Space and the Dark Energy in the Energy Pairs Theory Framework

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Abstract

This study's aim was to investigate the Energy embedded in electric and magnetic fields in Space. A detailed analysis has shown that in every point of Space, and all the time, electric and magnetic fields annihilate each other, so that their embedded Energy at any point in Space *seems* to violate the *"Energy Conservation Principle"*. The novel *"Energy Pairs Theory"* was used to resolve this problem. The *Energy Pairs Theory's*, central idea is that pairs of certain Energies, such as the energies embedded in electric or magnetic fields, can be accumulated and stored together in a state called: *"Energy Pair"*, where they *disable* each other from being detectable so that they *exist* but *cannot be detected. Thus, "Energy Pairs"* constitute *a type of energy* called: *Untraceable Energy*. The analysis entailed some revolutionary conclusions: (1) Each point of Space consists of a dynamic mixture of **two types of Energy**: *traceable energy* and *untraceable "Energy Pairs"*. Thus, Space is not 'Emptiness'; Rather, **Space is Energy!** (2) The unexplained **Dark Energy** is likely to be composed of the *untraceable "Energy Pairs"* in Space. This study shows that the *Energy Pairs* in Space constitute about twice the amount of the *traceable energy* of Space, which provides evidence that is, in good compatibility, with the cosmologists' evaluations that the *Dark Energy* makes up about 70% of the Energy in Space. The *unification* of *Space* with *Energy*, concluded in this study, complies also with the requirement of Einstein's *General Relativity Theory* that Space must be composed of some 'substance', such as *Aether*, to provide physical properties to the *Space/Time* entity. Thus, the *Energy Pairs Theory* might also turn to be a *connecting link* between *Electromagnetism* and *Gravitation*.

Key words: Space, Energy, Dark Energy, Energy Pairs, Aether.

1. Introduction

In a previous study published in an article titled: "Energy Analysis of a Null Electromagnetic Wave" [1] written by the author of the present article, the novel *Energy Pairs Theory* (EPT) was introduced. In that previous work, a scenario of two, one dimensional, Electromagnetic traveling waves that collide, then consolidate and unify, and continue to travel together in the same direction, was studied. Further analysis of this scenario, in that study, showed that it is possible to create a *Null* Electromagnetic traveling wave, which does *not contain* any electric and magnetic fields, and therefore, *seemingly*, does not contain energy at all. This *Null* Electromagnetic traveling wave is created from two *Electromagnetic Waves* that do contain electric and magnetic fields and thus have *energy* embedded in them. Thus, a *seemingly* violation of the *Energy Conservation Principle* was described there. That previous study also showed that whenever Electromagnetic Waves consolidate and continue to travel together in the same direction, some of their energies *seem* to disappear even if they do not convert completely into a *Null* Electromagnetic Wave. Thus, in such scenarios a *Partly Null* Electromagnetic Wave is created.

The *Energy Pairs Theory* (EPT) was developed and used to resolve this *seemingly* violation of the *Energy Conservation Principle* in the scenarios shown above, and the basic novel theoretical construct (concept) of *"Energy Pair"* was introduced. An *"Energy Pair"* in the EPT represents a physical state in which two Energies, of the same intensity, can be accumulated and stored together and at the same time *disable* each other from being detectable in a way that these

Energies *exist* but are *undetectable* or *untraceable*. The *"Energy Pair"* concept represents a new type (appearance) of Energy that exists in nature [1].

Further elaboration of the EPT on the well-known observations of a collision of an electron and a positron to provide gamma photons, and the reversed process of gamma photons splitting into an electron and a positron in appropriate conditions, provided two revolutionary conclusions of the previous work:

1. *Untraceable Energy Pairs* might convert back to *traceable energy*

2. *Electric Charges* are equated with *Energy* or can be considered as a form of *Energy*, analogous to the *Mass* being a form of *Energy* as derived from *Einstein's Special Relativity Theory*. In other words, the previous study concluded that if Mass and Electric Charges are both forms of *Energy*, the only entity that exists and governs natural processes is *Energy*.

That previous work also presented the assumption that *Energy Pairs* might be the cause of at least part of the unexplained (mysterious) *Dark Energy*. It was argued there that since a huge portion of the universe is composed of Electromagnetic Waves that can be bended, scattered and deflected, there is a high probability that these waves might create a significant amount of *Null or Partly Null Electromagnetic Waves*, whose energies are *untraceable* or *partly untraceable*. These *untraceable* Energies might constitute at least part of the *Dark Energy*.

Considering the above study's significant conclusions related to Electric Charges and forms of Energy, the present study is aimed to investigate energies embedded in *static electric fields*, generated by *static electric charges*, and energies embedded in *magnetic fields* generated by *moving electric charges* that move at a constant velocity, and to analyze if energy issues exist also in these scenarios.

The present study is based on the classical Physics' basic knowledge about the energies embedded in electric fields, and the energies embedded in magnetic fields. A brief summary of this knowledge will be given in the following paragraphs:

Energies embedded in Static Electric Fields

When a body is charged with an electric positive charge, it creates an electric field around it whose embedded Energy per unit volume **u** is provided by: $u_e = \varepsilon_0 \, (|E^{\rightarrow}|^2)/2$, where $|E^{\rightarrow}|$ represents the electric field magnitude in the unit volume, and ε_0 is the vacuum permittivity and is equal to: $8.854187817\ldots \times 10^{-12}$ F/m (Farad per meter) [2]. The electric field magnitude $|E^{\rightarrow}|$ is given by:

$|E^{\rightarrow}| = (1/(4\pi \, \varepsilon_0))(q/r^2)$, where **q** is the electric charge magnitude that generates the electric field **E$^{\rightarrow}$** and **r** is the distance of the electric charge to a point in Space in which the electric field is generated [3]. Electric field is a radial vector that points towards the line that connects the electric charge to the point in Space in which the electric field exists.

When a body is charged with an electric negative charge, it creates an electric field whose polarity is opposite to the polarity of the electric field that a positive electric charge creates. However, the embedded energy per

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unit volume of the electric field created by the negative electric charge and by the positive electric charge is expressed by the *same* formula as shown above.

Figure 1 represents the electric field's intensities in *Space* generated by a positive electric charge. The electric field direction at each point is radial which means that it points to the direction of the line that connects a point in Space to the electric charge that generated this electric field; in this case it points *outwards from* the electric charge. The electric field's intensity at each point in Space decreases by a factor of $1/r^2$, where **r** is the distance of that point from the electric charge. Thus, the arrows in the picture representing the electric field's intensity and its direction decrease in size as they become further away from the electric charge.

Figure 2 is a picture representing the electric field's intensities in Space generated by a negative electric charge. It is like Figure 1, with the only difference that the electric field's polarity (or direction) is opposite to the electric field's polarity generated by the positive electric charge. Thus, the arrows in Figure 2 representing the electric field's intensity and its direction, point inwards, towards the negative electric charge.

It is important to note that although both Figure 1 and Figure 2 are two-dimensional pictures, the electric fields exist in a three-dimensional volume of Space. Thus, both Figure 1 and Figure 2 represent a plane which is a two-dimensional slice of the volume of Space.

The first phase of this work is aimed to study the energies embedded in a particular point in Space, energies that are embedded in the static electric fields generated by static electrical charges in Space. This work evaluates if such static electric fields might manifest *seemingly* energy losses similar to the *seemingly* energy losses manifested by energies embedded in *Null* or *Partly Null* Electromagnetic Waves as described, analyzed and explained in the article titled "Energy Analysis of a Null Electromagnetic Wave", which was already mentioned above [1].
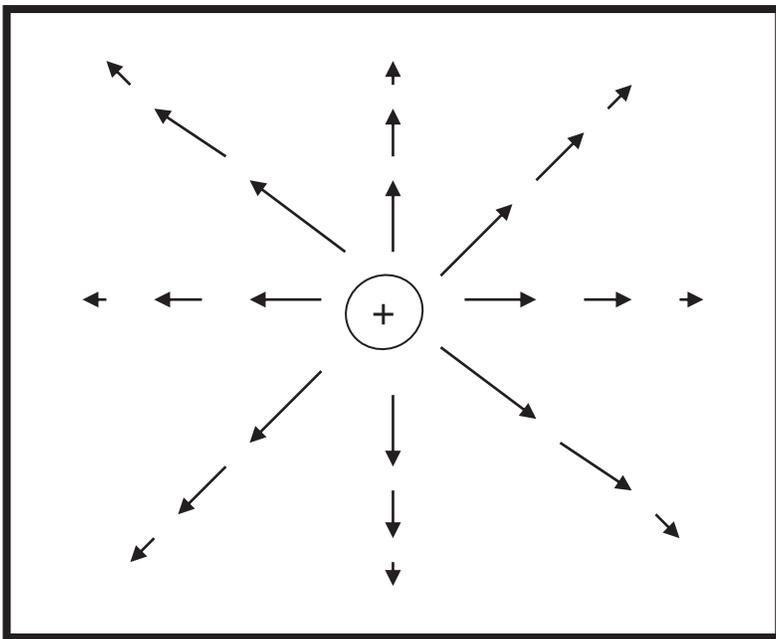

Fig 1 | Electric field's intensities in Space generated by a positive Electric Charge
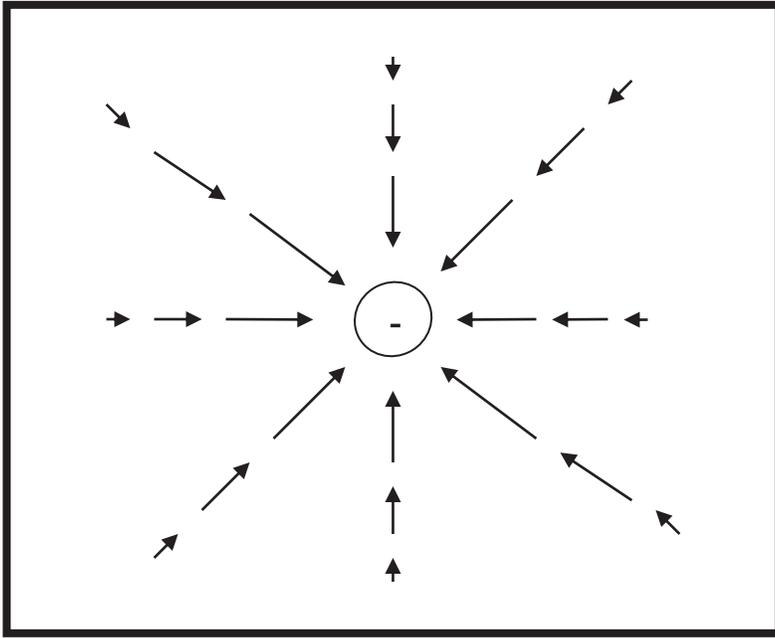
Fig 2 | Electric field's intensities in Space generated by a negative Electric Charge

Energies embedded in Magnetic Fields

When a body is charged with an electric charge of a certain polarity (positive or negative), and that body is moving at a constant velocity in a certain direction in Space, it creates a magnetic field $\vec{B}$ around it whose embedded energy per unit volume **u** is provided by:

$u_m = (|\vec{B}|^2)/(2\,\mu_0).$ where μ_0 is the vacuum magnetic permeability and is equal to: $4\pi 10^{-7}$ **H/m** (Henry per meter). [4].

The magnetic field $\vec{B}$ is described by: $\vec{B} = (\mu_0/(4\pi))(q(\,\vec{v}\,X\,\vec{r}\,)/r^2).$

where **q** is the magnitude of the electric charge generating the magnetic field; **r** is the distance between the electric charge that generates the magnetic field and the point in Space where the magnetic field is generated; $\vec{v}$ is the velocity vector of the electric charge; $\vec{r}$ is a unit vector pointing towards the direction of the line connecting the electric charge to the point in Space where the magnetic field is generated; **X** denotes vector multiplication [5].

When another body is charged with an electric charge of the opposite polarity (negative or positive) but with the same amount of charge contained in the first body mentioned above and that body is also moving in the same constant velocity, in the same direction as the first body described above, it creates a *magnetic field*, in the same Space volume, whose magnitude is expressed by the same formula (above) that describes the magnetic field's magnitude $\vec{B}$ but its direction (or polarity) is inversed to that of the first body. But the embedded energy per unit volume of the magnetic field created by both charged bodies is expressed by the *same* formula presented above.

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The second phase of this work is aimed to study the energies embedded in Space that magnetic fields of moving electric charges generate in Space. That work evaluates if such magnetic fields might manifest *seemingly* energy losses similar to the *seemingly* energy losses manifested by energies embedded in *Null* or *Partly Null* Electromagnetic Waves as described, analyzed and explained in the article titled "Energy Analysis of a Null Electromagnetic Wave", which was already mentioned above [1].

2. Analysis of Energies Embedded in Static Electric Fields Generated by Static Electric Charges in Space

The first stage of this analysis would be an examination of two *static electric fields*, generated by two static electric charges, of the same magnitude but different polarity, in a specific point - A in Space. Figure 3 is a simple diagram of two static electric charges, one positively charged, and one negatively charged, of an *equal magnitude*, that generate their static electric fields at an arbitrary point A in Space. As can be seen in Figure 3, point A is closer to the positive electric charge than to the negative charge; Therefore, the electric field that the positive electric charge generates at point A (represented in the picture by the black arrow), is more intensive than the electric field that the negative electric charge generates at point A (represented in the picture by the red arrow). Because electric fields are vectors that might annihilate each other, the resultant *net electric field* intensity that exists at point A is, then, a subtraction of the intensities of the two electric fields generated by the electric charges at point A (represented by the blue arrow).

The second stage of this analysis would be an examination of the *energy density* embedded in point A in Space, that is generated by the two electric fields described above:

The formula: $u_e = \varepsilon_0 |E^{\rightarrow}|^2/(2)$, that was presented above, shows that at each point in Space where an *electric field* $E^{\rightarrow}$ with intensity of $|E^{\rightarrow}|$ exists**,** there should also exist, an *energy density* whose *intensity* is proportional to $|E^{\rightarrow}|^2$ at that point. The electric field's intensity $|E^{\rightarrow}|$ is proportional to the magnitude of the electric charge that generated this electric field $E^{\rightarrow}$. As already noted above, electric fields are vectors that might be annihilated, fully or partly, by other electric fields.
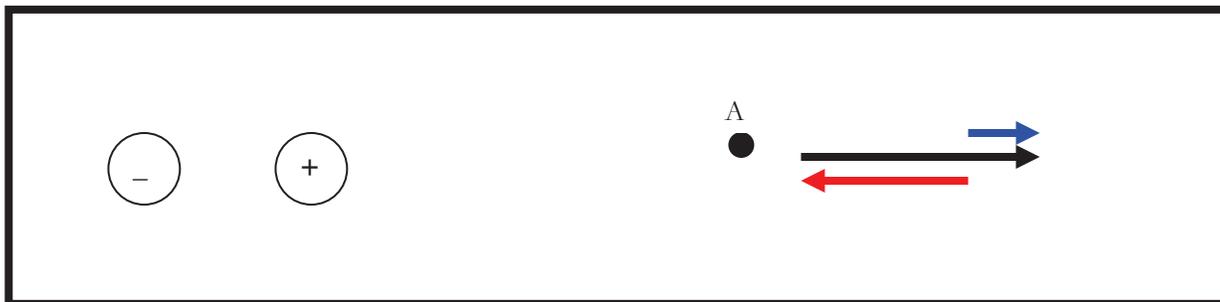

Fig 3 | Diagram of Static Electric Fields at point A generated by static negative and positive electric charges

However, the energy embedded in each point in Space that these two electric fields generate, cannot be destroyed, or annihilated; on the contrary, the energy at each point in Space should be conserved according to the

Energy Conservation Principle. Thus, since each of the two electric charges described above is not "aware" of the existence of the other electric charge, each electric charge still generates its *own* electric field, with its *full* electric field *intensity* |E->| that is proportional to the *magnitude* of that electric charge, which embeds its *full energy* presented by the formula presented above, describing the energy embedded in a static electric field, and these *full energies*, that each electric charge generates, should be conserved according to the *Energy Conservation Principle.* Thus even if some of the *electric field* that one electric charge generates at some point in Space is *annihilated* by an *inverse electric field* that *another electric charge* generates at the same point in Space, *not* any portion of the *energy density* that the two electric charges generate at that point in Space should be annihilated, or destroyed, or disappear. Energies are not supposed to be destroyed or be annihilated; On the contrary, they should be conserved! Thus, the total energy density at point A should be the sum of the original energy densities embedded in the two electric fields, generated by the two static electric charges shown in Figure 3, the energy embedded in the electric field presented by the black arrow *plus* the energy embedded in the electric field presented by the red arrow. But, the "net" electric field generated at point A (represented by the blue arrow) is smaller than the sum of the two electric fields generated by the two static electric charges (represented by the black and the red arrows), so it appears to be that the total *detectable* energy density at point A in Space *seems* to be smaller. Is it possible that the *Energy Conservation Principle* is violated? Is it possible that energy disappeared or was annihilated?

A summary of the controversy that was described above would say that the fact that some of the *Electric Field*, generated at point A by the positive electric charge (*the black arrow*), was *annihilated* by the *Electric Field*, generated at point A by the negative electric charge (*the red arrow*), *seems to cause* a violation of the *Energy Conservation Principle* at point A, because *some* of the *energy density* generated by the positive electric charge at point A, and *all* the *energy density* generated by the negative electric charge at point A, *seemed* to *disappear* or *seems* to be annihilated. This controversy indicates a paradox between the above examination and a fundamental law of physics *"The Energy Conservation Principle".* To resolve this paradox, *"The Energy Pairs Theory* (EPT)" [1] that was already represented above, will be used.

<u>*The Energy Pairs Theory* (EPT)</u> was developed to resolve a *similar* paradox existing in the energy embedded in a *Null* Electromagnetic Wave [1]. In that scenario the electric and magnetic fields of both colliding and unifying electromagnetic waves, that continue to travel together in the same direction, annihilated each other completely, which resulted in a *seemingly Energy Conservation Principle violation*, because *seemingly* the Energies embedded in the two unifying waves *seem* also to disappear.

The *Energy Pairs Theory* (EPT) [1] states that certain energies, such as the energies embedded in Electromagnetic Waves, or electric fields' embedded Energies (the case that was studied above), or magnetic fields' embedded Energies, can be stored as "*Energy Pairs*". "*Energy Pair*" is a theoretical construct designed to describe a novel *type of Energy* in which two energies' components, of identical intensities, exist together as one *Energy Pair* while they *disable* each other from being detectable and as such form an *untraceable* energy. The innovative *"Energy Pairs Theory"* (EPT) was developed by the author of this article and is discussed in the article

titled: "Energy Analysis of a Null Electromagnetic Wave" [1] mentioned before. In that article it was also shown that in appropriate conditions such *Energy Pairs* might convert back to *traceable* energies.

The EPT will be used now to explain the controversy relating to the violation of the *Energy Conservation Principle* that was described above: As shown in Figure 3, at point A, a *net traceable electric field* exists, represented by the *blue arrow*. This *net* electric field embeds *traceable energy density* at point A in Space. In addition, an *untraceable Energy Pair,* also exists at point A which contain two energies: the energy embedded in the electric field generated by the negative electric charge, represented by the red arrow, and part of the energy embedded in the electric field generated by the positive electric charge, the part that *seemed* to disappear. Both *intensities* of the energy components stored in that *Energy Pair* can be represented by the size of the red arrow. Thus, point A in Space contains *two components of energies*: the *traceable* energy density embedded in the *net* electric field that exists at point A, represented by the size of the *blue arrow,* and an *untraceable Energy Pair* that accumulates and stores the *two energy densities* that *seemed* to disappear. This explanation clearly resolves the controversy shown above and, clearly, now the *Energy Conservation Principle* is not violated.

Theoretically, if the two static electric charges shown in Figure 3 exist very close to each other, so close that they can be considered to be *virtually* residing at the same point in *Space,* the electric field that the positive electric charge generates at point A *annihilates* almost *completely* the electric field that the negative electric charge generates at that point; This results in *virtually zero traceable electric field* generated at this point, and zero *traceable energy* density. The energy in this case is stored *virtually* completely as an *untraceable Energy Pair,* and the *Energy Conversation Principle* is again not violated. This situation is in complete analogy to the annihilation of the electric and magnetic fields which create a *Null* Electromagnetic Wave.

Thus, analogous to the Null Electromagnetic Wave scenario, when two electric (or magnetic) fields annihilate each other fully or partially at any point in *Space,* the initial energy that existed in each of these electric (or magnetic) fields is not annihilated. Instead, what *seems* as Energy that was annihilated or disappeared is also stored into an *untraceable Energy Pair.*

At this point of the present study, it can be concluded that at any arbitrary point in Space, in which two or more electric fields generate Energy, the energy density embedded at this arbitrary point, might contain both, *traceable* energy, and an *untraceable Energy Pair,* such that the total Energy generated at this point in Space is conserved. In other words, what *seemed,* as Energy that was annihilated or disappeared is, in fact, stored into an untraceable *"Energy Pair"* that, at this scenario, resides in point A in Space.

The discussion so far related only to two electric charges of equal intensity and opposite polarity. But a more realistic picture of Space indicates that enormous number of electric charges of different magnitudes and polarity exists in Space. These electric charges generate electric fields in each of the infinite number of points in Space. The electric field that each electric charge generates at each point in Space has its *full* electric field *intensity* $|\vec{E}|$ that is proportional to the *magnitude* of that electric charge, which embeds its *full energy* presented by the formula presented above, describing the energy density embedded in a static electric field. Even if some of the

electric field that an electric charge generates at some point in Space is annihilated by an inverse electric field that another electric charge generates at that point, not any portion of the energy density that the first electric charge generated at that point, will be annihilated because energies are supposed to be conserved according to *the Energy Conservation Principle*. Thus, it can be further concluded that each point in Space consists of *two types of energy*: *traceable energy* that present the energy density embedded in the "*net*" field that exists in each point in Space, which is a result of the annihilation of different electric fields that exist at that point, and *untraceable "Energy Pairs"* that store the energies that were embedded in the annihilated electric fields in that point. This indicates that:

(1) The entity of Space (or each point of the infinite points of Space) is equated with energy;

(2) The energy that exists in Space (in each point of it) is of two types: *traceable energy* and *untraceable "Energy Pairs"*.

A general conclusion may be drawn at this point: **"Space is Energy"!** It is neither Emptiness nor Vacuum!

3. Analysis of Energies Embedded in Magnetic Fields Generated by Moving Electric Charges in Space

The previous section analyzed the Energy embedded in *static electric fields in Space*. However, electric charges in Space or in the universe are in continuous movement and change locations, relative to each other, all the time. Such electric charges create Magnetic Fields. The magnitude of a magnetic field and its embedded energy in an arbitrary point in Space is already presented above. The analysis presented in this section related to Magnetic Fields, is quite similar to that presented above for Electric Fields, though it contains additional details.

First, only two electric charges, one positively charged, and one negatively charged, of the same magnitude, will be analyzed. These electric charges are assumed to be in continuous movement relative to each other and, as such, create Magnetic Fields.

Similarly to the argumentations presented in the previous section of this article related to energies embedded in static electric fields, the following argumentations also apply: magnetic fields of opposite polarities existing at the same point in Space do annihilate each other fully or partially, but the original energies embedded in these magnetic fields are supposed to be conserved, according to the *Energy Conservation Principle* and no part of these energies is supposed to be annihilated or disappear.

At a *specific instant in time*, the fields that the two moving electric charges described above generate in *Space* are such that at *certain locations* (points) in *Space* the field generated by the positive electric charge has higher intensity than the field generated by the negative electric charge. Thus, in *such locations* (these specific points in Space) the *Space* contains *traceable energy* embedded in the "*net*" *residual* field whose intensity is equal to the higher intensity field that the positive electric charge generates, from which the weaker intensity field that the negative electric charge

generates is subtracted. Also, in *such locations* the *Space* contains an *untraceable Energy Pair* that contains two energy components of equal energy's intensities: the energy embedded in the field generated by the negative electric charge and part of the energy embedded in the field generated by the positive electric charge, the energy part that *seemed* to disappear. The intensity of each of these two energies is equal to the energy intensity embedded in the field generated by the negative electric charge. So, in such locations (points in Space) the *Space* contains both *traceable energy* and *untraceable Energy Pair*s.

Also, at a *specific instant in time*, the fields that the two moving electric charges described above generate in *Space* are such that at *certain locations* in *Space* the field generated by the negative electric charge has higher intensity than the field generated by the positive electric charge. Thus, in *such locations* the *Space* contains *traceable energy* embedded in the "*net*" *residual* field whose intensity is equal to the higher intensity field that the negative electric charge generates, from which the weaker intensity field that the positive electric charge generates is subtracted. Also, in *such locations* the *Space* contains an *untraceable Energy Pair* that contains two energy components of equal energy's intensities: the energy embedded in the field generated by the positive electric charge and part of the energy embedded in the field generated by the negative electric charge, the energy part that *seemed* to disappear. The intensity of each of these two energies is equal to the energy intensity embedded in the field generated by the positive electric charge. So, in such locations the *Space* contains, again, both *traceable energy* and *untraceable Energy Pair*s.

There might also be *other virtual locations* in *Space* where in an instance of time, the Magnetic Field generated by the negative electric charge has virtually *equal* intensity as the Magnetic Field generated by the positive electric charge. This case can be described by two electric charges of opposite polarity and equal charge magnitude that are remarkably close to each other, *virtually* at the same point in Space, and move together at a same constant velocity. In *such locations* in *Space* the two electric charges described above generate *virtually only* an *untraceable Energy Pair* which consists of two energies' components: the energy embedded in the Magnetic Field created by the negative electric charge, and the energy embedded in the Magnetic Field created by the positive electric charge. These energies' components reside together in an *Energy Pair* where they exist together but disable each other from being detectable, and therefore present *untraceable energy*. In such *virtual locations*, the two electric charges described above do not generate any *traceable energy*. This specific description is analogue to the energy embedded in a *Null Electromagnetic Wave* that contains only untraceable *"Energy Pairs"*. (The energy embedded in a *Null Electromagnetic Wave* is described and discussed in detail in the previous work mentioned above [1]).

Since electric charges in Space that generate Magnetic Fields, are at a continuous movement relative to each other, the *Space locations* described above are *points in Space* where the Magnetic Fields' energy embedded in them changes continuously and all the time. Therefore, it can be concluded that the *Composition* of the *Energy* in each point in *Space* (out of the infinite points in Space) is a *mixture* of *traceable* and *untraceable* energies, and this mixture is dynamic and changes continuously all the time and at each point in Space.

Because the number of electric charges in Space is virtually unlimited, there is almost complete certainty that at each point in Space some electric charge generates Electric or Magnetic Fields that is annihilated fully or partially by

other Electric or Magnetic fields that other electric charges generate at this point. Thus, *Space* is *filled almost completely* with *untraceable Energy Pairs* at *any point* of it, as well as *traceable* energy. This mixture of two *types of energy* at each point of Space is dynamic and changes all the time, as discussed above.

The above analysis of the energies embedded in magnetic fields, which is based on the *"Energy Pairs Theory"* leads towards two important conclusions:

1. Space itself is equated with Energy. In other words, **Space is Energy!** Space is neither "*Vacuum*" nor "*Complete Emptiness*".

2. The **Space-Energy** entity in the EPT framework is a mixture of **two types of energy**: *Traceable energy and untraceable "Energy Pairs"*. This mixture is dynamic and changes continuously, all the time, in each point of Space.

Figure 4 provides a visualization of a **Space-Energy** volume, containing many points in Space, in a snapshot of time that exhibits both *traceable energies* and *untraceable Energy Pairs*. (Figure 4 is a painting work made by the author of this article, named: *"And the Earth was Chaos"* or *"Space-Energy"*, and is kept with his other art works).

As discussed above, there are points in Space where the *traceable energies* are the outcome of a "*net*" embedded fields, where the intensity of the electric or magnetic fields generated by positive electric charges in that point of Space, is higher than those generated by negative electric charges in that point of Space. In the painting (Figure. 4), these portions of Space are colored by yellow. It is important to keep in mind that all these "yellow" portions or points in Space, contain also some *untraceable Energy Pairs* as mentioned already before.

When the "net" embedded energy in a specific point in Space is a result of Electric or Magnetic Fields' annihilation, where the electric or magnetic Fields, generated by negative electric charges are more intensive than those generated by positive electric charges, the *traceable energy* in this case, is colored in the picture by blue and black colors. Again, it is important to keep in mind that these portions in Space contain also some *untraceable Energy Pairs* as mentioned already before.

The sections that are colored by other shades and colors represent sections of Space which contain other kind of *mixture*s of *traceable* energies *and untraceable Energy Pairs*. The brighter portions in the painting contain more *untraceable Energy Pairs* than *traceable energy*, and even, as argued above, a very small portions of the picture, the white colored portions, represent points in Space in which *virtually*, there is almost *no traceable* energy at all, or points that consist of virtually *untraceable Energy Pairs* only. But also, in these points there is some *traceable* energy as mentioned already before.

The picture in Figure 4 represents a *snapshot in time* of a *Space-Energy* volume that constitute many points in Space, but obviously not all of them. In addition, the mixture of *traceable and untraceable energies* in Space is *dynamic*, as shown above, and is changing continuously all the time. So, another time snapshot of the same volume in Space would look and colored differently, etc.

Fig 4 | A visualization of a snapshot of a *Space-Energy* volume that consists of *traceable and untraceable energies*

4. *Space* and *Dark Energy* in the *"Energy Pairs Theory (EPT)"* Framework.

The analysis made in the present study provided surprising and innovative conclusions about the entity of Space:

First: It was shown that *every* point in *Space* contains a mixture of both *traceable Energy* and *untraceable Energy Pairs.* This mixture of *two types of Energy* at each point of Space is dynamic and changes all the time. Thus, the entity of Space, in the *"Energy Pairs Theory (EPT)* framework, is equated with Energy. The entity of *Space-Energy* is not a "Vacuum" or a "Complete Emptiness" or "Nothingness", as many still view it today. Rather, it is a mixture of *two types of Energy*: *traceable* or *detectable* energy, and *untraceable* or *undetectable "Energy Pairs"*.

The *detectable* or *traceable* energies in Space are the energies embedded in the "*net*" electric and magnetic fields in Space. However, it is important to keep in mind that *traceable energies* in Space are also exhibited by photons of Electromagnetic Waves that are also part of the Energies that composes Space as well, and also the Gravitational Energy embedded in the Gravitation fields in Space, which also is part of the energies that composes Space as well.

The *undetectable* or *untraceable "Energy Pairs"* are also part of *Space-Energy*, but, in addition, are also carried by photons in *Null* or *Partly Null* Electromagnetic Waves, as shown in the previous study presented in the article titled: "Energy Analysis of a Null Electromagnetic Wave" [1].

Second: The *untraceable "Energy Pairs"* that exists in Space but are *undetectable*, according to the analysis brought above, might be the source of the, unexplained yet, *Dark Energy*. In the previous article mentioned above [1], it was also concluded that the "mysterious" (unexplained yet) *Dark Energy* is composed of, at least partly, of *Energy Pairs* that are carried by *Null* or *Partly Null* Electromagnetic Waves that are part of the Energy that composes Space. Despite the fact that *Null* or *Partly Null* Electromagnetic Waves might compose a significant portion of the universe, and therefore, a significant portion of the *Dark Energy* in Space, the conclusion of the current study that *Space* itself consists of a considerable amount of *Energy Pairs*, at each point of it, continuously and all the time, strengthens this conclusion. Now, *Dark Energy* is seen as an integral part of Space itself.

The current knowledge about *"Dark Energy"* reveals that it is a theoretical Energy component that is assumed to exist in the universe. It is supposed to support cosmologists' observations about the rate of the expansion of the

Universe. The nature of this Energy is unknown, even called "mysterious" many times, but it is *untraceable*, and cosmology calculation indicates that it composes 68% - 70% of the energy in the Universe. [6]. Later, in the following sections of the analysis we'll try to provide a reasonable explanation to the question: why the *Dark Energy* is assumed to constitute a considerable amount of the Energy (about 70%) of the universe, about twice the amount of the *traceable energy* in Space.

To expand the conclusions, already drawn in the present study, about the entities of *Space-Energy* and the *Dark-Energy*, the theoretical construct of *"Energy Pairs"* of the *"Energy Pairs Theory"* will be further explored and elaborated.

5. Expanding of the Novel Theoretical Concept of *"Energy Pair (EP)"*

In the basic *"Energy Pairs Theory"*, *"Energy Pair"* is defined as in the following citation:

> "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" [1].

It was already shown in the present study that in the EPT framework, the answer to the question: "What is the "substance" that makes Space (or Universe)?" will always be: **What makes Space is Energy!** This entity of **Space-Energy** is of two types: *traceable energy* and *untraceable Energy Pairs*. For proceeding with further analysis and conclusions, it is important, at this point of the study, to provide further important characteristics of the nature of the *"Energy Pairs"*, and the way that this *untraceable* type of Energy "makes" the main part of Space, namely, the *Dark Energy* (about 70% of Space).

1. ***Energy Pairs*' Capability to Produce Activity in their Environment**

According to the *Energy Conservation Principle Energies* are *not* supposed to be *annihilated* or *destroyed*. Thus, the *total* amount of *Energy* in *Space* (or the universe for that matter) should be constant. This includes *all* the *Energies* in *Space*, *traceable* and *untraceable*, at any *instant* of *Time*. The fact that part of the *Energies* in the universe are *untraceable* and cannot be *detected* at some *instant* of *Time*, does not mean that the *untraceable Energies* do *not exist* at that *instant* of *Time*, and their *contribution* to the *total* amount of *Energy* in the universe, at that *instant* of *Time* is zero. What the *Energy Pairs Theory* claims is as follows: all *Energies* in the universe, *traceable* and *untraceable*, have *positive Energy values*. Any point in *Space* (or the universe, for that matter) that contains *virtually* only an *untraceable Energy Pair* does not contain zero *Energy* because the *untraceable Energy Pair* is *untraceable*. On the contrary, it contains, in the average case, *more Energy* compared a point in *Space* which contains *virtually* only *traceable Energy* because it always contains two energy components. Thus, the locations in *Space* containing *untraceable Energy Pairs* contribute to the *total* amount of *Energy* of the universe an amount of *positive Energy* which is *bigger* (actually, on the average, twice) in size

as compared to the amount of *Energy* contributed by the points that contain *traceable* energies. This will be further elaborated in a following section of this article.

The general concept of *"Energy"* encompasses its capability to execute work or create activity in its environment. As such, the *untraceable Energy Pairs* that exhibit a novel and special type of *Energy* should carry this capability, despite the fact that the electric and magnetic fields that generated these *Energy Pairs* annihilated each other, and caused the energy embedded in them to be *untraceable*. In other words, *Energy Pairs* should have the capability to be active or to be converted into *traceable Energy.*

The *Energy Pairs'* activity in Space, or their ability to manifest as *traceable Energy*, is supported in the following discussion, by two arguments. The first is based on scientific observations, and the second is based on theoretical scientific data, as follows:

First Argument Based on Scientific Observations

The well-known observable process of a photon producing an electron and a positron, when passing near a heavy atom, was analyzed in detail in the previous study: "Energy Analysis of a Null Electromagnetic Wave" [1]. A citation from that work explains why "*Energy Pairs*", carried by photons, exhibit the capability of creating activity in their environment:

> "In a case of a gamma photon transformed into an electron and positron, the electric charges created in the process, and added to the environment where they were created; contribute additional energy to the environment, in comparison to the energy that would be contributed to same environment if particles that contain same amount of mass and no electric charge at all were added to same environment. In this basic and simple point of view electric charges are also equated with energy. This implies that when a photon converts into an electron and a positron this increases the energy of the environment more than the traceable energy embedded in the photon itself, whose energy was converted only to the energy embedded in the masses of the electron and the positron. This implies that the charges created are energy. According to the "Energy Pairs Theory", that new energy, was created from a latent and untraceable Energy Pair that was embedded in the photon. This implies that such latent Energy Pairs can evolve and become detectable energy." [1].

Although the *Energy Pair* described above, resides in a photon and not at a point *in Space* as discussed in the current study, the *nature* of these two *Energy Pairs* is identical; Both *"Energy Pairs"* consist of energies that were generated by Electric or Magnetic Fields that annihilated each other. Thus, it can be assumed that if an *Energy Pair* embedded in a photon is capable of creating activity in its environment, as shown in the observable process of a Photon splitting into an Electron and a Positron, *Energy Pairs* that reside in *Space* and constitute a significant part of Space, as shown in the present study, are also capable of creating activities. It is important to note that any *type* of Energy, *traceable* or *untraceable*, can create activity because this is what *"Energy"* is about. However, there must always be some appropriate conditions for initiating this activity. Thus, *Energy Pair*s that reside in Space, as those that reside in a *Null* or Partly *Null* Electromagnetic Waves, possess the capability to be active in appropriate conditions.

Second argument that supports the active characteristic of *Energy Pair*s is based on the theory and observations related to "*Quantum Fluctuation*" or "*Virtual Particles*" [7]. The following citation describes the activity embedded in "Vacuum" or "*Emptiness*" in the *Quantum Mechanics* framework:

> "Pairs of particles are constantly popping into existence throughout the Universe. These "virtual pairs" consist of one particle with a negative charge and one with a positive charge. They exist for only a tiny fraction of a second before they collide and annihilate each other in a tiny burst of energy. This energy may be pushing outward on Space itself, causing the universe to accelerate faster." [7].

The basic assumption in the citation brought above that is based on the theory of *Quantum Mechanics*, is that particles popped from *Vacuum* or *Complete Emptiness*. The current study, based on the *"Energy Pairs Theory"* framework, already demonstrated that there is no point in *Space* that exhibits *Vacuum* or *Complete Emptiness*; On the contrary, it was clearly shown that *each point in Space (Universe) does contain untraceable Energy Pair*s in addition to *traceable* Energy. Thus, it is reasonable to assume that the particles mentioned in the above citation, actually, popped from the *untraceable Energy Pairs* in *Space*, and converted into *traceable* Energy, which might be another facet of the *untraceable Energy Pairs*' capability to produce activity in Space.

This argument might be also supported by the *dynamic composition* of the *two types of Energy* in *Space*, as related to the *mixture* of *traceable* and *untraceable Energies* in each point of *Space* that was already described in the current study. It might be that this dynamic nature of the two types of energies' existence is also a manifestation of the activity occurring in *Space* which involves *all its content*, the *traceable* and the *untraceable* energies. Further investigations into the issue of the new construct of *Energy Pairs*, as described in the *"Energy Pairs Theory"* framework, might disclose in the future, other facets and activities related to the *untraceable Energy Pairs* according to the changeable conditions that exist in the universe.

2. Quantitative Relation between *Traceable* and *Untraceable* Energy in Space

The current analysis relating to the energies embedded in Electric and Magnetic Fields in Space, has already shown that at any arbitrary point in Space, at any particular instant of time, there exists *traceable Energy* that exhibits the Energy generated by the "*net*" Electric or Magnetic Fields at this point, and *a pair of equal intensity components of Energy* that were generated by the fields that annihilated each other at that point. Thus, each point in Space is a combination of *one component of traceable Energy* of certain intensity, and an *Energy Pair* that consists of *two equal intensity components* of Energy that disable each other from being detectable and therefore exhibits an *untraceable* Energy. It is important to keep in mind that *Energy Pair*s have the capability to generate activity in their environment, and that they carry *two components of Energy*. Based on these two fundamental properties of *Energy Pairs*, further statistical elaboration will provide a brighter picture of the relative quantities of the two types of Energy in Space:

Because the number of the Electric Charges in Space (or the Universe) is enormous, and their movement relative to each other can be considered a random movement, there should be some probability distribution function, which

represents the values of the Energy Density that these Electric Charges generate at any specific point in Space. Taking into account that, each Energy Pair consists of two components of energy, the average value of that probability distribution representing the *untraceable Energy* at each point in Space, should be double as compared to the average value of the probability distribution representing the *traceable Energy* at each point in Space. Because the number of points in Space is infinite, it is statistically possible to conclude, almost precisely, that the total amount of *untraceable Energy* in *Space* (or the Universe) is twice the amount of *traceable Energy* in *Space*.

The above quantitative analysis relating to the *traceable* and *untraceable* Energies in Space reveals that the amount of the *Dark Energy*, which is composed of the *untraceable Energy Pairs* in Space, is double as compared to the amount of the *traceable* Energy in Space. This leads to a conclusion that the *untraceable Energy Pairs* in Space, probably the *Dark Energy*, compose about two thirds (about 67%) of all the Energy in Space. This conclusion complies fully with the observable cosmologic data that indicated that the *Dark Energy* should be about 70% of the total *Energy* of the Universe [6].

It is important to remember that the entity of the *Dark Energy*, at the first place, was introduced to explain the observable rate of the expansion of the universe [6]. Now, on the basis of the *"Energy Pair Theory"* (EPT), an appropriate explanation to the unexplained *Dark Energy*, is provided, claiming that the *untraceable Energy Pairs* that probably consists the main part of the *Dark Energy* in space, may provide an explanation to the fact that the Universe is expanding at a rate, much faster than expected by the measurements and evaluations that considered and took into account only the *traceable energy* of Space.

6. Summary, Conclusions, and Implications

The present study was primarily aimed to investigate the energy embedded in electric and magnetic fields that are generated by electric charges in Space. Detailed analysis has shown that *virtually* in all of the infinite points of Space, and continuously in time, electric and magnetic fields annihilate each other, in a way that their embedded Energy at arbitrary points in Space *seems* to violate the *"Energy Conservation Principle"*. The novel *"Energy Pairs Theory" (EPT)* was used to resolve this unacceptable *seemingly* violation of a basic rule of nature.

The *"Energy Pairs Theory"* central idea is that pairs of certain Energies, such as the Energies embedded in electric or magnetic fields, or in electromagnetic waves, can be accumulated and stored together in a state called: *"Energy Pair" (EP)*, where they *disable* each other from being detectable, so that their energies *exist* but *cannot be detected*. Thus, *"Energy Pairs"* constitutes *a type of energy* called: *Untraceable Energy*.

The resolution, of the *seemingly* violation of the *"Energy Conservation Principle"*, using the *"Energy Pair Theory"* framework, entails some surprising and revolutionary conclusions related to Space and the Universe. Following, are these conclusions:

1. Each point of Space consists of a dynamic mixture (that changes continuously all the time) of **two types of energy**: *traceable energy* and *untraceable "Energy Pairs"*. This conclusion completely abolishes the claim that Space might be a 'Vacuum' or a 'Complete Emptiness'. The entity of Space, in the view of the *Energy Pair Theory*, is equated with Energy. In other words, **Space is Energy!**

2. It is reasonable to assume that the 'mysterious', unexplained **Dark Energy** might be composed of the *untraceable "Energy Pairs"* in Space. These *untraceable "Energy Pairs"* of Space, has been shown, in the present study, to constitute about twice the amount of the *traceable energy* of Space, and to have a capability to create activity in its environment. These two characteristics of the nature of the *Dark Energy*, derived from the analysis made in the *"Energy Pair Theory"* framework, provides evidence, which is in good compatibility with the cosmologic observations and evaluations that the *Dark energy* is the energy that causes the accelerating expansion rate of the Universe.

The present study, together with our previous study [1], indicates that **Space is Energy**. An important source of this Energy is electric and magnetic *fields*, and Electromagnetic *Waves* that are generated by negative and positive electric charges that exist in Space. However, the entities of *Mass and Gravitation* are also a central sources of energy in Space too, and also contribute to the Energy that constitutes Space and the Universe; Therefore, this study's conclusions, as brought above, should be further expanded to provide a wider and more accurate answer to the question: "What is Space?" "Is Space really an entity made out of Energy only?"

One of the first theories dealing with these questions, was *"Aether Theory"* that claimed that Nature should shy away from "Complete Emptiness" (horror vacci), and therefore, that Emptiness contains the *Aether* medium or filling. It was also believed that this *medium substance* was necessary as a transmission medium for the propagation of electromagnetic and the gravitational forces, and electromagnetic waves. [8-9]. The *Aether* concept became obsolete in 1905 by Einstein's *Special Relativity Theory*, which stated that because the speed of light is a constant value, there is no need for a transmission medium for electromagnetic waves. However, one should distinguish between *Aether* that was introduced as a *transmission medium* for the propagation of electromagnetic waves, which the *Special Relativity Theory* showed 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 [10] and the fact that his *General Relativity Theory* requires *Aether* like medium. [11-12].

In recent years, there is a new interest in the *Aether* as a filling medium of Space, especially by going back to what Einstein argued about its necessity in the *General Relativity Theory*. Some scientists even connect it to the *Dark Energy* [13]. The following is a quote from a publication [14] demonstrating this trend of recent years:

"In an astonishing twist of fate, the key to relativity's salvation could lie in the Aether. Since the early 2000s, a small group of researchers have claimed that this invisible, space-filling substance could have the power to unify physics. Then, in late 2018, two independent groups suggested that the similarity between the Aether and the shadowy powers that populate our cosmos may not be mere coincidence. For one team, the Aether is a dead ringer for dark matter. For another, it could explain away dark energy. For others still, it might even be both. [14]".

The conclusions of the present study, that **Space** is **Energy** containing both *traceable energy* and *untraceable Energy Pairs*, correspond both with the requirements of the *General Relativity Theory*, and the claim, brought above, that *Space* itself might be, at least, source or part of the *Dark Energy*. As these conclusions were obtained, based on the *"Energy Pairs Theory"*, it might indicate that this novel and revolutionary *"Energy Pair Theory" (EPT)* may also play an important role in the efforts made by the scientific community to find a connecting link between *Electromagnetism* and *Gravity*.

As the present study has shown that *Energy Pairs* are created by *Electromagnetism* and are related to the *Dark Energy*, on the one hand, and *Aether* and *Dark Energy* are connected to the *Gravitational Energy* by the *General Relativity Theory*, on the other hand, the connecting link between *Electromagnetism* and *Gravity* might be found in the *"Energy Pair Theory"*. This further implication of the present study reveals that the activities that the *untraceable Energy Pairs* can manifest in Space or the Universe, might extend to new areas and aspects of Energy, constitutes also a connection to *Gravitation*, and not only to *Electromagnetism*.

As an integration theory of *Electromagnetism* and *Gravitation* is sought by the scientific community for a long time, thus, more research work, especially experimental one, is recommended to be invested relating the novel **"Energy Pair Theory"**.

Acknowledgment

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