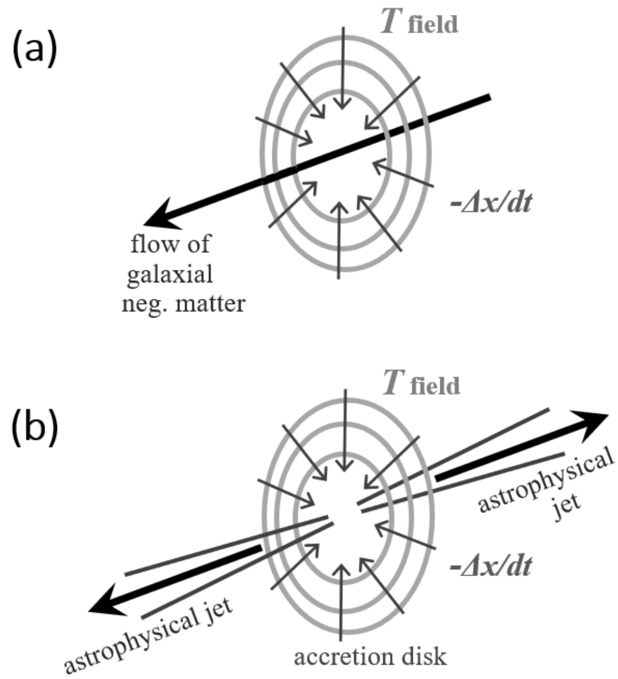

Figure 9. Gravitomagnetic field interaction with negative-matter at galaxy scale, concerning scenarios of straight negative matter flow (a), vs. mirrored astrophysical jet flow (b).

In such case, the next thing we would need to figure, is how the interaction could involve negative matter. According to observations, astrophysical jets correspond to outflows of ionized matter emitted along the axis of rotation close to the speed of light. These are considered likely to arise from dynamic interactions within accretion disks where energy is extracted through relativistic effects like frame dragging. Such active processes are commonly connected with objects such as central black holes of active galaxies, quasars, neutron stars, pulsars, and supermassive black holes [36]-[38]. It appears that in many of these cases the accretion disks seem to relate to "ergospheres" where a space dragging process takes place, which has the implication of the existence of opposite energy. This in fact, complies to the negative energy product shown between points f and g of Figure 8 part (a). According to existing theory, an object within the ergosphere cannot appear stationary with respect to an outside observer at a great distance unless that object were to move faster than the speed of light with respect to the local spacetime [16]. This also comes in compliance to the present model, since the processes in these regions should involve matter of negative sign, concerning antineutrinos and antibaryons, constituting a primary constituent of the astrophysical jets.

It also applies outside ergospheres, in reference to what was discussed through **Figure 6** and **Figure 7**, that a portion of quarks "lives" in negative energy. This portion should therefore be open to interactions with fields of negative energy (described by imaginary terms). In such case, two interacting imaginary entities (the negative-energy part of baryons and gravitomagnetic field which has negative-energy) may bring a negative real outcome, as per the relation $i^2 = -1$. And in relation to that, the flow of the astrophysical jets should generate around them a radial-like negative gravitomagnetic differential of the form $-\Delta x/dt$, extending beyond the ergosphere, which should act as a potential which tends to displace the imaginary part of particles inwards in a similar way to as the Bernoulli principle exhibits low pressure around the flow of matter. Only here, the range of action of such a differential is of long scale, as the two imaginary entities produce a real result, thus the negative gravitomagnetic action does not become evanescent. As this negative gravitomagnetic potential applies radial-like, it affects a centripetal-like force which points toward the center of the circular-like motion. The deflective action has the form of displacement-momentum, which tends to deflect the rotating galaxy's celestial contents centripetal-like, without changing their kinetic energy.

Since we have an effect of negative energy taking place, and that projects on the real world, as previously noted it should deploy on the real world through a *negative reciprocal* (since $i^2 = -1$ so $i = -1/i$). The gravitomagnetic force affected at long range is copied here in (88) for easiness in reference.

$$F_T \propto \left(\frac{h/\lambda}{\upsilon}\right) T_{d^+} \tag{50) or (88}$$

$$F_T \propto \left(\frac{h/\lambda}{\upsilon}\right) \overline{T}_{d^+} = -\left(\frac{h/\lambda}{\upsilon}\right)\left(\left(\frac{1}{\varepsilon_g}\right)\left(\overline{T}\cos\theta_w\right)\right) \tag{89}$$

Considering that the present case concerns opposite energy, the interaction may take a form like relation (89) which involves a cosine coordinate to account for the projection toward the real world. The reciprocal term $\left(1/\varepsilon_g\right)$ refers to $dt/\Delta x$, so in terms of units it resembles the reciprocal velocity $(1/\upsilon)$. In this case, the strength of the corresponding potential seems to vary with respect to the reciprocal radius $1/r$. It should therefore be less strong the closest to the center of the galaxy. Since this potential applies on top of the gravitational which varies with respect to r^2, the combination of these two independent forces (of relatively comparable strengths) would be a total force that varies roughly with respect to the radius from the center of a galaxy $\left(r^2\right)(1/r) = r$. (The approximation is rough since the two forces involved are not equal). In such way, this may account for spiral galaxy rotation keeping relatively flat as the distance from the center

DOI: 10.4236/jmp.2024.1512086

increases. And the negative matter involved appears to contribute toward the outcome of the observed characteristics of spiral galaxies, without a need for the existence of any additional dark-matter particles.

On a side-note, above we have described the action of an (*imaginary*) *displacement gravitomagnetic force* which applies at very long range (unlike its conventional application on positive matter, which is of short range). It seems likely that an analogous process may hold in inverse, in relation to the action of a *displacement* "*anti-magnetic*" *force* (a force of $\overline{B}_d$) and have this force apply at very *short range* (unlike the conventional magnetic force which applies at long range). In relation to material that shall be considered in section 7, such form of short-range magnetic-like action may have a symmetry to the gluon force between quarks being flat (independent from distance).

6. Extensions in the Electroweak Interaction

The electroweak interaction is mediated by four particles, the photon γ, the Z^0, the W^+ and the W^- bosons, of which only the photon is massless and associates to the electromagnetic interaction, while the Z^0 and the $W^{\pm}$s carry mass and are associated to the weak interaction. According to the discussion in previous sections, certain new clues arise in relation to these particles' nature, as follows.

(a) The photon vs. the Z^0 boson

In section 3.11 we discussed the propagation of electromagnetic radiation with respect to real space and time (56) as well as with respect to imaginary space and time (57). Since imaginary space and imaginary time concern inverse curvature (referring to the negative reciprocals of space and time), the electric and magnetic fields may project on those through their displacement field versions, hence through the involvement of the permittivity and permeability terms, ε or μ. Since the units of these terms involve capacitance (Farad) or inductance (Henry), they describe a displacement in time of the form $\varepsilon \to +\Delta t/dx$ and $\mu \to -\Delta t/dx$ respectively. The particular phase shifts $+\Delta t$ and $-\Delta t$ do not take *any* degree of angle (like it holds for LC electronic circuits depending on the properties of their circuit elements), since an electromagnetic wave does not associate to any inductive or capacitive element of any circuit. The value of the phase shift is fixed and refers to the Weinberg angle. But while an inductive or capacitive phase shift in electronic circuits develops in time, the Weinberg angle was explained to concern a shift in space. To address that, we need to look into a question of orthogonality:

Recall that according to the present model, all displacement-field versions have a real as well as an imaginary coordinate, and these two deploy in orthogonal directions. So, the same applies for the displacement electric field, which comes in two coordinates, a real and an imaginary:

- The imaginary coordinate of the displacement electric field deploys along the direction of flow-or-acceleration of charge. This is why an alternation of the electric field along this coordinate may cause the transmission of a displacement-current I_d across the plates of a capacitor, as per Faraday's law (56).

- The real coordinate, in turn, deploys in an orthogonal direction. This is why the emission of an electromagnetic wave takes place perpendicularly to the acceleration of a charge.

The above may be rephrased in that, a photon is emitted perpendicularly to the acceleration of charge, which is the radiative direction. The orthogonal direction instead, where current accelerates, or the electric flux changes between the plates of a capacitor, is not-radiative. The non-radiative direction could be considered to involve the exchange of "virtual photons", in reference to evanescent-wave modulation which dumps out quickly, since it has imaginary properties.

Here, there seems to be some mis-match between the conventional theory of electronics and the electroweak theory. The reason is, that the theory of electronics conventionally treats the inductive (L) or capacitive (C) displacement of fields as if they were deploying in time over the non-radiative direction. While the electroweak theory treats the phase shifts along the perpendicular direction (the radiative direction). A consequence of the orthogonality, is that the inductive and capacitive shifts along the radiative direction should not be treated in terms of displacement in *time*, but in terms of displacement in *space* (as time and space are each orthogonal to the other, since either one has imaginary character with respect to the other).

This inversion has the consequence that similar effects to the ones that the electric coordinate may achieve along the direction of charge's acceleration (like the transmission of displacement-current I_d), may be achieved by the *magnetic* coordinate along the radiative direction. In particular, the magnetic coordinate appears to allow for transmission of "displacement-negative-momentum", through a process that has some analogy to the one of barrier penetration which was discussed in section 3.5 (but now in long-range). That the magnetic field is capable to engage in transmitting displacement-negative-momentum may be approximated through its units. In section 3.9 is was discussed that the units of the magnetic field refer to [sec²/meter³]. This may be re-written in the form [sec²/meter][1/meter²], or alternatively be expressed in the form $\left(dt^2/dx\right)\left(1/dx^2\right)$. The later includes two terms; an inverse-acceleration-like term $\left(dt^2/dx\right)$, and a flux-measuring-like term $\left(1/dx^2\right)$. The former resembles the negative reciprocal of the units of the *gravitational* field, since $d\left(1/x\right)/d\left(1/t\right)^2=\left(dt^2/dx\right)$, while the latter describes a flux (actually a "flow", since it takes place with respect to positive space, and not with respect to negative reciprocal space). This could be accounted for as flow of displacement-negative-momentum, through an infinitesimal area $\left(1/d\mathrm{A}\right)$ where $d\mathrm{A}$ corresponds to dx^2.

Depending if the variant of the magnetic field is of positive energy or of negative energy, this accounts for either of two distinct cases:

(a) The displacement of *negative*-momentum is LONG range, where that seemingly refers to the photon. That a photon may convey negative-momentum can also be seen in that the energy transferred by this particle is capable to change the energy state of a receiving electron (where the energy state associates to the electron's matter content, not its charge). And since that momentum is of negative energy (therefore imaginary) the photon appears to be a massless particle.

(b) The displacement of *positive*-momentum in SHORT range, and that seemingly refers to the Z^0 boson which has its field components in opposite energy. And since that momentum is of positive energy (therefore real) the Z^0 appears like carrying mass.

In relation to the discussion in section 4.6, it is more proper to consider any interaction concerning displacement of matter as an effect of momentum (not mass). In that sense, the photon conveys "negative" form of displacement-momentum, from the emitting electron to an absorbing electron. In fact, even if the distance between an emitting and an absorbing electron is extremely large, the transfer resembles an instantaneous (tunneling-like) process since the photon travels at velocity c, so time halts from the viewpoint of the photon.

The reason why the energy exchange, either through a photon or through a Z^0 boson, comes in quantized (particle-like) form was discussed in section 4.5. It doesn't have to do with the electromagnetic field components, or with the way these propagate. It concerns the nature of the fermions (with which the electromagnetic field interacts). And more particularly, with the way fermions' wave nature perceives electromagnetic waves. What we perceive to be a classical electromagnetic wave, concerns propagation of displacement-fields with respect to the macroscopic single-valued time metric and single-valued space metric (both referring to point *e* of **Figure 1**). While, what makes that wave behave as a particle (a photon) concerns its interaction with respect to oscillating parameters of time and space (non-single-valued time metric and non-single-valued space metric) which comprise the quantum particles' wave nature as discussed in section 4:

Since an electron's nature includes a sinusoidal range of values of the time metric and the space metric, this gets the electron perceive a classical electromagnetic wave of certain frequency as a superposition of alternations of higher and of lower frequencies of diminishing strengths. A Fourier transform consequently gets that behave as a beat (a quantum) of energy corresponding to the Planck constant h, whose content measures in units of imaginary time, as described through the relation (68). This concept applies for all bosons in general, making them behave as quantized lumps of energy, where that corresponds to the fermions' point of reference.

The above concepts comply to the relation (90) which describes a photon in the electroweak interaction. In relation to the discussion in section 3.11, the component $\sin\theta_w W_3$ appears to concern how a fermion like an electron perceives the oscillating term $dD(\sin\theta)/idx$, while the term $\cos\theta_w \mathrm{B}$ appears to concern how an electron perceives the oscillating term $dH(\cos\theta)/idt$, alongside a Fourier-series effect that is responsible for the energy quantization.

$$\gamma = \sin\theta_w W_3 + \cos\theta_w \mathrm{B} \qquad (60) \text{ or } (90)$$

Then we also need to reconsider what holds in terms of the field displacement over the Weinberg angle. And on top of that, to make a reference on the units of the fields involved. Note that the units of $D = \varepsilon E$ refer to [sec/meter] [sec/meter^2] which resembles the previously described raw units of the magnetic field [sec^2/meter^3]. And likewise, the units of $H = (1/\mu)B$ refer to [meter/sec] [sec^2/meter^3] which resemble the corresponding raw units of the electric field [sec/meter^2]. This may provide a misleading impression that the electromagnetic wave concerns an alternation of electric and magnetic fields with respect to positive space and time. While instead, radiation appears to concern the displacement-field variants alternating with respect to imaginary space and imaginary time as per relation (59).

The phase shifts involved refer to $\varepsilon = (C/dx) \to +\Delta t/dx$ and $\mu = (L/dx) \to -\Delta t/dx$, which both describe a phase shift in time. However, as previously mentioned, the correct treatment as per the electroweak interaction concerns an orthogonal perspective, which perceives the same phase shifts from the point of view of space (which allows for the magnetic field to transmit negative displacement-momentum). That concerns the setting where the Weinberg angle applies (which does not have any association to inductive or capacitive elements like those of some circuit). And the value of this angle (θ_w) is fixed (at least in the part of universe where stable matter of any form exists).

Since both the magnetic displacement and the electric displacement are both of equal angle, radiation propagates without impedance. And in relation to the discussion in section 3.11, the propagation of an electromagnetic wave comes through the "repetitive displacement phase shifts" instead of "motion". As the fields alternate between each other they appear to displace over space in progressive steps; one of the fields shifts capacitively, then the other shifts inductively, both displacements pointing toward the same spatial direction.

The representation of the displacement-electric and the displacement-magnetic components with respect to space, appears to refer to the W_3 and B fields of the electroweak interaction. Existing theory associates the W s to a triplet and the B to a singlet. But this seems to be inaccurate, since the present model accepts 3 dimensions of time. This should have the B also refer to a triplet, associating it to the ability of photons and the Z^0 to convey negative or positive displacement-momentum correspondingly.

A symmetric interaction in opposite energy concerns the Z^0 boson. This particle is known to carry mass, and because of that, theory assigns it to the weak interaction. However, the notion that this particle "possesses" mass appears to be inaccurate. The representation of the Z^0 as per the electroweak interaction has as follows

$$Z^0 = \cos\theta_w W_3 - \sin\theta_w \mathrm{B} \tag{91}$$

This has similar structure, but refers to opposite sign of energy to that of the photon, hence the swapping between the sine and cosine terms. As previously, this relation is structured on the basis of how the field components comprising this particle is perceived from the reference frame of a fermion that interacts with them (and not from the point of view of the macroscopic world which relies on fixed values of the space and time metrics). Here, the same field components to those of the photon are involved, but the swapping of the sine and cosine terms implies that the Z^0 corresponds to a negative-energy cousin to the photon. As described above, this particle involves a negative energy variant of the magnetic field, which may account for the transfer of displacement-momentum over a very short range in positive space. Since the field components involved concern opposite energy, they should couple with leptons of opposite energy (seemingly relating to the equation of sines (64)) like neutrinos and antineutrinos. If the interaction takes place in a cosmic region where the metric of space has negative values, the interaction would be same as an interaction between a photon and an electron taking place in our cosmic region. In the other hand, in our cosmic region where the metric of space has positive values, the interaction would have rare chances of occurrence, at short range only (since the field components are imaginary, so they should quickly become evanescent over the real world). This is the reason behind the very short range of interaction of the Z^0 (concerning small subatomic distances), and its corresponding very short lifetime. Notice that the attribution of the short range and short lifetime of this particle to the evanescent nature of its fields serves in complement to the conventional notion that this comes due to its high mass (in conjunction to the uncertainty principle). Furthermore, the imaginary nature of this particle's field components, have it comply to the short-extend of transmission of an electromagnetic wave in frustrated total internal reflection. Subject to the difference that the particle-like interaction of the Z^0 with fermions takes place in non-unitary spacetime, so the Fourier transformation provides to the Z^0 its bosonic nature (similar to as was explained to hold for the photon).

As per the above, the field components of the Z^0 appear to concern the displacement versions of the anti-electric $\bar{E}$ and the anti-magnetic $\bar{B}$ fields, as these interact with respect to positive space and time. Actually, the positive space and time are imaginary to these negative-energy field variants, and that relates to the exchange of the sine and cosine dependences in the components of the Z^0 in (91). The displacement variant of the "anti-electric" field $\bar{E}$ concerns the field variant that was described in section 3 to engage in the transfer of displacement-current. But that case involved a shift in time with respect to negative space, while in the present case the field alternations concerning the Z^0 engage a shift in space. So, even though one of the field components of the Z^0 concerns the displacement "anti-electric" field, the particle does not displace "anti-charge" over space (as the corresponding field component does over time in the electronic regime). Hence the Z^0 appears to be neutral, and neither exhibits magnetic moment. However, as the "anti-electric" field is the ordinary field of neutrinos and antineutrinos, the Z^0 ordinarily couples with these particles. In cosmic regions of negative space metric the neutrinos should emit or absorb Z^0 s in analogy to as electrons emit or absorb photons in our cosmic neighbourhood. By extend, the interaction with neutrinos or antineutrinos also allows for the Z^0 to become co-involved in interactions concerning a decay toward a fermion and its negative energy counterpart, for example an electron and an antineutrino. In such cases the exchange of "anti-charge" is mediated without noticing since Z^0 appears electrically neutral to the classical world.

At the same time, as the displacement-momentum is transmitted (tunneled), this gets the Z^0 particle illusively appear as if it carried mass. Here again, the ability of a particle of the electromagnetic interaction to convey displacement momentum is traced in the units of the magnetic field as described above for the photon. In this case, the displacement "anti-magnetic" field constituent of the Z^0 (where the same field could alternatively be referred to as "weak-magnetic" field, as it refers to the weak interaction) appears to account for the transmission of displacement-momentum.

The Z^0 becomes involved in interactions of reaction character, thus it should engage at almost instantaneous response. The corresponding attribute is feasible since the field components of Z^0 are of negative energy. Such instantaneity is comparable to the one with which an "opposite magnetic force" is affected to an external magnet when it deflects a moving charge, for momentum to be conserved. In loose sense, the Z^0 interacts as in delivering "opposite momentum to the other end" for reasons of conservation of momentum. Such instantaneity may also be traced in the fact that the interaction involving a Z^0 boson exchange is "elastic", meaning that the kinetic energy is conserved. In fact, the "elastic" attribute is a feature of the electromagnetic interaction, and not of the weak interaction, which is another reason in support of the notion that the Z^0 actually concerns the electromagnetic interaction (and not the weak interaction as conventional theory assumes).

That the Z^0 illusively appears as if it carried actual mass, while it actually mediates the transfer of displacement-momentum (a mechanical counterpart of a "displacement current"), may allow to refer to it as carrying "pseudo-mass". Actually, this notion may be also supported via a comparison between the amount of this (pseudo)-mass and the amount of mass carried by the weak interaction bosons W^+ and W^- which shall be considered right next.

(b) The $W^{\pm}$ bosons, and the Graviton

According to textbook theory, the W^+ and W^- weak interaction bosons are described through the following relations

$$W^+ = \frac{W_1 - iW_2}{\sqrt{2}} \tag{92}$$

$$W^- = \frac{W_1 + iW_2}{\sqrt{2}} \tag{93}$$

We shall consider that the field components of W_1 and W_2 should be subject to an orthogonality with respect to the W_3 and B, and in relation to this we may consider the possibility that this concerns a swapping between the parameters of space and time. If so, that would imply that the W_1 and W_2 would relate to fields of mechanics (instead of fields of electronics). That notion may be supported by the fact that, as per textbook theory, the mass of the $W^{\pm}$ s (denoted as M_W) is lesser to the effective mass of the Z_0 (denoted as M_Z) by a coefficient of $\cos\theta_w$, where θ_w is the Weinberg angle, as shown in (94). Here, the presence of the cosine term $\cos\theta_w$ may be translated in that, when energy is spent to affect work upon the mass of the $W^{\pm}$ s, only the cosine coordinate does work in the Real domain, similar to as it applies on conventional matter (where the $\sin\theta_w$ coordinate associates to inertia). In other words, the mass of the $W^{\pm}$ s appears to be subject to the conventional Higgs field mechanism, unlike what holds with the pseudo-mass of the Z_0. Furthermore, the mass of the $W^{\pm}$ s should associate to the W_1 component, where that should refer to a negative energy displacement-field, with any change affected on it leaking energy to the *real* domain through a *cosine* coordinate, in analogy to as a change in a positive energy displacement-field leaks energy to the imaginary domain through a sine coordinate (in the case of inertia).

$$M_W = M_Z \cos\theta_w \tag{94}$$

Along these lines this relation also suggests that the field components W_1 and W_2 should *already* incorporate into them a coefficient (cosine and sine respectively) accounting for the leakage of energy, and this is why the relations (92) and (93) only need an imaginary term i in one of the two field components, and do not need cosine or sine terms in addition to that (as in (90) and (91)). Here, the imaginary term indicates that the two components (W_1 and W_2) refer to orthogonal curvatures, one associating to the curvature of space and the other to the curvature of time, so they are orthogonal to each other in a similar sense to as the displacement electric and displacement magnetic fields are orthogonal to each other. In that case, the imaginary term i next to W_2 is there for same reason that the magnetic permeability is reciprocated $(1/\mu)$ with respect to the electric permittivity (ε) in electronics, where this reciprocation exists in place of an imaginary term.

The involvement of a phase angle θ_w in (94) also translates in that, the fields components W_1 and W_2 have a displacement-field character. This in turn, complies to the notion that, since they concern negative energy fields, they project on real space along with a permittivity-like or a permeability-like term, *already* incorporated into them (contained in their representation) since they should concern displacement fields.

The W_1 appears to associate to a displacement negative gravitational field, as that projects to the real world. That exhibits inertial-impedance properties along the lines introduced in section 2.3, while it acts in quantized form due to the Fourier process discussed in section 4.5. Its corresponding inertial behavior should be degenerate in terms of direction of time, for the same reason that both matter and antimatter were explained to be gravitationally attractive (the reason being that to the parameter of time involved in acceleration has the units of time squared). Therefore, the W^+ vs the W^- seem to actually involve W_1 and $\overline{W}_1$ correspondingly (instead of W_1 only). In this sense, each of W^+ and W^- seem to be the antiparticle of the other, while the matter of both is of same sign, just like the electron's matter and the positron's antimatter are both of positive sign of matter. Or rather, just like the neutrino's negative matter and the antineutrino's negative antimatter were presented to both have negative sign of matter. So all that concerns both W^{+} and W^{-} particles' characteristic of carrying mass.

In the other hand, the terms $+iW_2$ and $-iW_2$ seem to concern the positive and negative displacement-gravitomagnetic field correspondingly, which appears to mediate tunneling of positive and negative pseudo-charge, very much like the Z^0 tunnels pseudo-matter and the photon tunnels pseudo-negative-matter as described previously. When the fields $+iW_2$ and $-iW_2$ interact with fermions (in alternating values of stretchiness of space and fastness of passing time that constitutes the essence of fermions), they are perceived by the fermions as quanta (beats) of energy due to the Fourier effect discussed earlier, getting the $W^{\pm}$ s carry characteristics of bosons. Furthermore, just like the exchange of a photon or a Z^0 may affect the energy content of a fermion in terms of matter, the exchange of a $W^{\pm}$ may similarly affect the exchange of energy content of a fermion in terms of charge. This is what allows for an exchange of a $W^{\pm}$ to affect on the charge that the produced particles will have. This gets the $W^{\pm}$ s constitute the actual mediators of the Weak interaction (without the Z^0, which was previously explained to concern the electromagnetic interaction). Since the field components of the $W^{\pm}$ s are of negative energy, they become quickly evanescent in the real world, this is why these particles have very short range of action.

Now let us recall that in the relation (10) of section 3.5(b) we considered the notion of gravitational flux. In (95) instead, we may have a case of "negative gravitational flux", or actually, a negative gravitational "flow", since that takes place with respect to positive time (instead of imaginary time which was the case in (10)). And in relation to that, just like in (12) barrier penetration was discussed to concern an effect of "displacement momentum p_d" (in symmetry to the "displacement current I_d" in electronics), here in (96) we have a case concerning displacement-negative-momentum:

$$\Phi_{\overline{g}} = \frac{\overline{g}}{dt^2} \tag{95}$$

$$\overline{p}_d = \varepsilon_{\overline{g}} \frac{\partial \Phi_{\overline{g}}}{\frac{1}{\partial x}} = \frac{\partial \Phi_{\overline{g}_d}}{\frac{1}{\partial x}} \tag{96}$$

As per the above, if we consider that the W_1 field refers to the displacement gravitational field, and the W_2 refers to the displacement gravitomagnetic field, then it is of reason to consider the $W^{\pm}$ s actually constituting a variant of the hypothetical particle graviton, which may be assumed to serve as a gravitational cousin of the photon. Consider that the gravitational waves are currently treated differently to electromagnetic waves due to two basic assumptions: (i) that matter is treated as having only one "sign" (always gravitationally attractive), while charge comes in two signs, positive and negative, and (ii) gravitational waves associate to an inertial oscillation, while electromagnetic waves do not relate to inertia. However, the model presented here may allow for a gravitational oscillation to take place in symmetry to the electromagnetic, as it assumes for the existence of positive and negative matter (as in electrons and in neutrinos), to both of which the $W^{\pm}$ bosons couple. As for the attribute of inertia, electromagnetic effects are subject to the symmetric effect of inductive impedance, in fact inductance associates to a phase shift in time Δt much like inertia was explained to associate to a phase shift in space Δx. And as the field of gravity corresponds to a force-gradient field, the gravitational waves arise from an alternating acceleration of mass (actually an alternation of "momentum"), much like the electromagnetic waves (EMWs) arise from an oscillation of charge (an alternation in current).

In that sense, gravitomagnetic waves (GMWs) should be possible to treat in a similar way with electromagnetic waves, subject to the swapping of roles between the parameters of space and time (as it was already stated to apply between the gravitomagnetic and electromagnetic interactions in general). We could therefore attempt a cross reference between gravitomagnetic wave (GMW) and electromagnetic wave (EMW) propagation through symmetric classical relations. For reasons of simplicity we shall start with the simplified EMW version (97). If we express the gravitational wave propagation under a symmetric expression, it would look like (98), but that would be wrong as it misses to take into consideration the swapping between the parameters of space and time, so we shall therefore switch to relation (99).

$$\frac{dE}{dx}=\frac{dB}{dt} \tag{56) or (97}$$

$$\frac{dg}{dx}=\frac{dT}{dt} \quad [\text{not valid}] \tag{98}$$

$$\frac{dg}{dt}=\frac{dT}{dx} \tag{99}$$

Same as the relation (97) provides only part of the picture, it similarly holds for the relation (99) and a more general relation is needed, involving the displacement-field variants $g_d=(\varepsilon_g)dg/dx$ and $T_d=-(1/\mu_g)dT/dt$ as shown in relation (100). And by exchanging the denominators between the left and right sides and putting a negative sign to both, it brings up their negative reciprocals, which yields relation (101).

$$\frac{dg_d}{dx}=\frac{dT_d}{dt} \tag{100}$$

$$\frac{dg_d}{-\frac{1}{dt}}=\frac{dT_d}{-\frac{1}{dx}}$$

$$\frac{dg_d}{idt}=\frac{dT_d}{idx} \tag{101}$$

Note that an incorrect positioning of dt and dx in the denominators, as in

(98), would apply as an equivalent to having missed to affect the reciprocation of parameters for the case of the gravitational interaction. That in turn, results to a calculational fault which assumes that the hypothetical graviton has a spin equal to the reciprocal of 1/2 (instead of 1/2), where that makes for the spin 2 (= 1/(1/2)) assumed for the gravitons.

According to the above, it therefore appears that the W^{+} and the W^{-} bosons may carry the characteristics of the hypothetical graviton and anti-graviton. Or, the negative graviton and the negative anti-graviton, if speaking with respect to our own cosmic region, and perception. And since these particles' field components are of negative energy, they quickly become evanescent in the real world, so these particles have a very short range of action.

(c) Notes on the Higgs boson

The Higgs boson does not belong to the electroweak interaction; however, it has a particular association to it. As discussed in previous sections, the Higgs field which permeates spacetime refers to the phase shift between the metric of space and the metric of time, as depicted in **Figure 1**. The existence of this shift allows for leptons' negative energy fields to engage in effects of reaction, through their displacement-field variants. The particular value of this shift was introduced to match the Weinberg angle, and this exact angle is the one that allows for the existence of quarks, and the particular value of their charge, as explained in section 4. The particle-nature of this field (in the form of boson) arises the same way it does for all other bosons, which concerns how it is perceived from fermions' point of reference. As explained earlier, since a fermion involves a sinusoidal-like alternation in the fastness of passing time and the stretching of space, that gets any interaction of such fermion with external fields (including the Higgs field) to take place as if the alternation of the external field consisted of a superposition of alternations of higher and lower frequencies of diminishing strengths, where that has the form of a beat, or quantum of energy. That is what gets the Higgs field too to interact in the form of a boson. Furthermore, as the Higgs field is described to concern the phase shift between the metric of space and the metric of time, its nature should rather be stationary and uniform throughout the universe (at least over the cosmic range where stable matter of any form exists). Because of that, when this field interacts in the form of a boson, its spin should have zero value, as verified [39].

7. Extrapolations Discussion

(a) On the Strong Force (Conceptual)

The limitations of the Standard Model to explain numerous effects in nature raises questions if parts of it may need revisions or additions [40]. That calls for proposals in particle physics, addressing points that include the dynamics inside the nucleus [41]. In this case, the symmetries described earlier allows for a new approach. In section 3 we described that the electric & magnetic fields come in positive or negative energy field variants, and either variant may apply over opposite space or time metric curvature through their displacement-field versions. The latter versions constitute complex entities, and engage in effects of reaction. For instance, under Lenz's law a change in magnetic flux (which was explained to measure with respect to negative reciprocal space) generates a negative-energy displacement electric field which in turn generates the displacement of current in a metal ring. Or, in an inverse case described by Faraday's law, a change in electric flux (which was explained to measure with respect to negative reciprocal space) generates a negative-energy displacement magnetic field which in turn generates a displacement voltage across the capacitor's plates. We shall loosely represent the former interaction as $\bar{D}H$, and the latter as $\bar{H}D$. While these interactions involve electrons, similar interactions should hold for negative energy particles, like neutrinos residing in cosmic regions of negative space metric which constitutes their habitat. Analogous interactions appear to hold in terms of the gravitational interaction as well.

Now let us shift attention to the nature of quarks. According to what was discussed in section 4.10, quarks resemble leptons which are subject to a phase-shift by 30˚ (the Weinberg angle, which accounts for one-third of the orthogonal 90º) or a multiple of it, into negative curvature. In loose terms, a quark resembles a particle that is 1/3 of an electron and 2/3 of neutrino, or vice versa. In such case, quarks may be subject to interactions as of above taking place in both directions in parallel, as if Maxwell's law and Lenz's law applied in parallel with a probability for each, in an interaction that looks like $\left(\bar{H}D \pm \bar{D}H\right)\big/\sqrt{2}$. Here the square root is for normalization purposes, signifying 50% chances for each part, while the displacement fields D and H should here associate to the fractional charges involved (1/3e or 2/3e). Similar conditions should also hold with respect to quarks' gravitational and gravitomagnetic field coordinates, associated to their matter and negative matter portions, where interactions in negative curvature should apply at very short range in the real world.

That the Weinberg angle corresponds to a third of 90º, that a multiple of that angle may refer to a different quark, and more particularly that the shift may take place per either of the 3 dimensions of time which the present model assumes in the previous sections, seems to provide grounds for the nature of the 3 "color-charges". The 3 dimensions of time in this case might refer to alternative states of phase shift of the quark's parameters of time, with respect to space. Actually, when an exchange in color-charge additionally involves a change in particle generation (to be discussed right next) then the triangularity of the three color-charges changes, and the cosine and sine coordinates involved in the displacement-field interactions no more concerns the Weinberg angle, but involves the corresponding Cabibbo angle.

The alternation of color-charge between quarks may resemble the alternation of polarity between the plates of a capacitor, which was previously discussed to involve a displacement-potential. Each one of the color charge fields, named red-green-blue, comes in two opposite energies, for example the red comes in red r

and anti-red $\overline{r}$, and that seems to correspond to a difference like the one between g and $\overline{g}$ in a gravitational equivalent, or T and $\overline{T}$ described earlier. A link of color fields to the three dimensions of time would in fact associate the color charge to the gravitomagnetic interaction. Yet, for same reason as in section 6(a) the units of the magnetic field were considered suitable to mediate transmission of displacement-negative-momentum, here an analogous symmetry may link color charge to displacement antimagnetic $\left(\overline{B}_d\right)$ properties.

The exchange of color-charge in the form of gluons should be quantized only from the reference point of quarks, for same reason as the photon was explained earlier to interact in quantized form only from the reference point of an electron's wave function, due to the Fourier-series involvement. But since the quarks extend in both the positive and the negative metrics, the interaction may involve a "combined state" of color and anti-color (loosely like the gravitational counterparts of Lenz's law and Faraday's law applying in parallel) with a probability, as theory specifies for a state of color charge to have a form like $\left(r\overline{b}+b\overline{r}\right)/\sqrt{2}$. And since these are displacement-fields and apply in opposite metrics of space or time in each case, they become quickly evanescent, hence the strong force has a very short range. Furthermore, in a similar way to as in section 5.6 the gravitomagnetic field was explained to be responsible for the galaxy rotation curves being flat, an analogous process in opposite energy (here in very short range) could be responsible for the gluon interaction keeping constant regardless the separation, letting color-fields behave as string-like objects referring to "flux tubes".

Elementary particles' masses are estimated through the Standard Model [42]. Regarding the reason why baryons are heavy, the present model allows for possibilities that: In one part, it may be attributed to an *effective* larger-than-the Weinberg angle inductive-like phase shift that quarks may experience due to the shifts described in section 4.10 (while leptons experience the Weinberg angle). In another part, it may be attributed to the gluons exhibiting inductive-like impedance characteristics through a symmetric process to the one that the Z^0 was considered to exhibit pseudo-mass in section 6.

(b) On Particles' Generations

According to textbook theory, the creation or decay of higher generation particles mainly involves the weak interaction where the change in mass comes through the exchange of $W^{\pm}$ bosons. Along this context, the exchange (transfer) of mass is here proposed to follow certain analogy to the exchange (transfer) of charge between the plates of a capacitor, if the latter is treated as a process co-engaging a photon and a Z^0 via a pattern as follows:

(i) In an ordinary (non-relativistic) case, electro-magnetic radiation is emitted sideways to the acceleration of charge. This is so, as in that direction the inductive and capacitive terms (lying within ε and μ) are balanced out, so the transmission of the wave does not carry (displace) charge, hence the emission of radiation along that direction is "radiative". As discussed in section 6(a), the inductive/capacitive terms refer to an alternating phase shift by the Weinberg angle, and the energy conveyed concerns displacement negative-momentum (which makes it possible to change the electronic energy state of a receptor electron).

(ii) In the orthogonal "non-radiative" direction instead, like between the plates of a capacitor, the interaction may be considered to involve the exchange of a "virtual photon", called virtual since it propagates in the non-radiative direction, so it refers to evanescent-wave modulation, which dumps out quickly, since it has imaginary character. This interaction involves the transmission of "displacement-current" (instead of transmission of displacement negative-momentum which is the case along the radiative direction). As the interaction between the plates of the capacitor does not exchange momentum, it requires two mediating particles to counterbalance their displacement-momentum properties. In relation to the discussion in section 6(a) this concerns a photon AND a Z^0 as the former was described to convey displacement-*negative*-momentum and the later to convey displacement positive-momentum. If that interaction was represented by a Feynman diagram, it should therefore involve the *mutual exchange of a virtual photon and a virtual* Z^0.

(iii) A symmetric process seems to be taking place during a change in particles' generation. Here, a different orthogonality holds, involving an exchange between the parameters of space and time. This applies as an effective change in the "gravitational" energy state of a particle (instead of a conventional change in the "electronic" energy state). As per this orthogonality, this process involves the *simultaneous involvement of a* W^+ *and a* W^- *boson* (instead of a photon γ and a Z^0). We may actually consider that, in relation to discussion in section 6(b), the W^+ *and a* W^- bosons resemble having a role of "gravitons". Moreover, the simultaneous use of a W^+ *and a* W^- yields a zero change in charge.

(c) On the Extra Dimensions

Along with the 3 dimensions of space, the present model assumes 3 dimensions of time, being necessary as well as sufficient to accommodate the interactions of nature. The existence of more than one dimensions of time has been discussed in section 3.5(b) through the paradigm of two rocket ships travelling side-by-side near lightspeed, where the crew of the one ages same as the crew of the other, but at the same time it ages slower that the people on earth, implying that at least two dimensions of time are accounted for to exist. That reasoning may also extend to generalize for 3 dimensions of time. The specific value of 3 dimensions of time is further supported through the relations (10) and (11) of the gravitational and the gravitomagnetic fluxes, as discussed correspondingly. In symmetry to the case of electromagnetic interaction, the notion of gravitational flux assumes "propagation" in the one dimension of time with respect to two orthogonal dimensions of time referred to in the term dt^2. In this respect, the use of 3 dimensions of space and 3 dimensions of time allows and suffices to account for the fields and action forces of the gravitational and the electromagnetic interactions.

Then we also considered new particulars in reference to negative time and negative space metrics. As explained, negative time has nothing to do with events progressing in reverse like in a motion picture played backward. Instead, it should be considered to simply concern a place where *anti*-particles reach stable form (in alignment with the Feynman-Stückelberg interpretation), like the positrons, while conventional matter, like the electrons, are vulnerable to disintegration, as through annihilation events. Likewise, the notion of *negative space* has nothing to do with measurement of space in the opposite direction. It concerns a far deeper notion, and can be considered to concern a place where negative-matter particles reach form, which this model associates to particles like the neutrinos and antineutrinos (with the latter two differing between each other by the direction of time being positive or negative). Concerning the negative-energy field variants that ascribe to these particles (meaning the anti-electric $\bar{E}$, anti-magnetic $\bar{B}$, negative-gravitational $\bar{g}$, and negative gravitomagnetic $\bar{T}$ fields) these may not directly affect real action forces in the real world, however they may engage in effects of reaction (like the inertial or the electromotive) through the displacement-field versions (D, H, g_d, T_d). These may engage in opposite energy too, meaning that the negative-energy field variants ($\bar{D}$, $\bar{H}$, $\bar{g}_d$, $\bar{T}_d$) may yield action toward the real world, as for example in the cases of the electric battery and exergonic reactions discussed in section 3.6. Such displacement-field versions involve a phase shift in time or in space, hidden within a permittivity or permeability-like term correspondingly. This constitutes an additional way that this model accounts for effects of time and/or space.

The negative-energy displacement-field variants were also explained to become involved in the weak interaction, and in that respect the 3 dimensions of space and the 3 dimensions of time are sufficient for, and allow to account for the weak interaction too. Furthermore, the strong interaction was discussed to fractionally involve such fields in both positive and negative energies concurrently, and to engage in their phase shifts per every dimension of time and space. In that sense, the strong interaction should also be accommodated by 3 dimensions of time and 3 dimensions of space.

There is still an additional key concept that needs to be brought up. Every single dimension of space and every single dimension of time may involve two forms of measurement:

(i) The one concerns conventional measurements, like a difference between two points in space or two points in time. For example, the distance between point A and point B being "X" meters, or, the time lapse between two events being "Y" seconds.

(ii) The other measurement per each single dimension, refers to and involves a different degree of space contraction, or/and time dilation. For example, time moves slower at low elevation, and faster at higher elevation. We may consider this as a single dimension of time, but the measurement here may account for time dilation and is subject to progressive curvature. And similarly applies for space contraction/stretching, where a high positive number refers to *stretched-out* space (e.g. free from relativistic contraction), while a low positive number refers to *space-contracted* space. Here again, negative values of space can account for interactions involving particles of negative matter (which the model associates to neutrinos and antineutrinos), while negative values of time can account for interactions involving antimatter (like the positrons and antineutrinos).

To account for all the above ways of measurement, it requires complex numbers. More particularly, each "single" dimension of space or time, should engage as a Real or as an Imaginary coordinate. An imaginary coordinate lies beyond the context of conventional classical physics, but is fully engaged in real life, as in describing effects of quantum nature (discussed in section 4), or in the accounting for interactions of displacement fields since the permittivity and permeability terms in both the electromagnetic and the gravitational interactions are complex entities, so any interaction involves a real or/and an imaginary coordinate. Note that a real or an imaginary coordinate of time, or of space, refers to the same inherent time or space (of positive or negative metric), depending on the reference frame in each case. For instance, recall that as previously described, the electric field refers to curvature in imaginary space, and the electric flux is measured with respect to an "area" in imaginary space since the area term dx^2 is not in a denominator. Therefore, the expression of the electric flux implies the existence of 3 *imaginary* dimensions of space. And the same holds for the magnetic field which refers to curvature in imaginary time, and its flux which is measured with respect to an "area" in imaginary space. Likewise, the gravitational field concerns different fastness of passing time per points in space, and is imaginary with respect to the electromagnetic interaction. Furthermore, the gravitational "flux" was explained to be a measure of the gravitational field with respect to (normal to) an "area" in imaginary time as described by equation (10), since the "area-like" term dt^2 is not in the denominator position. Therefore, the expression of the gravitational flux implies the existence of 3 imaginary dimensions of time. And it similarly applies for the gravitomagnetic field too, where, in relation to the discussion in section 5.6, its potential refers to the curvature in "real space", which causes a mechanical, Bernoulli sideways pressure that tends to deflect moving matter.

As per the above, all interactions accounted for in real numbers have complementary interactions which are accounted for by imaginary numbers. For instance, the curvature of "real space" (like in the neighborhood of a celestial object) refers to the essence of the "anti-electric" field as discussed, which is an imaginary field variant for electrons, but a real field for neutrinos upon which it affects an acceleration force. Or, in an example concerning time, in relation to discussion in section 4.1, a particle's matter wave refers to an oscillation in the imaginary coordinate of time, provided that the units of the Planck constant refer to [Joules · sec], where time in not in a denominator position, as explained through the relation (68).

That each of the 3 dimensions of space and the 3 dimensions of time may be accounted for as real as well as imaginary coordinates (where the corresponding axes are by definition orthogonal to each other), brings up additional orthogonalities, allowing for more interaction possibilities. These additional orthogonalities may even involve cross-bridging between interactions, since in relation to the above, a curvature in real time corresponds to the gravitational field, while the curvature in imaginary time refers to the difference in density of magnetic field "lines", causing a force sideways to the magnetic field. Likewise, the curvature in imaginary space refers to the electric field, while the curvature in real space refers to the difference in density of gravitomagnetic field "lines" causing mechanical pressure sideways to the field as described above. And it inversely applies for neutrinos and antineutrinos in the region of their own habitat (the negative space metric), where, for instance, the curvature in real space (according to their reference viewpoint) applies as an "anti-electric" field, while the curvature in imaginary space also corresponds to a difference in density of negative gravito-magnetic field "lines" which causes a sideways pressure in fluid mechanics.

A still additional key aspect of dimensioning, is that all fields generally form loops. Even fields that do not appear to have loop-like field "lines", and exhibit radial-like character, like the gravitational, the electric, the intrinsic magnetic or the intrinsic gravitomagnetic. These fields' "lines" eventually form loops of which we perceive only the real portion (looking radial-like with respect to our classical reference viewpoint) and we do not directly perceive the imaginary portion which concerns a hidden part of the loop.

In this respect, fields' "lines" may be loosely associated to hypothetical "strings". In the actual universe of course, the concept of waviness forming an ideal loop is hardly met, since at every scale (from very small, to as large as the cosmic scale) the actual waviness rather corresponds to a "sea of waves". This is just like in electronics an ideal circuit loop is hardly met, since actual electronic circuits include numerous co-involved loops.

(d) On Principles of Entanglement

Before addressing entanglement, we shall comment on what a gravitational wormhole may, or may not, correspond to. In sections 2.2 and 5.4 we described that the further away from a black hole's event horizon, time runs faster and faster, until it reaches a peak value by mid-distant universe and then starts moving slower and slower, until it reaches another nodal surface at the event horizon of an analogous celestial formation at the further-distant universe. Beyond both nodal points (behind the corresponding event horizons), time is predicted to "pass" in the negative direction. A question of interest is if spacetime behind these two event horizons may connect to each other. Or, to make the question more vivid, to consider if a hypothetical rocket that supposedly dives into the one black hole may travel-through or tunnel-through, to eventually reappear from the other one.

On the basis of what was described throughout the previous sections, and in relation to Figure 8 part(a), a rocket ship made of matter would actually not be able to sustain existence in a region where the time metric has negative values (as at the left of point b in that figure, where time moves in the negative direction) as its constituent particles (made out of ordinary matter) would disintegrate. That is unless it could be composed of antimatter (but in such case it would not sustain living long in our classical world of positive time, for the same exact reason). If that obstacle could somehow be overcome, then, the hypothetical rocket made of antimatter could move in the direction toward the left of *b*, and follow a loop (supposedly ignoring fuel/power requirements) all the way until approximating point *g* from the right side (as the figure's axis constitutes a loop), so as to reach the event horizon of the other black hole (but still being in the negative-time side of it). In the typical case, this journey requires to pass through another nodal region (point *a*) where the curvature of space also flips sign. This brings another impediment, as beyond that space-nodal range, the rocket would again not sustain being composed of antimatter any more, as antimatter may not reach particle-form in the negative space metric. It should now be composed of negative matter (like the essence of neutrinos and antineutrinos provided that these particles reside in that cosmic region so they may reach particle-like form).

As per the above, the composition of the rocket ship is substantial and depends on what kind of event horizons a hypothetical rocket ship should dive in to, and come out from. For instance, if both event horizons referred to conventional black holes, the rocket ship would have to go through a region of negative time but might not have to cross through a region of negative space. While, if the rocket hypothetically moves into a conventional black hole and tries to follow a trail to come out of a quasar, the rocket should go through a space-nodal region (like point *a*) and would have to change composition, to being made of negative matter, as explained.

If the issue of the rocket ship's composition were completely ignored, then the rocket could conventionally travel the distance from behind a black hole's horizon toward another black (or white) hole. Such journey would be extremely long lasting, much like it would be extremely long-lasting for a conventional rocket ship to travel from earth to a place at the very outer universe.

The particular paradigm of above does not concern a tunneling process in any way, but sets some intuitive grounds as of what holds in terms of curvatures of space and time. In that sense, diving into a black hole and coming out of another does not refer to a wormhole. There is however a different possibility allowed, which may account for tunneling. That possibility involves a new notion, of inductive-like or capacitive-like phase shifts, which refers to a completely different attribute. In section 3 it was discussed how an inductive or a capacitive shift in electronics conveys a reaction potential concurrently throughout a circuit loop (in similar sense to as, when turning a bicycle wheel all elements of the wheel rotate concurrently). That allows for instantaneous transfer of reaction to all elements of the loop, and as that concerns an attribute of instantaneity it may require imaginary numbers to be accounted for. We also discussed how a similar inductive-like or capacitive-like process applies on the gravitational interaction, where the shift deploys concurrently over the whole (hypothetical) trail of a gravitational field "line" (including both its real and imaginary portions). While in section 4.2 we also discussed how that form of path quantitatively associates to specific imaginary parameters of a particle's wave function. A phase shift that rides over a whole gravitational (or a gravitomagnetic) field "line" allows for instantaneous transfer (via a displacement shift), and engages in effects of reaction which involve the negative-energy field variants, which were explained to apply through their displacement-field versions. As for instance, the gravito-motive field (applying in symmetry to the electro-motive), described in section 3.

The corresponding instantaneity is what lies behind the effect of entanglement, which today's theory treats by conjecture as an effect of quantum nature, while the present model allows to approach in classical-physics terms via phase shifts and the involvement of displacement-field variants. A reaction-born field displacement in this case is conveyed instantaneously upon the full loop of a gravitational or a gravitomagnetic field "line" it rides upon, in the same sense to as an inductive phase shift is instantaneously conveyed over a circuit loop. (This is just like any motional change to any element of a bicycle wheel is mediated concurrently throughout the whole wheel). This however, applies only under a strict precondition, that the loop-like field trail should already be there in existence (so the displacement would be possible to ride over it). This is why particles need to be "entangled" so as to jointly ride upon common loop-like field line trails. (In effect, this "connects" two quantum particles much like a capacitor and an inductor are "connected" over a circuit loop, so any shift in current affects them both instantaneously). This also provides a limitation, that the "establishment" of the common field loop (of entangled particles) may not be set faster than the speed of light in the first place. But while it is set, any fluctuation may phase-shift instantaneously throughout the trail of the field "lines" of that loop.

The above process explains in a rational way how a fluctuation in a parameter of one quantum particle may phase-shift (tunnel through) and instantaneously get the combined wave function of two entangled particles collapse. This process addresses the so-called "spooky action at a distance", which therefore is not spooky at all. Furthermore, this attribute may similarly apply for any other displacement-fields as well.

A point that may seem puzzling, is how it can be possible for photons, which involve electric and magnetic components and therefore refer to the *electromagnetic interaction*, to engage in an effect of entanglement which by conjecture concerns an effect of quantum gravity and thus the *gravitational interaction*. The answer comes through points considered in section 6(a) above, according to which, a photon's magnetic coordinate may mediate the transmission of "displacement-negative-momentum" $\overline{p}_d$, and that is what brings its association to the gravitational interaction. Due to the momentum displaced being negative (and therefore imaginary with respect to the real world), the photon appears massless. Yet, this imaginary nature allows it to change the energy state of the electron (with this change associating to the particle's matter-essence, not its charge). That the magnetic coordinate may engage in the gravitational interaction may also be traced through the raw units of the magnetic field which were previously discussed to subtly associate to a measure of [sec^2/meter^3], where that may be re-written in the form [sec^2/meter] [1/meter^2], or expressed in the form $\left(dt^2/dx\right)\left(1/dx^2\right)$. The later includes two terms; an acceleration-like term $\left(dt^2/dx\right)$, and a flux-measuring term $\left(1/dx^2\right)$. The former resembles the negative reciprocal of the units of the gravitational field since $d\left(1/x\right)/d\left(1/t\right)^2=\left(dt^2/dx\right)$, while the latter describes a flux (actually a "flow", since it takes place with respect to positive space, and not with respect to negative-reciprocal space).

The above subtle association between photons and the gravitational interaction through the displacement-negative-momentum carried by them, allows for the present model to approach the effect of entanglement through inductive/capacitive-like phase shifts. Likewise it applies through a wave function's oscillations. The principle of entanglement is currently used to communicate bits of information in quantum computing. But there are far more possibilities than this, which can be accomplished through the present approach. For instance, if an established communication channel is used to apply phase shifts in an alternating way, it may be used to convey ultrafast signals. Once two systems are already coupled, the grounds exist for instantaneous displacement transmission, through appropriate modulation-demodulation in negative energy. Such type of modulation-demodulation would actually serve for extraterrestrial communication due to transmission fastness. A method that was conceived by the lead author in the early 90s for affecting such modulation/demodulation, and more particularly the understanding of its particulars, was actually what triggered the present research, as mentioned below in the section "Author Contributions".

8. Conclusions

Just like effects of induction and capacitance resolve a large number of effects in electronics, it similarly appears to apply with the gravitational interaction which is discussed and documented to similarly involve inductive-like and/or capacitive-like phase shifts. These appear to bring into surface new insights on how numerous effects of mechanics link to the gravitational interaction. The gravitational and electromagnetic interactions are shown to follow symmetric laws, subject to a particular way of exchanging parameters of time and space. This allows to address the functioning of the inertial force as an inductive-like potential in certain symmetry to the functioning of the electromotive potential (and associated inductive impedance in changing an electric current). The same general concept allows to address the way the Higgs field mechanism functions in "dressing" matter with inertia. The Bernoulli pressure is likewise discussed to function in deep symmetry with the way magnetic potentials exert deflection forces on moving charges, vortex flow in fluid mechanics is explored to follow analogies to Lenz's law, barrier penetration to function in deep symmetry to the crossing of displacement current through the plates of the capacitor, and more.

Much like the gravitational field associates to the curvature in the metric of time, a particular way to treat imaginary terms allows for a symmetric association between certain other fields and the curvature of negative-reciprocals of metrics. In fact, this appears to additionally allow to subtly associate certain fields with raw units, in close analogy to what holds for the gravitational field. Forces are discussed to function (in producing acceleration) by relaxing the potentials associated to the curvature in the corresponding metrics in each case. Reaction potentials are discussed to involve imaginary coordinates which appear to apply toward the real world through the involvement of displacement-field versions, similarly to as it holds with the displacement-electric field. It is discussed how this may similarly hold for a displacement-magnetic field, while similar displacement-field versions are also explored to apply for corresponding field-counterparts of the gravitational interaction. Just like inductive/capacitive displacements in electronics are known to deploy in time (through phase leads or phase lags in time) the gravitational counterparts are discussed to deploy over space, which is documented by re-interpretation of existing quantitative predictions. Furthermore, the exploration of how negative-reciprocals of parameters may engage in interactions, allows to address how fields' "fluxes" differ to classical "flows".

Wavefunction's imaginary terms are quantitatively explored to resemble alternations in the metric of time and/or space. This possibility allows to address an elementary particle's interaction with external fields through a Fourier-series process which provides insights on the reasoning behind the exchange of energy in a quantized way (as beats of energy) bearing the characteristics carried by bosons. An exploration of the deeper role of specific imaginary terms of a wave function is additionally discussed to indirectly associate to particles' external fields. This possibility allows for a new approach in addressing fundamental differences between the four leptons. It also gets to associate the negative solutions of the Dirac relativistic equation to a negative form of matter (not to antimatter), linking it to neutrinos residing in negative metrics (and not to positrons). In this respect, just like the Feynman-Stückelberg interpretation suggests the association of antimatter to negative direction of time, neutrinos are discussed to associate to the negative space metric on the basis of symmetry. Furthermore, effects of relativity get to bridge with wave nature by addressing on the relativistic aspect of particle's momentum wave properties, instead of relativistic mass alone.

The reason of existence of the Weinberg angle is presented to arise by symmetric means to that of an inductive phase-shift in electronics. The particular value of this angle is discussed to possibly link to a particle's spin 1/2 value (being equal the sine of the Weinberg angle 30˚), while it is also discussed how the same particular value of this angle could very likely constitute a key element for the existence of quarks and the precise value of their charge (1/3 or 2/3 of e).

The above concepts have large implications in astrophysics. They allow addressing the abundance of matter over antimatter (in certain symmetry to the measure of power curves under conditions of inductive or capacitive phase shifts in LC electric circuits), they also appear to address the reasoning behind spiral galaxies' rotation curves (through a co-involved negative energy interaction), and seem to shed light on specific transitional processes that take place during supernova explosions, as discussed. The same model also allows to address the observed acceleration at astrophysical scale on the basis of opposite inclination of curvature in the metric of Time.

The model further predicts cosmic spots in the universe where the time metric has negative values, and cosmic spots where the space metric alike takes negative values, which appears to find grounds in specific astrophysical observations. This has no link to interpretations of parallel universes. Instead, these cosmic spots (regions) appear to provide stable habitat for different leptons, which comes to match existing unconventional astrophysical observations. The existence of cosmic regions of positive and negative metrics of space and time allows for a balancing of energy, and this in turn allows for the total positive and the total negative energy (in effects of both time and space) in the cosmos to sum up to null, making it plausible for the cosmos to exist without any need for external supply of energy, and without the need for the existence of a "cosmological constant". At the same time, the waviness discussed to apply at the cosmic scale waives any need for singularities.

Furthermore, that the electromagnetic and gravitational interactions carry symmetrical characteristics subject to a particular swapping between parameters of space and time, addresses deep reasons for the coexistence of matter and charge on the basis of energy balancing. To cope with the corresponding quantitative symmetry, the model introduces arguments that support the existence of 3 dimensions of time along with the 3 dimensions of space. Yet, other than conventional measuring in space or time, a complementary requirement is set in measuring on curved space and curved time. This brings the need for every dimension of space and time to be accounted for through real and imaginary coordinates, based on the reference frame in each case. That introduces additional orthogonalities between dimensions, and a phenomenological discussion is provided on how this may engage all interactions. Furthermore, in addition to measurements with respect to any dimension of space or time, the model also involves the notion of phase-shifts per dimension of time or space, in this way allowing to cope with imaginary terms, and in accounting for interactions in opposite sign of energy.

Furthermore, restrictions are set on the concept of "time travel" by addressing issues of disintegration when particles need to go through opposite metrics of time or/and space. In the other hand, the introduction of phase shifts in the gravitational interaction provides new possibilities in exploiting processes and attributes similar to those of entanglement, opening up a new window for technological innovation in energy transfer, propulsion at the quantum scale, ultrafast communication, and exploitation of negative-energy interactions, over interdisciplinary areas.

Author Contributions

The present research on bridging elements between interactions was triggered upon earlier research by the lead author (C. Tsikoudas) since the late 80s, then a student of electrical engineering, as he had conceived a method of energy transfer through a resonant interaction at the microscopic scale. That had gone through confidential evaluation by academics in the early 90s, and a very simplified model was tested to work. The energy transfer could yield local propulsion, but that required means of conservation of momentum which was a not-local process, and that was running into imaginary numbers. The lead author was proposed to carry on further work into it, and a long-lasting research followed independently in private while in his homeland Greece, aiming to associate the imaginary numbers to the reaction potentials that were needed to apply concurrently on the basis of conservation laws. It was figured that this was plausible through the involvement of displacement-field variants, utilizing inductive-like or capacitive-like phase shifts. The associated research took a different direction, that led to the development of the model introduced in this paper, providing elements contributing toward a bridging between the gravitational interaction and the Standard Model. In reference to that, the first author's (C. Tsikoudas) involvement concerns the conceptualization and the writing of the present paper. The co-author's (Th. Karacostas) involvement has been very significant over the active appraisal and supervision upon completion, especially in relation to effects of fluid flow which constitute a primary aspect of the theory.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

[1] Feynman, R.P. (1964) The Speed of Clocks in a Gravitational Field. *Feynman Lectures on Physics*, **II**, 42-46. http://www.feynmanlectures.caltech.edu/II_42.html

[2] Feynman, R.P. (1949) The Theory of Positrons. *Physical Review*, **76**, 749-759. https://doi.org/10.1103/physrev.76.749

[3] Cramer, J.G., Forward, R.L., Morris, M.S., Visser, M., Benford, G. and Landis, G.A. (1995) Natural Wormholes as Gravitational Lenses. *Physical Review D*, **51**, 3117-3120. https://doi.org/10.1103/physrevd.51.3117

[4] Abramowicz, M.A. (1993) Black Holes and the Centrifugal Force Paradox. *Scientific American*, **266**, 74-81. https://doi.org/10.1038/scientificamerican0393-74

[5] Tsikoudas C. (2022) Chapter 6.2: The Gravitomotive Potential in Inertia & Vortex Flow. In: Tsikoudas, C., Ed., *Time vs Space, and the Universe Beyond the Standard Model*, Amazon Digital Services LLC, 139-148. https://inspirehep.net/literature/2060341

[6] Woodley, J. and Mojahedi, M. (2010) On the Signs of the Imaginary Parts of the Effective Permittivity and Permeability in Metamaterials. *Journal of the Optical Society of America B*, **27**, 1016-1021. https://doi.org/10.1364/josab.27.001016

[7] Singh, C., Bindra Narang, S., Hudiara, I.S., Sudheendran, K. and James Raju, K.C. (2008) Complex Permittivity and Complex Permeability of Sr Ions Substituted Ba Ferrite at X-Band. *Journal of Magnetism and Magnetic Materials*, **320**, 1657-1665. https://doi.org/10.1016/j.jmmm.2007.11.002

[8] Heras, J.A. (2011) A Formal Interpretation of the Displacement Current and the Instantaneous Formulation of Maxwell's Equations. *American Journal of Physics*, **79**, 409-416. https://doi.org/10.1119/1.3533223

[9] Enders, A. and Nimtz, G. (1993) Evanescent-Mode Propagation and Quantum Tunneling. *Physical Review E*, **48**, 632-634. https://doi.org/10.1103/physreve.48.632

[10] Eisberg R. and Resnick R. (1985) 5.2 Plausibility Argument Leading to Schroedinger's Equation. In: Eisberg, R., Ed., *Quantum Physics of Atoms, Molecules, Solids, Nuclei, and Particles* (2*nd Edition*), John Wiley & Sons, 128-134. https://www.academia.edu/34663945/Quantum_physics_2nd_eisbergresnick

[11] Bowen, D. (2016) The Real Reason Why the Electron's Bare *g*-Factor Is 2 Times Classical. *Journal of Modern Physics*, **7**, 1200-1209. https://doi.org/10.4236/jmp.2016.710109

[12] Smarandache, F. (2012) Centric Cardinal Sine Function. *International Journal of Geometry*, **1**, 27-40. https://digitalrepository.unm.edu/math_fsp/471

[13] Feynman, R.P. (1964) The Relativity of Magnetic and Electric Fields. *Feynman Lectures on Physics*, **II**, 13-16. https://www.feynmanlectures.caltech.edu/II_13.html

[14] Hautmann, F. (2010) An Introduction to QED & QCD. https://www-thphys.physics.ox.ac.uk/people/FrancescoHautmann/Ralhep/ralss10_p.pdf

[15] Kowitt, M. (1996) Gravitational Repulsion and Dirac Antimatter. *International Journal of Theoretical Physics*, **35**, 605-631. https://doi.org/10.1007/bf02082828

[16] Williams, R.K. (2005) Gravitomagnetic Field and Penrose Scattering Processes. *Annals of the New York Academy of Sciences*, **1045**, 232-245. https://doi.org/10.1196/annals.1350.018

[17] Bheghella-Bartoli, S., Bhujbal, P.M. and Nas, A. (2014) Confirmation of Antimatter Detection via Santilli Telescope with Concave Lenses. *American Journal of Modern Physics*, **4**, 5-11. https://studylib.net/doc/7053859/confirmation-of-antimatter-detection-via-santilli-telesco

[18] Santilli, R.M. (2014) Apparent Detection of Antimatter Galaxies via a Refractive Telescope with Concave Lenses. https://www.prweb.com/releases/2014/02/prweb11589410.htm

[19] Davis, R.J., Unwin, S.C. and Muxlow, T.W.B. (1991) Large-Scale Superluminal Motion in the Quasar 3c273. *Nature*, **354**, 374-376. https://doi.org/10.1038/354374a0

[20] Mirabel, I.F. and Rodríguez, L.F. (1994) A Superluminal Source in the Galaxy. *Nature*, **371**, 46-48. https://doi.org/10.1038/371046a0

[21] Recami, E., Castellino, A., Maccarrone, G.D. and Rodonò, M. (1986) Considerations about the Apparent "Superluminal Expansions" Observed in Astrophysics. *Il Nuovo Cimento B Series 11*, **93**, 119-144. https://doi.org/10.1007/bf02722327

[22] Tsikoudas, C. (2022) Chapter 4: Cosmic Regions & Their Particle Inhabitants. In: Tsikoudas, C., Ed., *Time vs Space, and the Universe Beyond the Standard Model*, Amazon Digital Services LLC, 19-32. https://inspirehep.net/literature/2060341

[23] Bartoli, S.B. (2017) Trajectories of Antimatter Asteroids in Our Solar System. *AIP Conference Proceedings*, **1798**, Article ID: 020020. https://doi.org/10.1063/1.4972612

[24] Woosley, S. and Janka, T. (2005) The Physics of Core-Collapse Supernovae. *Nature Physics*, **1**, 147-154. https://doi.org/10.1038/nphys172

[25] Steiner, A.W., Hempel, M. and Fischer, T. (2013) Core-Collapse Supernova Equations of State Based on Neutron Star Observations. *The Astrophysical Journal*, **774**, Article 17. https://doi.org/10.1088/0004-637x/774/1/17

[26] Hayakawa, T., Iwamoto, N., Kajino, T., Shizuma, T., Umeda, H. and Nomoto, K. (2006) Principle of Universality of γ-Process Nucleosynthesis in Core-Collapse Supernova Explosions. *The Astrophysical Journal*, **648**, L47-L50. https://doi.org/10.1086/507703

[27] Mann, A.K. (1997) Shadow of a Star: The Neutrino Story of Supernova 1987A. W H Freeman & Co., 122. https://www.amazon.com/Shadow-Star-Neutrino-Story-Supernova/dp/0716730979

[28] Fryer, C.L. and New, K.C.B. (2003) Gravitational Waves from Gravitational Collapse. *Living Reviews in Relativity*, **6**, Article No. 2. https://doi.org/10.12942/lrr-2003-2

[29] Becker, W. (2006) Old Pulsars Still Have New Tricks to Teach Us. The European Space Agency. https://www.esa.int/Science_Exploration/Space_Science/Old_pulsars_still_have_new_tricks_to_teach_us

[30] Becker, W., Kramer, M., Jessner, A., Taam, R.E., Jia, J.J., Cheng, K.S., *et al.* (2006) A Multiwavelength Study of the Pulsar PSR B1929+10 and Its X-Ray Trail. *The Astrophysical Journal*, **645**, 1421-1435. https://doi.org/10.1086/504458

[31] Mooley, K.P., Deller, A.T., Gottlieb, O., Nakar, E., Hallinan, G., Bourke, S., *et al.* (2018) Superluminal Motion of a Relativistic Jet in the Neutron-Star Merger Gw170817. *Nature*, **561**, 355-359. https://doi.org/10.1038/s41586-018-0486-3

[32] Garrett, K. and Duda, G. (2011) Dark Matter: A Primer. *Advances in Astronomy*, **2011**, Article ID: 968283. https://doi.org/10.1155/2011/968283

[33] Corbelli, E. and Salucci, P. (2000) The Extended Rotation Curve and the Dark Matter Halo of M33. *Monthly Notices of the Royal Astronomical Society*, **311**, 441-447. https://doi.org/10.1046/j.1365-8711.2000.03075.x

[34] Milgrom, M. (1983) A Modification of the Newtonian Dynamics as a Possible Alternative to the Hidden Mass Hypothesis. *The Astrophysical Journal*, **270**, 365-370. https://doi.org/10.1086/161130

[35] Tsikoudas, C. (2022) Chapter 5.4: The Imaginary Gravitomagnetic Field. In: Tsikoudas, C., Ed., *Time vs Space, and the Universe Beyond the Standard Model*, Amazon Digital Services LLC., 90-128. https://inspirehep.net/literature/2060341

[36] Beall, J.H. (2014) A Review of Astrophysical Jets. *Acta Polytechnica CTU Proceedings*, **1**, 259-264. https://doi.org/10.14311/app.2014.01.0259

[37] Miller-Jones, J.C.A., Tetarenko, A.J., Sivakoff, G.R., Middleton, M.J., Altamirano, D., Anderson, G.E., *et al.* (2019) A Rapidly Changing Jet Orientation in the Stellar-Mass Black-Hole System V404 Cygni. *Nature*, **569**, 374-377. https://doi.org/10.1038/s41586-019-1152-0

[38] Ciufolini, I. and Pavlis, E.C. (2004) A Confirmation of the General Relativistic Prediction of the Lense-Thirring Effect. *Nature*, **431**, 958-960. https://doi.org/10.1038/nature03007

[39] Aad, G., Abajyan, T., Abbott, B., Abdallah, J., Abdel Khalek, S., Abdinov, O., *et al.* (2013) Evidence for the Spin-0 Nature of the Higgs Boson Using ATLAS Data. *Physics Letters B*, **726**, 120-144. https://doi.org/10.1016/j.physletb.2013.08.026

[40] Talios, V. (2023) The Standard Model Theory [May Be] a Wrong Theory. *Journal of*

High Energy Physics, Gravitation and Cosmology, **9**, 602-610. https://doi.org/10.4236/jhepgc.2023.93050

[41] Ulaanbaatar, T. (2023) Supreme Theory of Everything: The Fundamental Forces in Quantum Hystereris. *Journal of Applied Mathematics and Physics*, **11**, 3274-3285.

[42] Mongan, T.R. (2024) Standard Model Fermion Masses and Charges from Holographic Analysis. *Journal of Modern Physics*, **15**, 796-803. https://doi.org/10.4236/jmp.2024.156035

Appendix: List of Notations

	Field	Displacement-field variant (inductive *or* capacitive)	Negative energy variant	Flux
Electric	E	$D\ \left(D^{-}\ \text{or}\ D^{+}\right)$	$\bar{E}$	Φ_E
Magnetic	B	$H\ \left(H^{-}\ \text{or}\ H^{+}\right)$	$\bar{B}$	Φ_B
Gravitational	g	$g_d\ \left(g_{d^-}\ \text{or}\ g_{d^+}\right)$	$\bar{g}$	Φ_g
Gravito-magnetic (imaginary)	T	$T_d\ \left(T_{d^-}\ \text{or}\ T_{d^+}\right)$	$\bar{T}$	Φ_T

Electromagnetic Interaction		Gravitational Interaction	
Δt	Phase shift (displacement) in time. Either inductive (a lag in time $-\Delta t$) or capacitive (a lead in time $+\Delta t$)	Δx	Phase shift (displacement) in space. Either inductive-like (a drag $-\Delta x$) or capacitive-like (a lead $+\Delta x$)
L	Inductance	L_g	Mechano-inductance
C	Capacitance	C_g	Mechano-capacitance
ε	Permittivity	ε_g	Mechano-permittivity
μ	Permeability	μ_g	Mechano-permeability