

Electric Charges might be a form of Energy

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Abstract

After the presentation of the *Special Relativity Theory* by Einstein, the concept of *Mass* was discovered to be a special form of *Energy*. Thus, the concept of *Electric Charge* remained the only distinct entity in Physics that is not equated with *Energy*. This study presents the following argument: *Electric Charges* are also a form of *Energy* as *Mass* is a form of *Energy*.

The study starts by trying to answer the following question: is it possible to detect the energy embedded in a Null electromagnetic traveling wave, which is an electromagnetic traveling wave that does not contain any electric or magnetic fields at all. The article describes how to create such a Null electromagnetic traveling wave from two normal electromagnetic traveling waves, that do contain electric and magnetic fields, which collide and following their collision consolidate and unify and continue to travel together in the same direction. In three different proposed experiments of producing a Null, or a partly Null electromagnetic traveling waves, examined in the study, energy loss in the process was observed, which *seems* as a violation of the *energy conservation principle*. The main part of this study is the development of the "*Energy Pair Theory*" (*EPT*) that explained the above energy loss by the central idea of this theory that certain energies can be accumulated and stored as "*Energy Pairs*" that *exist* but *disable* each other, and therefore, the energy that is accumulated in the pairs *exists* but is *undetectable* or *untraceable*.

Finally, the article examines the well-known observations of electron positron collision (known also as electron positron annihilation) to produce Gamma Photon, and the reversed process of Gamma Photon producing electron and positron (known also as pair production), in the EPT framework, and comes to the unexpected conclusion that *Electric Charge* is a form of *Energy*, or in other words ***the entities of Charge and Energy are actually equated***, as *Mass* is recognized of being *Energy*. This implies that the only distinct entity in *Nature* is *Energy*. This surprising and revolutionary conclusion has many future implications in both scientific research and technology.

The *Energy Pairs Theory*, developed in this study, puts the concept of "Energy" in a new and an interesting framework that is flexible and convenient to be further used as a framework in studying other physical and natural observations.

Introduction

The issue of electromagnetic traveling wave's interference was already analyzed and presented extensively. Examples of such scenarios might be counter propagating one dimensional two source waves, or a single source wave propagating in two or more dimensions via scattering one portion of the wave into another portion, such as a double slit experiment with a single source. Analysis of these scenarios has shown that the interference between such waves always conserves the waves' energy (Ref. 1).

The research presented in this paper describes a different scenario in which, a two source electromagnetic traveling waves, focused in a way that they can be considered as traveling only in one dimension are colliding, then the two waves unify and continue to travel together in the same direction. If the two waves unify when they oscillate at exactly the same frequencies,

have exactly the same intensities in their electric and magnetic fields, are exactly at a phase shift of 180 degrees relative to one another, and have proper polarization (as is explained later in this article), the resultant electromagnetic wave will be a Null wave which does not contain any electric or magnetic fields. According to our best knowledge, this kind of scenario has not been studied yet.

The present study provides a description of a possible lab experiment targeted to implement a Null Electromagnetic Wave. Then, analysis of possible results of such an experiment is discussed, and a new theoretical framework is developed to explain the results.

The conclusions drawn in this study are innovative and quite surprising, not only relating to the specific process examined, the Null Wave, but also in providing a better understanding of other unresolved scientific problems, as the disappearance of charge in electron positron collision, a possible explanation of the nature of the *Dark Energy* which affects the rate of expansion of the universe, which expands in a rate which is much bigger than the expected rate according to the current state of knowledge, and the surprising conclusions that *Electric Charges* and even the *Space* itself might be forms of *Energy* as *Mass* is a form of *Energy*.

Implementation of a Null electromagnetic wave

Consider a traveling electromagnetic wave propagating along the x-axis. According to Maxwell's equations, the electric and magnetic fields associated with such a wave take the form of (Ref. 2):

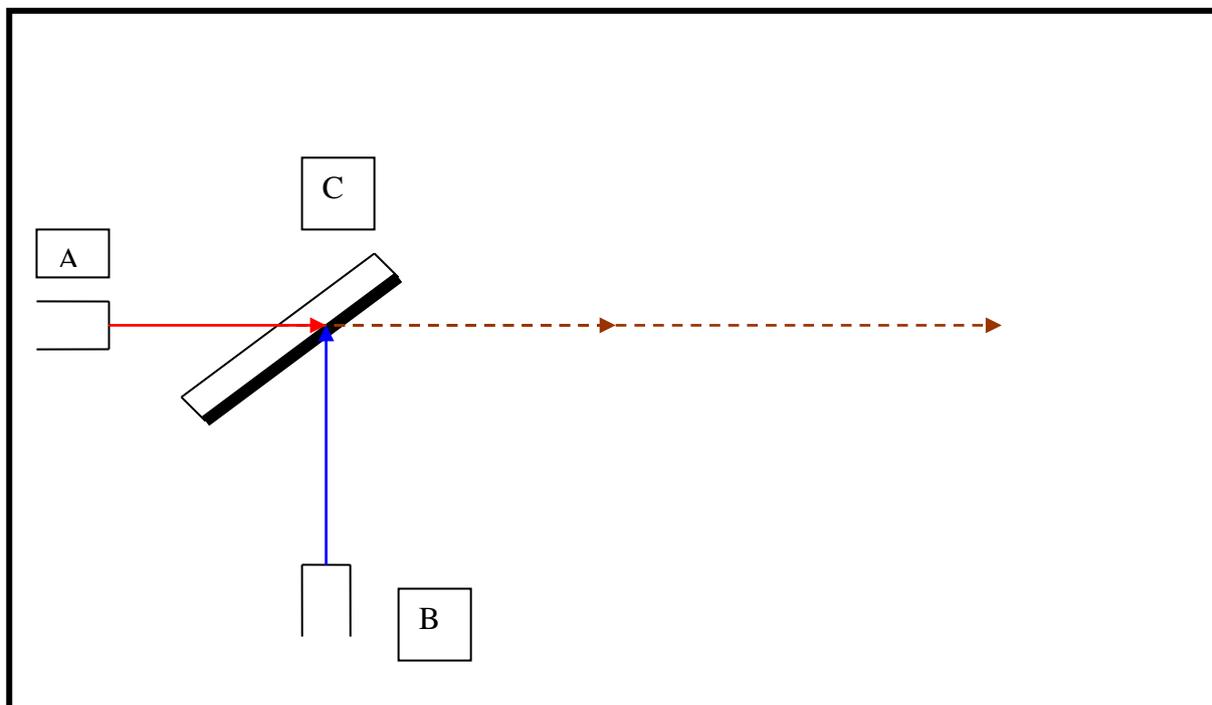
$$E_y = E_0 \cos [2 \pi ((x / \lambda) - f t)]$$

$$B_z = B_0 \cos [2 \pi ((x / \lambda) - f t)]$$

Thus, an electromagnetic wave contains two synchronized oscillating fields, an electric and a magnetic field, where each field oscillation occur at a line in space which is perpendicular to the line of the oscillation of the other field, and both these oscillation lines are perpendicular to the line of traveling of this wave. All electromagnetic waves travel at the velocity of the speed of light.

The scenario of two one dimensional electromagnetic waves which unify, and continue to travel together in the same direction can be described and implemented as shown in Fig. 1.

Fig 1



An Electromagnetic Wave source A generates a much focused one dimensional electromagnetic traveling wave (red), that passes through a half transparent mirror C, and continues to travel, as indicated by the dotted line. Another Electromagnetic Wave source B generates a much focused, one dimensional electromagnetic traveling wave (blue), that is deflected by the mirror C, such that it continues to travel on exactly the same line as the first wave A, as indicated by the dotted line.

From a Technical point of view, it might be difficult to implement such an experiment because of the requirement that the blue wave should arrive at the mirror C at a time and at an angle that it will be deflected such as to consolidate completely with the red wave A. This might be difficult to achieve. Moreover, the waves should be much focused and one dimensional, which might present an additional difficulty in arranging the equipment needed. However, thinking about the above scenario and trying to analyze it theoretically (like a thought exercise), provides the following possible result: If the two waves A and B unify when they oscillate at

exactly the same frequencies, have exactly the same intensities in their electric and magnetic fields, are exactly at a phase shift of 180 degrees relative to one another, and have proper polarization (as is explained later in this article), the resultant electromagnetic wave is a Null Wave which does not contain any electric or magnetic fields. Such a wave is described by Fig. 2.

Fig. 2

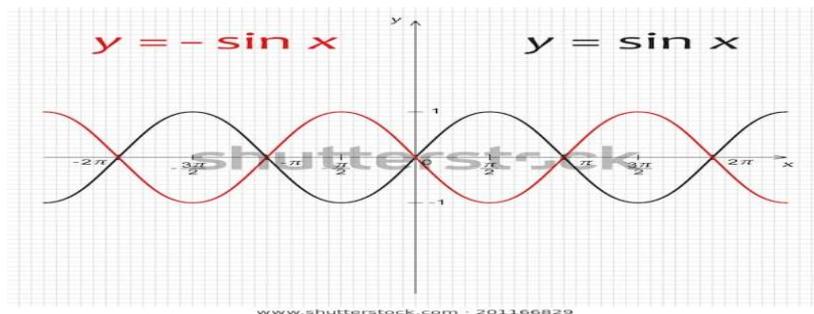


Fig 2 shows the electric fields intensities of the two waves after their unification. Clearly, the electric fields of both waves will disappear after their unification, because each field cancels the respective field in the other wave, completely and continuously. The same applies for the magnetic fields of both waves. The magnetic fields intensities of these two waves can be described also by Fig. 2, only the y-axis should be replaced by the z-axis, because the electric and magnetic fields are perpendicular to each other. So, the magnetic fields of both waves will disappear after their unification exactly as in the case of the electric fields.

It's important to add that the ***original polarization of wave A*** (the red wave) and the ***original polarization of wave B*** (the blue wave), should be such as to achieve the following result: the oscillations of the electric fields, of both waves A and B, after they pass the half transparent mirror C, must occur exactly on the same line in space. And also the oscillations of the magnetic fields, of both waves A and B, after they pass the half transparent mirror C, must also occur exactly on the same line in space (which, of course, is perpendicular to the line of oscillation of the electric fields). This polarization demand of waves A and B validates that each field cancels the respective field in the other wave, completely and continuously, after the unification of the two waves.

As already mentioned, the requirement that the waves unify when they oscillate at exactly the same frequency, have exactly the same intensities in their electric and magnetic fields, are exactly at a phase shift of 180 degrees relative to one another, and have proper polarization (as described above), might create an extra complication in carrying out such a lab experiment.

However, this experiment can also be examined also by reasoning only, or as a "thinking exercise".

The main question we want to answer relating to this experiment is:

"Is it possible to detect a Null Electromagnetic traveling wave, which is a wave that does not contain any electric or magnetic fields?"

In order to answer this question, more experimental tools should be utilized in the described experiment: A tool that can be inserted at the wave's propagation line and is able to measure the energy embedded in each electromagnetic wave. For example, since electric charges are affected by electric and magnetic fields, inserting a detector that its measurements are based on the interactions between charges and electromagnetic fields might be appropriate. Any other technically suitable detector tool can also be devised and inserted in the propagation line of the two original electromagnetic waves A and B (Fig. 1), and then in the Null Wave's propagation line (Fig. 2) and provide an indication whether the fields in the Null Wave exist, or whether the Null wave is detected via some other features it might have (for example, its energy). Actually, there are only two possible results: *One*, if the inserted tool will be affected by waves A and B, but will not be affected by the Null Wave, it will be an indication that the fields in the Null Wave, as shown in Fig 2, really do not exist and the Null wave energy is undetectable. *Two*, if the inserted tool will be affected by waves A and B, and also by the Null Wave, then, some new conclusions about the characteristics of electromagnetic waves should be drawn. These two possible scenarios are analyzed in the following section.

Analysis of Two Possible Experiment's Results

Scenario (2) - A scenario in which a Null Wave is detected in the experiment

It is accepted by the science of Physics that the energy in an electromagnetic wave is embedded in the electric and magnetic fields it carries (Ref. 3). Since these fields do not exist in the Null Wave, but the lab-detector still measured energy according to scenario-2 of the experiment, it must be concluded that *the energy in electromagnetic traveling waves is not necessarily embedded in the electric and magnetic fields it carries*. If scenario-2 is really the case, this conclusion is surprising, and raises some questions: In what, then, the energy of an electromagnetic wave is embedded? Could it be that it is embedded in the photons existing in such a wave? And if so, is it possible that these photons remained intact when the electric and magnetic fields of the wave do not exist? It might be that there are more questions that should be asked and studied if a Null Wave can really be detected as scenario-2 of the lab-experiment shows.

In our view, the assumption that the energy of an Electromagnetic Null wave is embedded in its photons, and can be detected when the electric and magnetic fields of the wave do not exist, is unacceptable. The current scientific knowledge indicates that both manifestations of a traveling electromagnetic wave, its wave and its photons or particles, are two manifestations of a single phenomenon. Thus, one cannot exist without the other. Photons are both manifestation of energy and particles, which are believed to carry the electromagnetic field force. As such, photons can't exist in the absence of an electromagnetic field. Moreover, if photons are the particles that carry the electromagnetic fields, then, their energy patterns should coincide with the energy patterns that these fields carry. But since the fields in the Null Wave disappeared and their energy cannot be detected, it is reasonable to assume, that the energy of the photons will not be detected either.

Actually, we believe that any experimental attempt to detect the Null Wave will fail, because according to the basic physical laws, it is really impossible to detect energy in a wave that doesn't have electric or magnetic fields. A new theoretical approach that explains this assumption is discussed in the following section.

Scenario (1) - A scenario in which a Null Wave is not detected in the experiment

According to scenario-1 of the experiment, the Null Wave is not detected. If we conclude that the Null Wave does not contain energy, we clearly face a violation of the **Energy**

Conservation principle: Since the Null wave was created from two electromagnetic waves, A and B, that unified and each contained energy, the accumulated energy of these two waves should be manifested in the Null Wave. If this doesn't happen, then, it is simply a *violation of the Energy Conservation Principle*. Thus, a conclusion that the Null wave is really "Null" and does not contain energy seems as an unacceptable conclusion.

In the following section we introduce a **new theory** relating the energies embedded in electromagnetic fields that will provide an appropriate explanation to the results obtained in scenario-1 of the experiment.

The "Energy Pairs Theory"

"Energy Pair" is a novel theoretical construct representing a physical state in which certain energies can be accumulated and stored together, and at the same time disable each other in a way that these energies exist but are *untraceable*.

To resolve what seems as a violation of the *energy conservation principle* discussed above, and to show that energy conservation in the creation of a Null Wave still exists, we'll introduce the *"Energy Pairs Theory"* and the novel construct of *Energy Pair* to explain the experimental results obtained in scenario-1 above. Accordingly, the energies in the Null Wave are not annihilated; they still **exist** together after the unification of waves A and B as *"energy pairs"* that **disable each other**, such that it only *appears* that the Null Wave does not have any energy and the energy conservation principle is violated. The Null Wave's embedded energies disable each other and therefore this energy is untraceable.

What is this *"Energy Pair"* and how do the energies accumulated in it disable each other?

Following is a detailed description of ***"The Energy Pairs Theory"***:

The energy embedded in an electric field generated by a **positive charge**, and the energy embedded in an electric field generated by a **negative charge**, are assigned to one set of

"Energy Pairs". The same is applied for the energies embedded in magnetic fields generated by moving charges: The energy embedded in a magnetic field generated by a ***moving positive charge***, and the energy embedded in a magnetic field generated by a ***moving negative charge***, are assigned to another set of "Energy Pairs". And, energies belonging to an ***Energy Pair*** that exist together in the same location in space and have equal intensities can still ***exist*** together but disable each other, a disabling that ***seems*** as a violation of the *energy conservation principle*.

In each set of *"Energy Pairs"* the energies of the electromagnetic waves that unified and created the Null Wave, were accumulated and continued to be stored into that *Energy Pair*. The mutual annihilation of the fields or the waves that was seen and measured as a mutual annihilation of energies belonging to these fields, and a violation of the energy conservation principle, can be viewed now as ***mutual disabling of the energies*** that continue to be stored into each *Energy Pair*.

The idea of "Energy Pairs", can be better understood by examining an analogue situation: A rope in a rope pulling game (tug-of-war): Two people pull a rope each holding one edge of the rope and each in a direction exactly opposite to the other; if their pulling force is exactly equal, the rope does not move; this does not mean that the pulling energies that are exerted on the rope annihilate each other or disappear; The energies are accumulated and stored as a potential latent energy in the rope tension. The fact that the rope does not move, does not mean that the energies disappeared; they seem to be undetectable. The same applies when two electric or magnetic fields' forces of exactly the same intensity but ***opposite polarity*** annihilate each other. The energies of these fields are not annihilated or disappear; they are accumulated and stored into two sets of *"Energy Pairs"*, one that was created by the unification of the electric component of the waves, and the other by the unification of the magnetic component of the waves. The energies in each set of these *"Energy Pairs"* disable each other; as a result, the Null Wave cannot be detected.

The "Energy Pairs Theory" Related to Photons

The novel idea of *"Energy Pairs"* that exists in a Null Electromagnetic Wave is actually a new concept related to accumulation and storage of energy that ***can not*** be detected because its

components disable each other. This new concept should be expanded to the particle manifestation of an Electromagnetic Wave, namely, the Photon.

If a Null Wave cannot be detected, then the energies embedded in the photons that are carried by the Null Wave, *continue to exist but should be disabled* in a way that the wave cannot be detected, exactly as the energies embedded in the electric and magnetic components of the Null Wave cannot be detected. How can such a state of photons be explained, or how can photons continue to exist in a disabled state? We offer an explanation related to the "*Energy Pairs Theory*"; Photons should be capable of being in two different states in order to disable each other. When the wave's electric and magnetic *fields' polarity is positive*, the photons exist in one state (state-1). When the wave's electric and magnetic *fields' polarity is negative*, the photons exist in a second state (state-2). State-1 and state-2 are opposing each other. So, two photons that *exist together* in the same place in space but are at *opposite states* as related to one another *disable each other*. This, of course, is analogous to the conclusions derived relating the energies embedded in the electric and magnetic fields carried by the Null Wave. Photons can exist in two opposing states only if they have the capability to oscillate between these two states (1 and 2) synchronized with the oscillation frequency of the wave that carries them. So, photons should be always *physically oscillating* between two states. Since the two photons' states are synchronized with the frequency of oscillation of the wave that carry them, and the two unified waves that created the Null Wave are at a phase shift of 180 degrees as related to one another, then photons in the Null Wave *exist but all the time disable each other* such that the Null Wave cannot be detected.

The assumption that a photon physically oscillate also explains why the energy embedded in each photon is proportional to the frequency of oscillation of the electromagnetic wave that carries this photon. Because photons are particles, and if they oscillate between two states, the frequency of this oscillation must be proportional to the energy embedded in them.

Thus, photons in the "*Energy Pairs Theory*" framework can also be manifested as *Energy Pairs* that are capable of disabling each other and therefore, being undetectable.

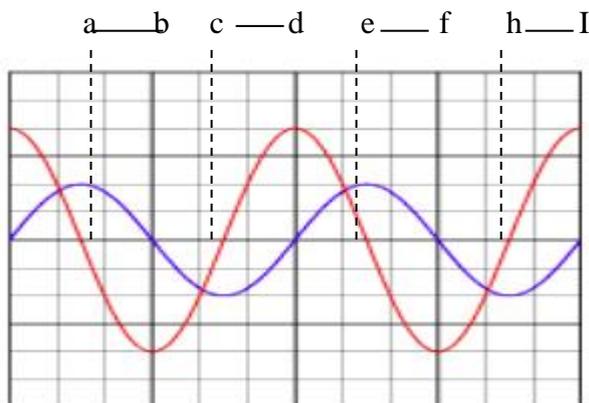
Expansion of the Experimental Implementation of a Null Wave

The Null wave experimental implementation described in Fig. 1 is now expanded to two more scenarios: One in which two electromagnetic waves unified, and continue to travel together in the same direction, but they have **a phase shift relative to one another** before the unification, and a second in which the two waves have **different frequency of oscillation** before the unification.

(1) The two electromagnetic waves have a phase shift before their unification

Fig. 3 represents two electric fields waves' oscillations, as a function of time, which has a phase shift relative to one another before their unification. After their unification, they still have a phase shift relative to one another. However, there are portions of time such as: a-b, c-d, e-f and h-I, in each oscillating cycle, where one wave has opposite polarity relative to the other wave. In these portions of the oscillating cycle, **one wave will annihilate part of the other wave**, which will result in reducing both the electric field's intensity and **the energy** of the unified wave in these portions of the oscillation cycle. This result may **seem** again as an energy loss after the unification of the two waves; more than that, because all waves have the same velocity along the one dimensional x-axis (that represents time), this **seemingly energy loss** will occur continuously. In this case the unified wave is a Partly Null Wave.

Fig. 3

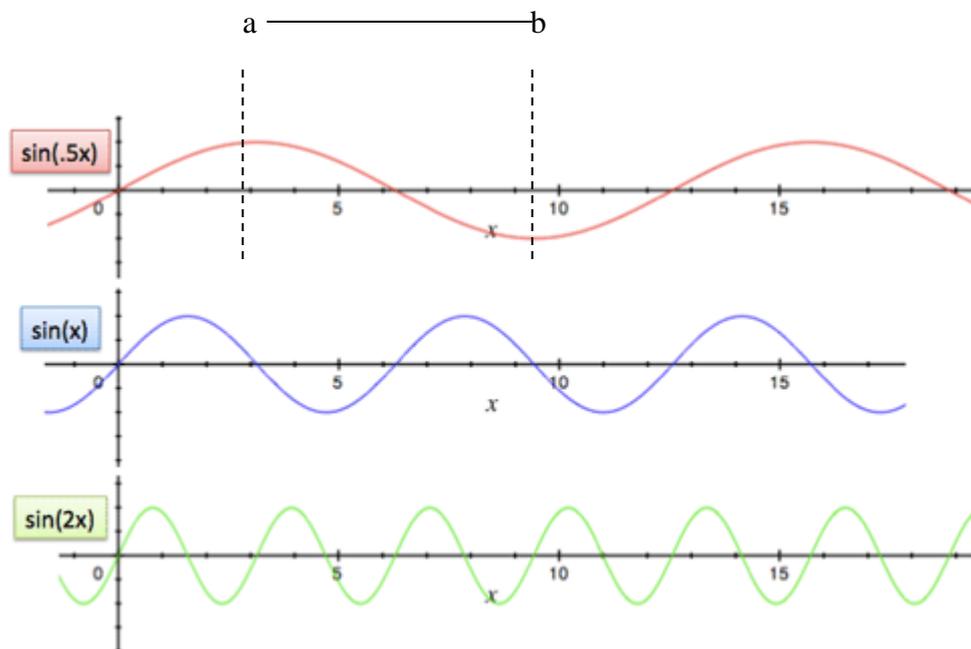


(2) The two waves have different frequency of oscillation before their unification

Fig. 4 shows the electric fields of three waves that have different frequency of oscillation before their unification. We'll examine unification between the first two waves in Fig. 4: Wave A - the red, and wave B - the blue. After their unification they still have different frequency of oscillation.

Because waves A and B oscillate at different frequencies, after unification between these two waves, there are portions of time, such as a-b, in each oscillating cycle of the unified wave, in which one wave has opposite polarity relative to the other wave. In these portions of the oscillating cycle, one wave will annihilate only *part* of the other wave, which will result in reducing both the electric field's intensity and the energy carried by the unified wave in this portion of the oscillation cycle. This result may *seem again as an energy loss* following the unification. This *seemingly* energy loss will occur continuously, because all electromagnetic waves have the same velocity along the one dimensional x-axis that represents time. In this case, again, the unified wave is a Partly Null Wave.

Fig. 4



We conclude at this point that for electromagnetic waves that consolidate and become unified, and continue to travel together in the same direction, the *Energy Conservation Principle seems* to be violated almost always and almost in any constellation.

It should be noted that the polarization conditions of the two unified waves, that was necessary to create a *completely* Null Wave, is not required for the Partly Null Wave which will manifest a *seemingly* energy loss after unification, in any case of the polarization of the original waves, because now the two unified waves do not have to turn completely into a Null Wave. If the polarization of the two unified waves is arbitrary, then, the electric or magnetic fields of one wave, which are vectors, can always be considered as being composed of two perpendicular vector components. And then, one of these components can be a component who is aligned on the same line in space with the component of the other wave. Then, according to the above discussions, this will, almost always, generate *some seemingly energy loss*, when the two waves unify, and continue to travel together in the same direction.

Thus, as stated above, for electromagnetic waves that consolidate and become unified, and continue to travel together in the same direction, the *Energy Conservation Principle seems* to be violated almost always, and almost in any constellation; even if the waves oscillate at different frequencies, have some phases shift as related to one another, have different field's intensities and also *arbitrary polarization*.

According to the *Energy Pairs Theory* described above, portions of the energy that *seem* to be lost actually exist as latent potential *Energy Pairs* in the photons that are the particle manifestation of these electromagnetic waves, which actually produce a Partly Null Wave.

Electron - Positron Collisions and the Energy Pairs Theory

In this part of the study the interrelationships between charge and energy will be discussed based on physics' well-known observations relating the Electron – Positron collisions (also known as Electron-Positron annihilation): When an electron and a positron collide, neutral gamma ray photons are emitted, with energy equal to the sum of the energies embedded in the *masses* of the electron and the positron (Ref. 4). In the reversed process (also known as Pair Production), a gamma photon that passes near a heavy atom, in appropriate conditions, is

converted into a *negative charged electron* and a *positive charged positron* (Ref. 5). Each of these two elementary particles, the positron and the electron, has two fundamental features: *mass* and *charge*. But the energy embedded in the photon is converted only to the sum of the energies embedded in the *masses* of the electron and the positron, and, from the point of view of the energy transformation occurring in this process, the created charges are ignored. And, in the process of electron and positron collision, again, the energy of the newly created photon is equal only to the sum of the energies in the *masses* of the colliding electron and positron, and their charges are not considered in this energy balance and are assumed to just disappear. Therefore, it is required to ask some basic questions about these two processes: In the process of the electron-positron collision where a gamma photon was emitted: How could the electron's and the positron's charges disappear? How could a fundamental feature of basic particles disappear without leaving any trace of their previous existence? In the reversed process, where an electron and a positron were created from a gamma ray photon in appropriate conditions: Since the photons do not contain mass or charge, but the photon energy is converted only to the sum of the *masses* of the created electron and positron, how did the charges of the particles emitted in this process, evolve? Were these charges created out of nothing?

Although charge disappearance in the electron - positron collision process and charge creation in the reversed process, obey the charge conservation principle, the questions whether charges can disappear or be created in physical processes without being taken into considerations regarding the energy transformation occurring in the process, is necessary to be asked and analyzed. We'll use the novel "*Energy Pairs Theory*", to provide reasonable answers to the above questions, and to further discuss charge characteristics and its essence in physical processes.

Electric Charges might be Energy analogous to Mass being Energy

The fact that photons are composed of energy only and do not contain mass or charge, and still, a Gamma photon in the reversed process discussed above and observed in an experiment, converts into two particles that do contain charge, the electron and the positron, implies that **Energy can be converted to Charge**. This surprising implication would be further analyzed.

Previously, in the part that discussed "*The Energy Pairs Theory Relating to Photons*", the possibility that **photons might exist as Energy Pairs** that disable each other and therefore can not be traced, was presented. Thus, the charges of the electron and the positron that were generated from a Gamma photon passing near an heavy atom, might be a result of a split of an ***Energy Pair*** embedded in the Gamma photon, into a negative charge of the electron and a positive charge of the positron. It is important to emphasize that this process is independent of the process in which the *traceable* energy embedded in the photon itself was converted into the *masses* of the electron and the positron produced in this process and obeyed the *energy conservation principle*. Actually, according to the "***Energy Pairs Theory***", the Gamma photon itself might be built out of two different kinds of energy: One is the traceable energy embedded in the Gamma photon itself that obeys the energy conservation principle by converting into the energy embedded in the masses of two particles, an electron and a positron. Second is the untraceable "***Energy Pair***" carried by the photon, which is converted into two electric charges, the negative electron, and the positive positron. In this specific latest process latent undetectable energy is manifested as charge. Thus, it can be concluded that energy, not only can be converted to charge, but actually, ***Energy is equated with Charge***.

Thus, if we conclude that ***Energy is equated with Charge***, this can be used to explain the charge disappearance in the process of the electron-positron collision where a gamma ray photon was emitted (the first process discussed above). It can be concluded that the Gamma photon produced in this process, embeds an ***Energy Pair*** that contains disabled energies that originated from the negative electron and the positive positron charges before their collision, and thus, the charge of the electron and the positron does not disappear, it is converted to a latent untraceable ***Energy Pair*** embedded in the created photon.

Actually, the phenomena that a photon converts to a pair of electron and positron might provide additional support to the assumption that electric charges are a form of energy, also because of the following argumentation:

As stated above, the ***energy calculations*** in this process are based on the fact that the energy in the photon is converted into the energy in the *masses* of the newly created electron and positron, and the fact that these particles contain also charges was ignored. The charges did not contribute anything to the energy calculation described above. This is, thus, equivalent, from

the energy balance point of view, to a hypothetical case where a photon converts into two particles having the same masses as the electron and the positron and no charge at all.

But particles that contain only mass and no charge contribute differently to the energy balance of their environment as compared to adding to this environment same number of particles which contain each mass and charge. Particles containing only mass create only a gravitational field around them and interact only with masses. While particles that contain mass and charge create around them a gravitational field and also an electric field (and also a magnetic field if they move). And particles that contain mass and charge interact with masses and with other charges.

So, when particles that contain mass and charge are added to the environment, they have the ability to generate more activity in this environment, compared to adding to that environment same number of particles with same amount of mass but no charge. Thus, particles that contain mass and charge should have more energy than particles with same amount of mass but no charge.

This implies that the phenomena that a photon converts into a pair of electron and positron increases the energy of the environment more than the energy embedded in the photon, whose energy was converted *only* to the energy embedded in the *masses* of the electron and the positron, which implies that the *Charges created are Energy*.

And, because that new energy was created from a latent and untraceable *Energy Pair* embedded in the photon (as assumed by this article), this implies that such latent *Energy Pairs* can evolve and become detectable energy.

Thus, this analysis presented above clearly leads to a possible surprising conclusion that basically *Charge and Energy are equal entities*. (The same as *Mass is equated with Energy* according to Einstein's analysis in his *Special Relative Theory* (Ref. 6). If so, the only entity that exists and governs the natural world is *Energy*. This conclusion has tremendous implications both on research and technology.

The *Energy Pair* built of the energy embedded in two electric charges a negative and a positive charge, resembles the *Energy Pair* that was built out of two electromagnetic unified waves, by

the fact that in both cases an *Energy Pair* is created out of two entities that might annihilate each other. Second, in both cases the *Energy Pair* is built out of two components that disable each other and therefore the *Energy Pair* is undetectable, and in both cases the *Energy Pair* might be created and might split again into traceable energy. Thus, the *Energy Pair* is a flexible theoretical construct that might be useful in other lab experiments and scientific observations.

Energy Pairs Theory might resolve other Energy Conservation Issues

The *Energy Pairs Theory* can be also used to provide an explanation to a magnetic field potential energy conservation paradox. This magnetic field potential energy conservation paradox is described as follows:

When a body is charged with electric charges of a certain polarity (such as positive electric charges) and a certain amount of charge, and the body is moved at a specific constant speed in a certain direction, it creates a magnetic field \vec{B} around it whose embedded energy per unit volume u is provided by the following formula:

$u = |\vec{B}|^2 / (2 \mu_0)$ (Ref. 8) Where μ_0 is the vacuum magnetic permeability and is equal to: $4\pi 10^{-7}$ H/m (Henry per meter). While the magnetic field \vec{B} is described by:

$$\vec{B} = (\mu_0 / (4\pi)) (q(\vec{v} \times \vec{r}) / r^2) \quad (\text{Ref. 7})$$

When a second body is charged with electric charges of the opposite polarity (negative electric charges) but with the same amount of charge, and that body is also moved at the same constant speed in the same direction, it creates a magnetic field in the same space volume, whose magnitude is still expressed by the same formula that describes the magnetic field \vec{B} created by the first body when it was moved, but its direction (or polarity) is inverse to the polarity of the magnetic field \vec{B} that the first body created when it was moved. But, the embedded energy per unit volume of the magnetic field

created by that second body is still expressed by the formula presented before for energy per unit volume in a magnetic field. (Ref. 8).

When both bodies are tied to an apparatus that keeps them very close to each other, (but inhibits them from being attracted completely to each other), and both bodies are moved together, at the same speed, in the same direction, no magnetic field is created around them (or a negligible magnetic field, because the bodies are not exactly at the same point in space). The reason why in that third case scenario basically no magnetic field was created is well understood.

Magnetic fields obey the superposition rule. Since the first body creates a magnetic field which has the same intensity, but inverse polarity compared to the magnetic field the second body creates, and both magnetic fields occupy the same volume in space, they cancel each other, and basically no magnetic field is created in that volume in space. However, there is still a paradox, concerning the conservation of the energy embedded in these two magnetic fields.

The first body does not "know" that a second, inverse magnetic field is created, and it still creates its own magnetic field. This magnetic field embeds energy per unit volume described by the formula above (Ref. 8). The same is true for the second body. So, the fact that each field cancels the other, *contradicts the energy conservation principle*, since the energies of both fields also disappear.

A logical explanation to that paradox might be provided by the *Energy Pairs Theory* presented above, which states that certain energies, such as magnetic fields embedded energies, come in an *Energy Pairs* form. And, energies belonging to energy pairs might still *exist* but *disable* each other in certain conditions.

Actually, since the energy density in a magnetic field depends on the magnitude of the magnetic field B^{\rightarrow} in space at each point, and B^{\rightarrow} is a vector which can be cancelled by another vector of similar size but opposite direction, it is obvious that the energy density of a magnetic field is not a complete scalar.

Thus, in case of magnetic fields energy, the condition of energy disabling that occurs at each *Energy Pair* is clear, and it happens when another magnetic field exists at the same space volume, with equal magnitude and opposite direction.

From the above, it is obvious that the *Energy Pair* for magnetic fields contains the following two energy types: one type is the energy embedded in magnetic fields created by moving positive charges, the other type is the energy embedded in magnetic fields created by moving negative charges.

Thus, the mutual annihilation of energies belonging to *Energy Pairs* can be also viewed not as mutual annihilation but as mutual disabling, assuming that the energies *exist* as *Energy Pairs* and their mutual disabling is only *seen* as annihilation.

Similarly, to the explanation of the magnetic field energy conservation paradox, the *Energy Pairs Theory* provides a similar explanation to a similar electric field energy conservation paradox.

This electric field energy conservation paradox is very similar to the magnetic field energy conservation paradox. Thus, it will be described here more briefly, since its description is very similar to the description of the magnetic field energy conservation paradox.

When a body is charged with electric positive charges it creates an electric field around it whose embedded energy per unit volume u is provided by the following formula: (Ref. 9).

$u_e = \epsilon_0 |E^{->}|^2 / (2)$. Where $E^{->}$ is the electric field magnitude in the unit volume, and ϵ_0 is the vacuum permittivity and is equal to: $8.854187817 \dots \times 10^{-12}$ F/m (Farad per meter)

When a second body is charged with same amount of negative charges, it creates an electric field whose polarity is inverse to the polarity of the electric field that the first body created.

But, the embedded energy per unit volume of the electric field created by that second body is still expressed by the formula presented before for energy per unit volume in an electric field. (Ref. 9)

When both bodies are tied to an apparatus that keeps them very close to each other, (but inhibits them from being attracted completely to each other), no electric field is created around them (or a negligible electric field, because the bodies are not exactly at the same point in space).

As before, the paradox is, again, the fact that the energies also disappear, although, each charge is not "aware" of the other charge, and, thus, is supposed to create still its own electric field with its own embedded energy.

Space itself might be a form of Energy

The *Energy Pairs* of the Null electromagnetic wave was assumed to be embedded in the photons that these waves carry.

However, since the *Energy Pairs Theory* was used above to explain energy conservation issues also in static electric fields, and in magnetic fields generated by moving electric charges that move at a constant velocity, the question of where the *Energy Pairs* reside in these cases might be also asked.

In these cases, it seems that the *Energy Pairs* reside simply in the space volume where the two opposing fields exist. Then, this space volume actually should be equated with these *Energy Pairs*, which might mean that the *Space* itself might be a form of *Energy*.

This might be also supported by the findings of the *General Relativity Theory* that the cause of the *Gravitation Force field* around a *Mass* is actually the distortion of the *Space* around the *Mass* that creates this *Gravitation field*. And since the *Gravitation field* is actually a form of *Energy*, then *Space*, which causes this *Gravitation field* to occur by being distorted by the *Mass*, might be a form of *Energy*.

Aether theory versus the claim that Space itself is a form Energy

Aether theory is a theory that claimed the existence of an elastic mass less medium, or a space-filling substance or field, which fills all the empty volumes in Nature. It was introduced initially as a means to claim that Nature is revolted or should shy away from complete emptiness (horror vacci), by claiming that emptiness actually contains this aether medium. It was also believed that it was necessary as a transmission medium for the propagation of the electromagnetic or gravitational forces and the electromagnetic waves. (Ref. 10 and Ref. 11). The aether concept became obsolete in 1905 by Einstein's *Special Relativity Theory*, which stated that the speed of light is a constant value and there is no need for a transmission medium for electromagnetic waves.

Actually, the assumption (or claim) presented above in this article, that the *Space* itself might be a form of *Energy*, resembles this aether theory, and seems to bring it back.

However, one should discern or distinguish between aether that was introduced as a transmission medium for the propagation of electromagnetic waves, which the *Special Relativity Theory* shows that such a medium is not required, and aether as a medium which is required, according to the *General Relativity Theory*.

Albert Einstein himself returned to the aether theory and saw it as a necessary medium that provides physical properties to his *Space/Time* entity. In his speech in the university of Leiden in May 5th, 1920, he explained the difference between the aether theory before the Michelson-Morley experiment (Ref. 14) and the fact that his *General Relativity Theory* requires an aether like medium. (Ref. 12 and Ref. 13).

Thus the assumption presented in this article, that the *Space* itself might be a form of *Energy*, fits with the requirements of the *General Relativity Theory*, and the claim that the *Space* itself might contain *Energy Pairs*.

Review of Energy densities equations

In addition to the above described colliding waves scenario that creates a complete Null or a partly Null electromagnetic traveling wave, from which, this article derives the claim that electric charges might be energy, the claim that electric charge might be energy is discussed in this article also from additional angles.

As will be shown in this article, there are similarities between *Mass* and *Charge* which might also lead us to conclude that *Charge* should also be considered as a special form of *Energy*. To present these similarities this section starts by a review of the energy density equations of electric and magnetic fields.

The embedded energy per unit volume in the electric field u_e is provided by the following formula: (Ref. 16)

$u_e = \epsilon_0 |\vec{E}|^2 / (2)$. Where \vec{E} is the electric field magnitude in the unit volume, and ϵ_0 is the vacuum permittivity and is equal to: $8.854187817 \dots \times 10^{-12}$ F/m (Farad per meter)

Since, for a non moving point charge q_0 ,

$|\vec{E}| = (1/(4\pi \epsilon_0))(q_0/r^2)$ Where q_0 is the non moving point charge magnitude and r is the distance from the non moving point charge to the location of the unit volume.

(Ref 17), then,

$u_e = (1/(32 \epsilon_0 \pi^2))(q_0^2/r^4)$ If we denote $K = 1/(32 \epsilon_0 \pi^2)$ then $u_e = (K q_0^2)/r^4$

Because K is a constant and r^4 is dependent only on the unit volume in space where \vec{E} resides, then, u_e , the embedded energy per unit volume in the electric field, is directly dependent and is directly proportional only to the square of the magnitude of the non moving point charge Q_0 that generated \vec{E} .

Similarly, the embedded energy per unit volume in the magnetic field u_m is provided by the following formula: (Ref. 15)

$u_m = |\vec{B}|^2 / (2 \mu_0)$. Where \vec{B} is the magnetic field in that volume unit and μ_0 is the vacuum magnetic permeability and is equal to: $4\pi 10^{-7}$ H/m (Henry per meter).

Since, for a moving point charge q , $|\vec{B}| = (\mu_0 / (4\pi)) (qv \sin \alpha / r^2)$ (Ref 18).

Where q is the moving point charge magnitude that generated the magnetic field \vec{B} moving at the velocity v , and α is the angle between v and the line connecting that moving charge to that volume unit. then,

$$u_m = (\mu_0 / (32\pi^2)) (q^2 v^2 \sin^2 \alpha / r^4) \quad \text{and since } \mu_0 = 1 / (\epsilon_0 c^2) \text{ (Ref 18), and,}$$

$v \sin \alpha$ is the velocity component that is perpendicular to the line that connects the external spectator to the moving point charge q , and thus, can be denoted v_1 then

$$u_m = (1 / (32 \epsilon_0 \pi^2)) (q^2 (v_1^2 / c^2) / r^4)$$

since we already denoted $K = 1 / (32 \epsilon_0 \pi^2)$ then,

$$u_m = (K q^2 (v_1^2 / c^2)) / r^4. \quad \text{Denoting } x = (v_1^2 / c^2), \text{ then,}$$

$$u_m = (K q^2 x) / r^4 \quad \text{and as shown above } u_e = (K q_0^2) / r^4$$

Both equations, u_m and u_e , have exactly the same structure, only u_m contains $q^2 x$ as its generation source and u_e contains q_0^2 as its generation source.

Also, it turns out that what generates u_e is q_0^2 and what generates u_m is a fraction of q^2 because x spans from 0 for $v=0$ to a maximum of 1 when $v=c$. Thus, these equations already imply that charge should be the energy embedded in the electric and magnetic fields. Because, the only components in these equations that can be considered as containing the energy are q_0^2 and q^2 , because, all the other components in these equations are either constants, or components that depend only on the location in space where these energy densities reside.

More arguments why Charge might be also Energy

At this point we can supply more arguments why we claim that *Charge* might also be considered as another form of *Energy*.

In the previous paragraph we already claimed that the only components in the energy densities equations of the electric and magnetic fields u_e and u_m that can be considered as containing the energy, are q^2_0 and q^2 .

Indeed, u_e and u_m are the energy density embedded in the electric and magnetic fields and not in the charges that generated these fields.

But, according to Ref 19 "The gravitational field of a point mass and the electric field of a point charge are structurally similar" and when analyzing "the energy density for the electric field, and a similar expression" which "represents the energy density for the magnetic field, no such energy density term has ever been defined for the gravitational field. But one suspects that it could be, and possibly even should be".

Also, Ref 19 does provide an expression for the energy density in the gravitational field in which m^2 (the square of the mass magnitude) can be considered as the only component containing the energy, as q^2_0 and q^2 (the square of the charge magnitude) are the only components that can be considered as containing the energy densities u_e and u_m in the energy density equations for the electric and magnetic fields.

And, because mass is already recognized as being another form of energy, it implies that the energy in the mass is also manifested in the energy density of the gravitational field as the square of the mass magnitude.

Thus, analogous to the above, the fact that the only components in the energy densities equations of the electric and magnetic fields u_e and u_m that can be considered as containing the energy, are q^2_0 and q^2 , (the square of the charge magnitude) might also imply that this energy density is a manifestation of the energy embedded in the charge, and that the charge is also a form of energy.

In addition to that, modern physics sees the detection of magnetism by a spectator external of a charge moving at a constant velocity, as a combination of maxwell equations and special relativity. And, analogous to the detection of magnetism by a spectator external to such a

moving charge, a spectator external to a mass moving at a constant velocity sees a phenomenon denoted as gravitational electromagnetism (GEM), which is the analogy of magnetism in gravitation (Ref 20). Thus, structural similarities between mass and charge extends beyond the case of stationary masses and stationary charges, as described above.

These strong similarities between *Mass* and *Charge*, might imply that *Charge* might also be a form of *Energy*, as mass turned to be.

Indeed, there are also differences between *Mass* and *Charge*.

An external spectator to a moving mass sees an increase of this mass. On the other hand, because of the charge invariance principle, charge does not increase by velocity. Also, masses are usually positive entities and always attract each other, while charge comes as positive and negative charges and different signed charges attract each other while similar signed charges repel each other. Also, masses can be converted to energy, while, according to the charge conservation principle, the total number of positive and negative charges must balance each other, such that only one type of charges cannot be eliminated alone. Also, equations such as $P = m V$ or $F = m a$ do not exist in the case of charges.

However, these differences do not cancel the similarities between charge and mass presented before, and do not cancel the possibility that charge might be also another form of energy, implied by the similarities between charge and mass described above.

At this point, a few words about the validity of the additional arguments presented in this section, that charge **might** be also be considered as being a form of energy, might be helpful.

Indeed, these additional arguments are reasonable but **are not a proof** that charge **might** be also considered as being a form of energy. They are only provided here as an additional support to the arguments provided in a previous section of this article, the section titled: *Electric Charges might be Energy analogous to Mass being Energy*.

But the strong **structural similarity** (or even **structural identity**) between a **point mass** and a **point charge**, and the structural identity between the **coulomb force law** and the **universal gravitation force**, strongly implies that if one entity (Mass) was already discovered to be

Energy, the other entity (Charge) might also be Energy, because the **basic equations governing the forces they create have identical structure.**

In addition to the above, this article intends to propose also the following (which might be also considered to be a reasonable argument but not a proof):

The components that compose the equation of a specific physical entity (such as energy) can be sorted out such that each component can be decided if it is a component that can be considered to contain the specific physical entity (such as energy), or a component that specify how this specific physical entity is dependent on other physical entities (such as space or time).

For example: since Force multiplied by Distance is Energy, then, in this equation of energy, Force is the component that can be considered to contain the energy, and Distance specify how this energy is dependent on the distance in space. Moreover, in the equation that defines the Force, further sorting can be done to specify the component that can be considered to contain the energy. Thus, since Force multiplied by Distance is Energy, then, in the equation of the universal gravitational force, the masses can be already **identified as the energies**, since they are the only components in the equation that can be considered to contain the energy (which will be the result of this force multiplied by distance).

And, indeed, Mass is discovered to be Energy, by the special theory of relativity.

And, as already shown before, this mass energy is also manifested in the energy density equation of the gravitational field, as m^2 .

Thus, analogous to the above, in the equation of the coulomb force law, the charges can be already **identified as the energies**, since they are the only components in the equation that can be considered to contain the energy (which will be the result of this force multiplied by distance).

And, as already shown before, this charge energy is also manifested in the energy density equation of the electric and magnetic fields, as q^2 .

However, as already mentioned above, these additional arguments why *Charge* might be *Energy*, that might be reasonable arguments, but not a proof, are only supplementary

arguments to the arguments that *Charge* might be *Energy*, based on the *Energy Pairs Theory*, and the Null wave scenario described before, in this article.

Summary and Conclusions

Summary of this Study

This study was aimed to provide supports to the claim that *Electric Charges* are a form of *Energy* as *Mass* is a form of *Energy*. The study starts with the analysis of a Null Electromagnetic (EM) Wave, which is an electromagnetic wave that does not contain any electric or magnetic fields. The article shows how such Null waves can be created by consolidation of unified EM waves that continue to travel together in the same direction. The study shows that in several measurable cases where Electromagnetic waves unify and continue to travel together in the same direction, the process is bound to energy loss that *seems* as *contradicting the "Energy Conservation Principle"*. In one case the *seemingly* energy loss is total and a Null Electromagnetic Wave is produced, and in other cases the *seemingly* energy loss is partial, so that the produced unified wave *seems* to carry less energy than the two Electromagnetic waves carried separately before their consolidation, so that a Partial Null Wave is produced. In all cases we've noticed a *seemingly "Energy Conservation Principle" violation*, which was our initial reason to think about a resolution to this problem and to develop a new theoretical framework - the "**Energy Pair Theory**" (EPT), which might provide an explanation to these results.

The central idea in the EPT is that certain energies can be accumulated and stored together in a state called: "**Energy Pair**" (EP), and at the same time disable each other so that the energies *exist* but can not be *detected*. According to this new theoretical framework, the energy that was seemingly lost in Null waves creation is actually conserved into an "*Energy Pair*" that exists as latent energy in the Null wave because its two components disable each other. Thus, the energy is conserved into an "*Energy Pair*" though it can't be detected.

A further step in the EPT development was to create a basic understanding of the manifestation of these EP, or to answer the question: Where do the *energy pairs* reside in a Null wave? In the EPT framework *Photons of energy might exist as Energy Pairs* based on their feature to

oscillate between two opposing states. In addition, *Photons might also carry Energy Pairs*, in the case of a partial Null wave, where a photon has its own *traceable energy* and **in addition** it also carries the *untraceable Energy Pair* of the partial Null wave. These two "kinds" of energy that are embedded in a photon, implies that in a process that a partly Null wave is produced, the energy is conserved. In the case of a Null wave, photons exist as energy pairs only, that disable each other and therefore a Null wave's energy is totally undetectable.

A further assumption made in the EPT, was that an *Energy Pair*, in appropriate conditions, might split into detectable energy, and its untraceable energy becomes detectable again. This assumption is supported by the well-known Pair Production phenomena in which a photon converts to a pair of electron and positron.

A second attempt to apply the "Energy Pair Theory" was carried out on the two well-known observations of collision of electron-positron to obtain a Gamma neutral Photon, and the reversed process of a Gamma neutral photon producing electron and positron in appropriate conditions (like moving near a heavy atom Ref. 5). Though all conservation laws are obeyed in these processes, our concern was about the disappearance of both electric charges in the first process and the creation of negative and positive electric charges out of a neutral Gamma photon in the reversed process. We examined the questions: How could electric charges be obtained out of a neutral Gamma photon that doesn't carry charges at all, and while ***all the energy*** of the photon was converted only to the energies embedded in the **masses** of the created electron and positron? And in the electron positron collision process, how did elementary electric charges of the negative electron and positive positron disappear? Electric charges are basic feature of the elementary particles the electron and the positron, and can't disappear just like that. It is obvious then, that there should be something in common between electric charge and photons of energy in order to understand how could electric charges disappear and convert to photons or photons could produce electric charges. To our best knowledge, these basic questions have not been studied yet.

Examination of the above two processes in the "***Energy Pairs Theory***" framework, provides the following explanation: In the collision between an electron and a positron, the negative charge of the electron and the positive charge of the positron combine to create an untraceable "***Energy Pair***" that is embedded in the Gamma photon created and carried by it. In the reversed process, a splitting of this "***Energy Pair***" that is embedded in the Gamma photon

occurred, and created the two basic elementary particles, the negative charged electron and the positive charged positron. In these views charges have not disappeared, they created "**Energy Pairs**" that were carried by the Gamma photon. This analysis of the two processes, in which an electron and a positron produced a Gamma photon, and a Gamma photon produced an electron and a positron, results in a surprising and revolutionary conclusion that **Energy is equated with Electric Charge**. In other words *Electric Charge* is actually a manifestation of *Energy*. If so, and if *Mass* is also equated with *Energy* according to Einstein's *Special Relativity Theory*, then, as *Mass*, ***Electric Charges are a form of Energy***.

The article also uses the *Energy Pairs Theory* to explain Energy Conservation Issues also in static electric fields and in magnetic fields generated by moving charges that travel at a constant velocity. In these cases the article concludes that the resulting *Energy Pairs* must reside in the space volume where they exist. This might imply that the *Space* itself might be a form of *Energy*. This also seems to bring back the old notion of the *Aether*. However, this new notion of *Aether* is also supported by arguments from the *General Relativity Theory*.

The article also provides additional arguments that support the claim that *Electric charges* are a form of *Energy*, by presenting many similarities between *Mass* and *Charge*, especially, as relating to *Energy*. And, since *Mass* is already recognized as a form of *Energy*, these similarities might support the claim that *Charge* might also be recognized as a form of *Energy*.

A final and important comment: The fact that a Gamma photon was actually observed to produce an electron and a positron in appropriate conditions (as when passing near a heavy atom), is a manifestation of a splitting of an *Energy Pair*, and conversion of the untraceable energy of the ***Energy Pair*** back into traceable energy. This provides a basis to the assumption that undetectable *Energy Pairs* in Null or Partly Null waves might compose at least part of the *Dark Energy* or the *Complete Emptiness*, and, such ***Energy Pairs*** (or *Dark Energy*) might split back and produce traceable energy. These issues are further elaborated in another article that can be found at: <http://viXra.org/abs/1911.0176>), (Ref. 21)

Conclusions of this Study

First, This study contributes to the energy entity a new "state of energy": the "***Energy Pair***" that establishes a theoretical framework to study untraceable energies like the *Dark Energy* and

the *Complete Emptiness* entities. Following are three important features of *Energy Pairs* as shown in the *Energy Pairs Theory* developed in this study:

1. *Energy Pair* that is built of the energy embedded in negative and positive charges, resembles the *Energy Pair* that is built out of two electromagnetic unified waves, by the fact that in both cases the *Energy Pair* is created out of two entities that might annihilate each other.
2. *Energy pairs* are built out of two components that disable each other and therefore the energy *exists* but is undetectable.
3. *Energy pair* might be created and might split again into traceable energy. For example, in the process where a Gamma photon splits into a negative charged electron and a positive charged positron.

Thus, *Energy Pair* is a flexible theoretical construct that might be useful in better understanding other lab experiments and scientific observations. The *Energy Pairs Theory* as shown in this study has the right components to establish a robust theoretical framework for other natural and lab observations that are not resolved yet.

Second: The most unexpected and revolutionary conclusion of this study is that *Electric Charge is equated with Energy*, in other words, electric charges can be manifested as energy and vice versa. Further elaboration of this conclusion with Einstein's *Special Relativity Theory* equating *Mass* with *Energy*, implies that *Energy* is the only entity that governs the natural world. *Mass and Electric Charges are manifestations of Energy*. This conclusion might lead to new scientific and technological future implications.

Third: Following the present study, it is highly recommended carrying out lab experiments that can produce Null waves or partly Null waves as those described in this study, in order to establish a stronger and solid base for the theory developed in this study.

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