Title: Dark Energy and Electromagnetism

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Abstract: The study addresses the following question: what is the source of the Dark Energy? The study provides sound argumentations that Electromagnetic Waves, from separate sources, can consolidate, even though such consolidations ***seem*** to embed paradoxes. The study also proposes a physical experiment which might implement consolidations of Electromagnetic Waves, from separate sources. In addition to the above, the study also addresses paradoxes related to the Mutual Annihilation and the Pair Production processes. The study proposes a resolution for all these paradoxes which also concludes that most of the Dark Energy might be related to Electromagnetism and that the Electric Charge is also a form of Energy.

One-Sentence Summary: A complement to the Pointing Theorem predicts the source of the Dark Energy, and that the Electric Charges are Energies.

Main Text: The notion of the Dark Energy is related to the following unanswered question: What is the Energy that supports the measured expansion rate of the Universe?
The measured expansion rate of the Universe must be supported by an amount of Energy which is much bigger than the amount of Energy that can be detect in the Universe. Thus, the notion of the Dark Energy states that there is an extra amount of Energy embedded in the Universe, above and beyond the amount of the Energy that can be detect, whose nature and source are still a mystery.

This study proposes an explanation to the above presented yet unanswered question.
The study analyses paradoxes as related to consolidations of Electromagnetic Waves, from separate sources, and to the Mutual Annihilation and the Pair Production processes. This analysis utilizes thinking experiments, logic, and reason. The study provides sound argumentations that Electromagnetic Waves from separate sources can consolidate, even though such consolidations ***seem*** to embed paradoxes. This study also suggests a physical experiment which might implement consolidations of Electromagnetic Waves, from separate sources. The study provides an explanation for all the above-mentioned paradoxes which also predicts that Electromagnetism might be the source of most of the Dark Energy and that the Electric Charge is also a form of Energy and what Humans perceive as Space is also just a form (or facet) of Energy.
The paper refers to materials which were already presented in several published papers. The paper summarizes these materials, and puts the explanation as related to the source of the Dark Energy, and the additional conclusions derived, into a comprehensive, ***complete*** framework. Because this

paper refers to already published papers, this paper does not need to delve into detailed mathematics. This helps in presenting the new ideas, because the discussion needs to focus mainly on the new points of views relating to existing issues in Electromagnetism, which were yet ignored, and by not delving into mathematics, these new points of views are better presented.

1. Unifications of Electromagnetic Waves from separate sources

A significant observation which led to the conclusions derived in this paper is the following observation:

Electromagnetic Waves, from separate sources, ***can*** consolidate.

That observation contradicts what Physics today assumes about unifications of Electromagnetic Waves, from separate sources. The acceptable notion today is that Electromagnetic Waves, from separate sources, ***cannot*** consolidate.
An example to the above-mentioned notion about Electromagnetic Waves, is demonstrated by the following paper (*1*):
That paper states, when referring to Electromagnetic Waves, the following: "A one-dimensional wave moving in one direction can have only one source, and there can be only one such wave at a given point", which implies that Electromagnetic Waves, from separate sources, cannot consolidate.
However, several paper (*2*), (*3*), (*4*), (*5*) , (*6*) provide sound argumentations, that Electromagnetic Waves, from separate sources, can consolidate.
The paper (*2*) also proposes a physical experiment which describes how unification of Electromagnetic Waves from separate sources can be implemented.
Following is a brief presentation of the arguments provided which imply that Electromagnetic Waves, from separate sources, can consolidate.

The Wave facet of Electromagnetic Waves is a direct derivation from Maxwell's equations, which conclude, that an accelerating Electric Charge emits Energy in the form of Electromagnetic Waves, which can be presented by the following equations (7) :

$$Ey = E_0 \cos (2 \pi ((x / \lambda) – f t))$$
$$Bz = B_0 \cos (2 \pi ((x / \lambda) – f t))$$

Figure 1 below presents a schematic of an Electromagnetic Wave.

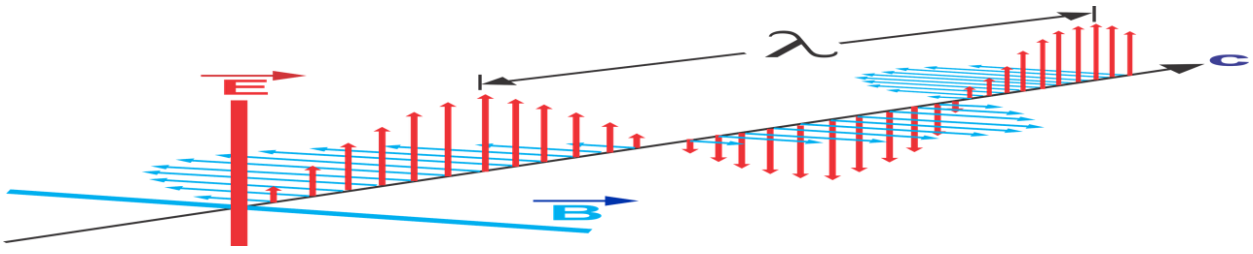

Fig. 1. Schematics of an Electromagnetic Wave. (Image source: pixabay.com).

In the equations presented above Ey is the Electric Field component of the Electromagnetic Wave and Bz is the Magnetic Field component of the Electromagnetic Wave. The above equations imply that an Electromagnetic Wave is composed of two propagating and oscillating Energy Fields, a propagating and oscillating Electric Field and a propagating and oscillating Magnetic Field. The above equations also imply that an Electromagnetic Wave always travels at the speed of Light (c), and each of its Fields is perpendicular to the other Field, and both are perpendicular to the line of traveling of the Electromagnetic Wave.

Because an Electromagnetic Wave, in its Wave facet, is composed of only two propagating and oscillating Energy Fields then, the necessary and sufficient conditions, for two Electromagnetic Waves, from separate sources, to unify and consolidate, are:

The two Electromagnetic Waves, from separate sources, must meet on a point in Space, and following that meeting moment the following must occur:

1. Each Electromagnetic Wave must continue to propagate in the exact same direction that the other Electromagnetic Wave propagates.
2. The two Electromagnetic Waves must continue to propagate on the exact same line in space.
3. The polarization of each of the two Electromagnetic Waves must be such, that, following their meeting moment, the line of oscillation of the Electric Field of one Electromagnetic Wave is the exact same line on which the Electric Field of the other Electromagnetic Wave oscillates.
4. The polarization of each of the two Electromagnetic Waves must be such, that, following their meeting moment, the line of oscillation of the Magnetic Field of one Electromagnetic Wave is also the exact same line on which the Magnetic Field of the other Electromagnetic Wave oscillates.

If the above conditions apply, following the meeting moment of these two Electromagnetic Waves, which initially emerged from separate sources, then, the Electric Fields of both waves, following their meeting moment, will always exist on the exact same location and on the exact same line in Space, and the same applies also to the Magnetic Fields of both waves.

Electric and Magnetic Fields are vectors, and such vectors which reside on the exact same location and on the exact same line in Space, unify to create a resultant vector, by adding up, or subtracting from each other, depending on their polarities.

Thus, the above implies that the Electric Fields of both waves consolidate, into one consolidated Electric Field, and the same applies also to Magnetic Fields of both waves, which implies that the two waves consolidate continuously into a new consolidated Electromagnetic Wave.

If the Electromagnetic Waves are polarized, as described in conditions 3 and 4 above, then a ***complete*** unification of these Electromagnetic Waves occurs. But even if the two Electromagnetic Waves are not at all polarized, then, a ***partial*** unification of the two Electromagnetic Waves occurs, and this partial unification still complies with all the discussion provided in the paper (*2*) .

The paper (*2*) describes a physical experiment which contains two Electromagnetic Waves, from separate sources, which meet on a half transparent mirror and unify, after leaving the half transparent mirror, into a consolidated Electromagnetic Wave.

The first Electromagnetic Wave comes from the transparent side of the half transparent mirror, and just passes and leaves the half transparent mirror, without being deflected by the half transparent mirror.
The second Electromagnetic Wave comes from a direction perpendicular to the direction on which the first Electromagnetic Wave propagated, hits the deflecting side of the half transparent mirror where the first Electromagnetic Wave exits the half transparent mirror, and is deflected by the half transparent mirror.
The half transparent mirror is tilted at 45 degrees, relative to the direction of the propagation of the first Electromagnetic Wave.
Thus, from the above follows, that the second Electromagnetic Wave, continues to propagate, after it is deflected by the half transparent mirror, in the exact same direction and the on exact same line in Space, on which the first Electromagnetic Wave propagates, after it passes and leaves the half transparent mirror.
Thus, after the two waves leave the half transparent mirror, they both continue to propagate in the exact same direction and on the exact same line in Space. If the Electromagnetic Waves are also polarized as the above-mentioned conditions 3 and 4 require, then, after the two waves leave the half transparent mirror, they consolidate ***completely*** into one consolidated Electromagnetic Wave.

An additional paper, the paper (5) provides an observation, that anybody can experience, every day, that indicates, that Electromagnetic Waves, from separate sources, can and do consolidate. That observation can be described as follows:
When one looks at items that exist behind a glass, when the illumination around is not intense, one usually can see the items that exist behind that glass and a reflection of himself, looking at that glass. The Light beams emerging from the items behind the glass, and the Light beams that return the reflection of this person, are Light beams that originate from separate sources (items behind the glass and the body of the person looking at the glass).
Then, some of these Light beams might be travelling in the exact same direction and on the exact same line in Space because these Light beams reach the person's eyes, and thus, consolidate.
Figure 2 below demonstrates manikins standing in front of a glass door. In the image the reflection of a manikin can be seen, along with items on the other side of the glass, the side external to where these manikins exist, which implies that some of the Light beams emerging from the items on the other side of the glass, and some of the Light beams returning the reflection of this manikin, might travel in the same direction and on the same line in Space and thus consolidate.

Fig. 2. A photo of items outside the glass and a reflection of the manikin in front of the glass. (Image source: pixabay.com).

The reason and logic provided, in the paper (2), (3), (4), (5) , (6) , that Electromagnetic Waves, from separate sources, can consolidate, seem to be reason and logic which might be difficult to contradict. Thus, the question:
Why Physics today holds the notion that Electromagnetic Waves, from separate sources, cannot consolidate? must be asked, and addressed, based on the significant, sound argumentations that Electromagnetic Waves, from separate sources, ***can*** and do consolidate, presented above.
The following might provide a possible answer to that question:

It turns out, that unifications of Electromagnetic Waves, from separate sources, ***seem*** to embed paradoxes, because this scenario ***seems*** to violate the Energy Conservation Principle.

Because Electromagnetic Waves, in their Wave facet are just two oscillating and propagating Energy Fields then, if two Electromagnetic Waves, from separate sources, unify and consolidate when:

1. Their Electric and Magnetic Fields oscillate at the exact same frequency.
2. They embed the exact same intensities in their Electric Fields.
3. They embed the exact same intensities in their Magnetic Fields.
4. They are at anti phase as related to each other, which implies an exact 180-degree phase shift as related to each other.
5. They have proper polarization, as explained in the paper (2) .

Then, the Electric Field of one consolidating Electromagnetic Wave, annihilates completely and continuously, the Electric Field of the second consolidating Electromagnetic Wave, after the Electromagnetic Waves meet and consolidate. Also, the same applies to the Magnetic Fields of the two waves.
The above implies that the resultant consolidated Electromagnetic Wave has zero Electric and Magnetic Fields, which is a Null Electromagnetic Wave.
Because the Energy embedded in an Electromagnetic Wave is proportional to the combined squares of the intensities of its Electric and Magnetic Fields, then, the resultant Null Electromagnetic Wave ***seem*** to embed no Energy at all, even though, the Electromagnetic Waves that created it embedded Energy, which ***seems*** as if Energy disappeared, which ***seems*** like a violation of the Energy Conservation Principle.

The above described an extreme scenario in which the consolidating Electromagnetic Waves meet and consolidate when they are exactly at anti phase (180-degree phase shift), as related to each other.

The other extreme scenario is the scenario in which the Electromagnetic Waves are exactly at phase (0-degree phase shift) as related to each other, when the Electromagnetic Waves meet and consolidate. Thus, if condition 4, in the five conditions above, is replace by:
The consolidating Electromagnetic Waves are ***at phase*** as related to each other when they meet and consolidate, which implies a 0-degree phase shift then, the resultant consolidated Electromagnetic Wave ***seem*** to embed more Energy, as compared to the combined Energies

embedded in the Electromagnetic Waves that created it, which ***seems*** as if Energy was created out of nothing. The following explains what was just presented:
In the scenario just described, the Electromagnetic Waves are in phase (0-degree phase shift) when they meet and consolidate, which implies that the Electric Fields of both consolidating Electromagnetic Waves add up.
Then, if E_1 is the intensity of the Electric Field in the first Electromagnetic Wave then, the Energy embedded in this Electric Field is proportional to E_1^2, because the Energy embedded in an Electric Field is proportional to the square of the intensity of this Electric Field.
And, if E_2 is the intensity of the Electric Field in the second Electromagnetic Wave then, the Energy embedded in this Electric Field is proportional to E_2^2.
Because, as presented already above, in the scenario just described the Electric Fields of both consolidating waves add up, then, the intensity of the Electric Field of the resultant consolidated Electromagnetic Wave is $E_1 + E_2$.
Then, the Energy embedded in the Electric Field of the resultant consolidated Electromagnetic Wave is proportional to $(E_1 + E_2)^2$.
And because $(E_1 + E_2)^2$ is always bigger than $E_1^2 + E_2^2$, then, the resultant consolidated Electromagnetic Wave, ***seem*** to embed more Energy in its Electric Field, as compared to the combined Energies embedded in the combined Electric Fields, of the Electromagnetic Waves that created it.
The above related to the Electric Fields of the consolidating Electromagnetic Waves, but similar argumentations apply also to the Magnetic Fields of the consolidating Electromagnetic Waves.

Thus, the above implies that in a scenario, in which the two Electromagnetic Waves meet and consolidate when they are at phase, the Energy embedded in the resultant consolidated Electromagnetic Wave, ***seems*** to be bigger than the combined sums of the Energies embedded in the Electromagnetic Waves that created it, which ***seems*** as if Energy was created out of nothing, which also ***seems*** like a violation of the Energy Conservation Principle.

The scenario in which a Null Electromagnetic Wave was created, in which Energy ***seems*** to disappear, and the scenario in which Energy ***seems*** as if it was created out of nothing, are just two extreme scenarios of consolidating Electromagnetic Waves, from separate sources.

However, if none of the conditions presented at the beginning of this chapter apply, it can also be shown, that in ***any*** scenario of consolidating Electromagnetic Waves, from separate sources, the resultant consolidated Electromagnetic Wave, ***seems*** to embed either less or either more Energy, as compared to the combined Energies embedded in the Electromagnetic Waves that created it. This also ***seems*** like a violation of the Energy Conservation Principle, and this is also described in the paper *(4)* .

Because the Energy Conservation Principle is a foundation building block of Physics, then, consolidations of Electromagnetic Waves, from separate sources, ***seem*** to destroy one of the foundations upon which Physics today is constructed.
Thus, this might be an explanation to why the notion, that Electromagnetic Waves, from separate sources, cannot consolidate, is still held today, even though, there are sound argumentations, based on thinking experiments, logic and reason, that Electromagnetic Waves, from separate sources, can and do consolidate, logic and reason that seem difficult to contradict.
However, the paper *(2)* proposes a reasonable explanation to these paradoxes, an explanation which keeps the Energy Conservation Principle intact.

2. The Energy Pairs Theory

Because, as presented above, consolidating Electromagnetic Waves from separate sources exhibit, in one extreme situation, the creation of a Null Electromagnetic Wave, which contains no Electric or Magnetic Fields at all, and, in the creation of this Null Electromagnetic Wave, Energy ***seems*** to disappear, that Energy disappearance can be assumed to be the creation of Dark Energy, because Dark Energy is also Undetectable. This paper, and papers (*2*), (*3*), (*4*), (*5*) , (*6*) propose a new theory, the Energy Pairs Theory, which complements the Pointing Theorem, which provides a reasonable resolution to the paradox embedded in scenarios of consolidating Electromagnetic Waves, from separate sources. The new Energy Pairs Theory explains how consolidations of Electromagnetic Waves, from separate sources, can occur, and still the Energy Conservation Principle is not violated.

Following is a short presentation of the elements embedded in the new Energy Pairs Theory:

The new Energy Pairs Theory states that, in certain conditions, Energies embedded in Electromagnetic Waves can be accumulated and be stored together in pairs. These Energy Pairs ***disable*** each other from being detected, such that the Energies ***Exit*** but are Undetectable Energies, or ***Dark Energy***.

The new Energy Pairs Theory expands the concept of Energy to embed two forms (or facets) of Energy: Detectable Energy and Undetectable (or Dark) Energy. The Undetectable (or Dark) Energy is accumulated in Pairs of Energies which ***disable*** each other from being detected. And the new Energy Pairs Theory also states that Photons can carry both, Detectable and Undetectable (or Dark) Energies.

Examples of Energy Pairs might be the two Electric Fields, or the two Magnetic Fields, of the two consolidating Electromagnetic Waves, from separate sources, which resulted in the creation of the Null Electromagnetic Wave. These two Electric Fields annihilate completely each other, and disappear, after the two consolidating Electromagnetic Waves, from separate sources, meet and consolidate, causing the Energy embedded in these two Electric Fields to ***seem*** also as disappearing. And the same applies also to the two Magnetic Fields, of these two consolidating Electromagnetic Waves, from separate sources.

The new Energy Pairs Theory states that the Energies embedded in these two Electric Fields (or these two Magnetic Fields), did not disappear, even though these two Electric Fields (or these two Magnetic Fields) annihilated each other, and disappeared. The new Energy Pairs Theory states that the Energies embedded in these two Electric Fields (or these two Magnetic Fields) still ***exist***. These Energies were converted into Undetectable or Dark Energy, embedded in Space.

If it can be assumed that Space is just a form (or facet) of Energy, then, Space can be a media which stores the Energies of these two Electric Fields (or these two Magnetic Fields), which annihilated each other, causing also the Energies embedded in them to ***seem*** also as being disappearing.

The assumption that Space is a form (or facet) of Energy, presented above, might be also derived from Einstein's four-dimensional Interwoven Space/Time entity provided by Einstein's General Relativity Theory. Einstein's four-dimensional Interwoven Space/Time entity was introduced for explaining the origin of attraction between Mass bodies. As such, Einstein's four-dimensional Interwoven Space/Time entity is supposed to replace Newton's Gravitational Field, which should be recognized as a form of Energy. Since the Gravitational Field is a form of Energy, then, the Interwoven Space/Time Entity should also be a form of Energy.

In a speech, in the University of Leiden on May 5th, 1920, (*8*) , Einstein claimed that the Ether should exist to provide physical properties to his Space/Time entity, which implies, that Einstein also agreed that his Space/Time Entity is a form of Energy. Thus, because Einstein's four-dimensional Interwoven Space/Time entity is just a form of Energy, and Space is just an ingredient in Einstein's four-dimensional Interwoven Space/Time entity, then, this implies, that Space is just a facet (or attribute) of a form of Energy.

An analogy to what was presented above, as relating to the new Energy Pairs Theory, might be the rope pulling game named tag-of-war.

Figure 3 below presents a tag-of-war game.

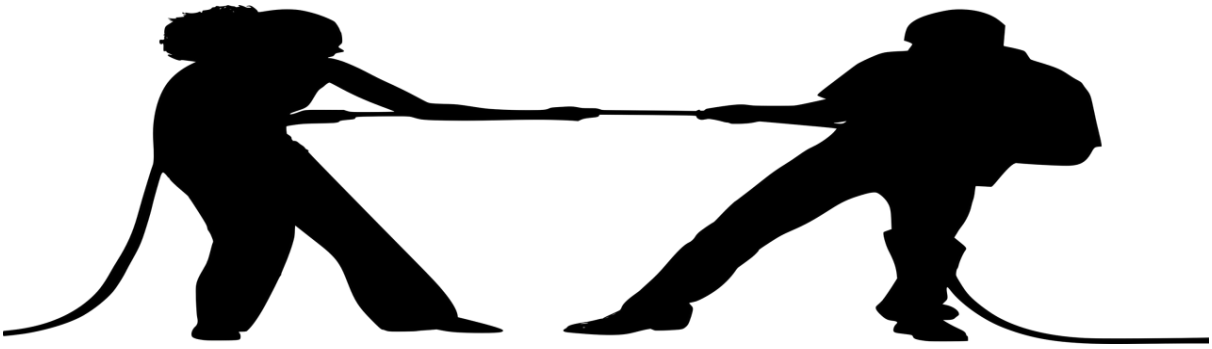

Fig. 3. Tag-of-war game. (Image source: pixabay.com).

In that game, two persons pull a rope, each from the other side of the rope. If the magnitude of the force exerted on the rope, by the first person, is equal exactly to the magnitude of the force exerted on the rope, by the other person, the rope does not move at all. This might ***seem*** as there is no force exerted at all on the rope, and no Energy imposed on the rope. But because the rope is a tangible substance, the Energy imposed on the rope can be detected via the tension embedded in the rope, which stores the Energy inserted in the rope, even though, the rope does not move at all.

Similarly, to the above, the two Electric Fields (or the two Magnetic Fields) mentioned above, do annihilate each other, because they are of exact equal magnitude and opposite polarity, and this also ***seems*** as if the Energies embedded in them also disappeared.

But the new Energy Pairs Theory states that the Energies embedded in these two Electric Fields (or these two Magnetic Fields) did not disappear. The new Energy Pairs Theory states that these Energies were converted into Undetectable or Dark Energy embedded in Space.

And if Space is just a facet of Energy, then, it can store these Energies which ***seem*** to disappear. But because Space is not a tangible substance, as the rope is, in the tag-of-war game, the Energies it stores cannot be detected, and are stored as Dark Energy.

Some physicists believe that the media that stores the Dark Energy is Space itself. This is exactly what the new Energy Pairs Theory, also assumes. However, these Physicists believe that the Energies that might be stored in Space as Dark Energy are only Energies related to Gravitation. The new Energy Pairs Theory assumes that Space might also be the media that stores Dark Energy originating from Electromagnetism.

The previous paragraphs provided a partial explanation to how the new Energy Pairs Theory resolves the paradox embedded in consolidating Electromagnetic Waves, from separate sources. The Following discussion completes this explanation:

As already stated above, in the creation of the Null Electromagnetic Wave, the new Energy Pairs Theory states that the Energy did not disappear. Instead, the Energies embedded in the Electric Fields (or the Magnetic Fields) of the two consolidating Electromagnetic Waves that created the Null Wave, which annihilated each other, and thus, ***seem*** as if their Energies also disappeared, can be considered as Energies that were converted together into Dark Energy, that still ***exist***, and stored in Space, as Undetectable Energies or Dark Energies. It was already presented above, that the new Energy Pairs Theory states that Photons can also embed both, Traceable and Untraceable (or Dark) Energies. Thus, Space can be also assumed to be able to store this Energy as Photons, which embed Untraceable (or Dark) Energy.

However, an additional paradox was also presented, the paradox in which Energy ***seemed*** to be created out of nothing. The new Energy Pairs Theory also resolves this paradox.
In that scenario, the new Energy Pairs Theory states, that Energy was not created out of nothing. Instead, in that scenario, Untraceable or Dark Energy, stored in the Photons of the consolidating Electromagnetic Waves, converted back into Traceable Energy, embedded in the Photons of the resultant consolidated Electromagnetic Wave.

Thus, the new Energy Pairs Theory provides a reasonable resolution to the paradoxes related to consolidating Electromagnetic Waves, from separate sources.

But the new Energy Pairs Theory provides resolutions also to other unanswered questions. The new Energy Pairs Theory explains two additional paradoxes.

One of these two paradoxes relate to the famous Mutual Annihilation process (*9*) . The second of these two paradoxes relate to the famous Pair Production Process (*10*) .

The following refers first to the paradox in the Mutual Annihilation process:
In the Mutual Annihilation process an Electron and a Positron meet and annihilate each other to create Photons. An Electron is composed of Mass and a Negative Electric Charge.
A Positron is composed of Mass (equal in magnitude to the Mass of the Electron) and a Positive Electric Charge (but equal in magnitude to the magnitude of the Negative Electric Charge embedded in the Electron). In the process of a Mutual Annihilation, the Energy Conservation Principle implies, that the combined Energies embedded in the Electron and the Positron, which converted into Photons, must be equal to the Energies embedded in the created Photons.

Photons are recognized as being composed of Energy only, and do not embed any Mass or Electric Charge.
Mass, on one hand, is already recognized as a form of Energy, following the introduction of Einstein's Special Relativity Theory.
On the other hand, Electric Charge is not recognized (yet) as being a form of Energy.
From the above follows, according to the Energy Conservation Principle, that the Energies embedded only in the ***Masses*** of the Electron and the Positron must be equal to ***all*** the Energies embedded in the created Photons.

The above also implies that the Electric Charges of the Electron and the Positron just ***disappeared***.

That disappearance of the Electric Charges ***seems*** like a paradox.

Electric Charges, along with Mass are the basic building blocks of any tangible substance. Before Mass was recognized as a form of Energy, the science of Physics contained a Mass Conservation Principle stating that Mass is conserved and cannot disappear. After Mass was recognized as a form of Energy, following the introduction of Einstein's Special Relativity Theory, this conservation rule was discarded, and Mass was included in the Energy Conservation Principle.
Thus, why the Electric Charge can be let to disappear? Why the science of Physics allows a basic building block of materials, the Electric Charge, to just disappear, while the other basic building block of materials, the Mass, never disappears?

Thus, the Electric Charge disappearance ***seems*** like a paradox.

The following refers now to the paradox embedded in the Pair Production process:
In the Pair Production process, a Photon, in certain conditions, converts into an Electron and a Positron. Similarly, to the above, because the Electric Charge is not recognized (yet) as a form of Energy, according to the Energy Conservation Principle, ***all*** the Energy embedded in the Photon, which converted into an Electron and a Positron, in a Pair Production process, must be embedded only in the ***Masses*** of the created Electron and Positron. The above implies that the Electric Charges embedded in the created Electron and the created Positron were created out of nothing. How the science of Physics can allow, that a basic building block of materials (the Electric Charge) be created out of nothing, while the other basic building block of materials (the Mass) is never allowed to be created out of nothing? Thus, that creation of Electric Charges, in a process of a Pair Production, also ***seems*** like a clear paradox.

The new Energy Pairs Theory resolves also the above-described paradoxes.

The new Energy Pairs Theory states that in the Mutual Annihilation process, the Electric Charges did not disappear. They were converted into Untraceable or Dark Energy, and stored in Space, as Photons, which embed Dark Energies (originating from the Electric Charges that ***seemed*** to disappear), in addition to Traceable Energies (originating from the Masses of the Electron and the Positron that converted to Photons).

The above explanation is similar, to how the Energy Pairs Theory resolved the paradox embedded in the creation of the Null Electromagnetic Wave, because the Energy Pairs embedded in the creation of the Null Electromagnetic Wave, in which Energy ***seemed*** to disappear, were converted into Untraceable or Dark Energies, and stored in Space, as Photons that embed only Dark Energies.

The new Energy Pairs Theory also states, that in a Pair Production process, Electric Charges are not created out of nothing. The new Energy Pairs Theory states, that in a Pair Production process, Untraceable or Dark Energy embedded in the Photon, which converted into an Electron and a Positron, converted into the Electric Charges embedded in the created Electron and Positron.

The above explanation is similar, to how the Energy Pairs Theory resolved the paradox, in which Energy ***seemed*** to be created out of nothing, in some scenarios of consolidations of Electromagnetic Waves, from separate sources, because in such scenarios, the new Energy Pairs Theory stated, that Dark Energy embedded in Photons, in the consolidating Electromagnetic Waves, converted back into Traceable Energy, in the creation of the resultant Electromagnetic Wave, that ***seems*** to embed more Energy as compared to the combined Energies embedded in the Electromagnetic Waves which created it.

Thus, the new Energy Pairs Theory states that Electric Charges can be converted into Dark Energy, and that Dark Energy can be converted back to Electric Charges, similarly to what is already recognized and accepted today, that Mass can be converted to Energy, and Energy can be converted back to Mass.

Thus, the above implies that Electric Charges are also forms of Energy.
But Mass is always Positive and Electric Charges can be Positive or Negative.

It should be also noted that Physics does contain a ***Charge Conservation Principle***, which states that the amount of all the Positive Electric Charges in the Universe, must be equal to the amount of all the Negative Electric Charges in the Universe.
Thus, from the Charge Conservation Principle follows, that Electric Charges can be converted only into Dark Energy, and an amount of Positive Electric Charge can convert into Dark Energy only with an exact same amount of Negative Electric Charge, to keep the amount of all the Positive Electric Charges in the Universe, equal to the amount of all the Negative Electric Charges in the Universe. Also, from the Charge Conservation Principle also follows, that only Dark Energy can convert into Electric Charges, but only into a pair of Positive and Negative Electric Charges, where the amount of the Positive Electric Charge created equals exactly the amount of the Negative Electric Charge created, to keep the amount of all the Positive Electric Charges in the Universe, equal to the amount of all the Negative Electric Charges in the Universe. But still, although Mass can convert to regular Traceable Energy, and Electric Charge can convert only into Dark Energy, Electric Charge must still be recognized as a form of Energy, because Dark Energy is still Energy.

The recognition of the Electric Charge, as a form of Energy, presented above, can be also seen, as an expansion of the Energy Conservation Principle, to include in it the Electric Charge entity, as the Energy Conservation Principle was expanded when the entity of Mass was included into it.

Thus, the new Energy Pairs Theory was shown to resolve also the paradoxes embedded in the Mutual Annihilation and the Pair Production processes, which also resulted in the statement that the Electric Charge is also a form of Energy, similarly to Mass being already recognized as a form of Energy, following the introduction of Einstein's Special Relativity Theory.

3. Electromagnetism might be the source of most of the Dark Energy

The new Energy Pairs Theory provided a resolution for the paradoxes presented in scenarios of consolidations of Electromagnetic Waves from separate sources, and provided the following conclusions:

1. Electromagnetism might be the source of at least part of the Dark Energy.
2. Electric Charge is also a form of Energy.
3. Space is also just an ingredient (or facet) of a form of Energy.

However, an additional paper, the paper (*11*) provides argumentations which imply that Electromagnetism might be the source of ***most*** of the Dark Energy. These argumentations are based on the following observation:
The way that Physics treats today, Energy Fields, including the Electric or Magnetic Fields, embed an intrinsic peculiarity, and this can be presented via the following argumentation:

On one hand, Physics recognizes that an Electric (or Magnetic) Field in Space is generated by Electric Charges, and such Fields embed Energy.
The Energy density embedded in such Fields, at each point in Space, is recognized as being proportional to the square of the Intensity of the Electric (or Magnetic) Field at these points in Space.
Thus, if a Positive Electric Charge is the cause of the creation of the Electric Field that surrounds it, and that Electric Field embeds Energy density, then, if a Negative Electric Charge affects a point in Space by inducing into that point ***its*** Energy such that it reduces the Intensity of the Electric Field that the Positive Electric Charge induced in that point in Space, then, because Energies are not supposed to be annihilated then, although the Intensity of the Electric Field in that point in Space is reduced, the Energy densities induced in that point in Space by both, the positive and the negative Electric Charges, should ***not be reduced***.
On the other hand, Physics today does assume that in the above-described scenario, the Energy density in the above-mentioned point in Space is equal ***only*** to the square of the Intensity of the ***net*** (reduced) Electric Field at that point in Space.

Paper (*11*) refers or treats the Electric (or Magnetic) Fields in Space differently.
It assumes that Space embeds ***all*** the Energies that ***all*** the Electric Charges in the Universe induce at each point in Space. Thus, in situations in which parts (or all) of the Intensity of an Electric (or Magnetic) Field in any point in Space were reduced, the Energy density in such a point in Space ***is not*** reduced. Instead, some of the Energy in such a point in Space turns into Untraceable (or Dark) Energy.

Thus, in view of the discussion presented above, the paper (*11*) presents a paradox, like the paradox described already in scenarios of consolidations of Electromagnetic Waves from separate sources, because it presents that Electric (or Magnetic) Fields in Space always annihilate each other, which ***seems*** like a violation of the Energy Conservation Principle.

Based on the above, the paper (*11*) , uses the novel Energy Pairs Theory to explain this paradox, and the paper concludes that Space itself is also a form of Energy, that contains continuously, and at each point of it, Traceable and Untraceable Energies, which implies that ***most*** of the Untraceable (Dark) Energy, is of Electromagnetic origin.
That paper (*11*) , also calculates the total amount of the Dark Energy in Space and concludes that the Energy embedded in the Dark Energy in Space is about two thirds of the total Energy in the Universe, which complies with the acceptable agreement about the amount of Energy embedded in the Dark Energy in the Universe.

Thus, from the above follows that the paper (*11*) implies that the Dark Energy which originates from Electromagnetism might be ***most*** of the Dark Energy in the Universe.

The acceptable notion held, by Physics today, is that the Dark Energy relates only to Gravitation, and must be looked for, using Einstein's General Relativity Theory.
This paper does not discard the possibility that parts of the Dark Energy might be related to Gravitation, because there are similarities between the Mass and the Electric Charge entities such as:

1. The identical structures between Newton's Universal Gravitational Law and Coulomb's Law.
2. Gravitation embeds the entity of Gravitational Waves which is analogous to the Electromagnetic Waves.
3. Analogous to the detection of Magnetism by a spectator external to a moving Electric Charge, a spectator external to a Mass moving at a constant velocity sees a phenomenon denoted as Gravitational Electromagnetism (GEM) (*12*) , which is the analogy of Electrical Magnetism in Gravitation.

All the above-described similarities, between the Mass and the Electric Charge entities implies that like the prediction presented, that parts of the Dark Energy originate from Electromagnetism, parts of the Dark Energy, might originate also from Gravitation.

However, Electromagnetism is much more ***potent*** as compared to Gravitation, this can be demonstrated by the following:
The Gravitational Force between two 1-kg Mass Objects that are 1 meter apart is $6.67 \cdot 10^{-11}$ (*13*) Newtons, while the Attraction or Repulsion Force caused by the Coulomb's Law, between two 1 Coulomb Electrically Charged Bodies, held 1 meter apart, is $9 \cdot 10^{9}$ (*14*) Newtons. The above clearly indicates that the Coulomb's Force might be more ***potent***, as compared to the Gravitational Force, by a magnitude factor of $1.35 \cdot 10^{20}$!

Thus, the above might indicate that ***most*** of the Dark Energy originates from Electromagnetism, as this paper predicts.

4. The Energy Pairs Theory versus the Pointing Theorem

The new Energy Pairs Theory provided a resolution to the paradoxes that exist in scenarios of consolidations of Electromagnetic Waves from separate sources, by providing an explanation which indicates that such scenarios also comply with the Energy Conservation Principle.
However, Physics today already contains a theory which deals with the issue of compliance of scenarios of Electromagnetism with the Energy Conservation Principle. That theorem is the Pointing Theorem. Thus, it might be argued, that the new Energy Pairs Theory is not required.
However, although the Pointing Theorem does provide acceptable results as related to Electromagnetic scenarios that ***do not*** contain paradoxes, it fails in explaining the paradoxes existing in Electromagnetic scenarios that ***do*** contain paradoxes, as presented already in this paper, because it does not take into consideration at all, the possible existence of Untraceable (or Dark) Energies in some scenarios relating to Electromagnetism.

Thus, in view of the above, the new Energy Pairs Theory is required, because it complements the Pointing Theorem.

The Pointing Theorem is based on the following statement:

The time rate of change of Electromagnetic Energy within a specific volume V in Space, plus the net Energy flowing out of V through its surface area S per unit time, is equal to the negative of the total work done on the Electric Charges within V.

Thus, for a scenario to comply with what the Pointing Theorem states, its ingredients must contain a volume V which contains Electric Charges, and work done on these Electric Charges. However, the scenarios relating to consolidations of Electromagnetic Waves from separate sources, presented in this paper, do not contain Electric Charges or work done on Electric Charges.

If the volume V, mentioned above, is defined as a volume that contains only the half transparent mirror described in the experiment proposed in the paper (2) , then, because half transparent mirrors are Electrically neutral devices, no work is done on Electric Charges in such a volume and also there is no time rate of change of Electromagnetic Energy within such a volume, apart from the Energies embedded in the two Electromagnetic Waves that meet on this half transparent mirror.

Thus, from the Pointing Theorem follows, that the net Energy flowing out of that volume through its surface area S per unit time must be also zero.

If in the experiment proposed in the paper (2) the half transparent mirror is ***not*** tilted at exactly 45 degrees, as presented in the paper (2) , then, in such a case, the two Electromagnetic Waves ***do not consolidate***, and the Energies embedded in the two Electromagnetic Waves which ***enter*** the volume are equal to the Energies of the two Electromagnetic Waves that ***exit*** the volume, which implies that the ***net*** Energy flowing out of that volume through its surface area S per unit time is indeed zero, as the Pointing Theorem predicts.

However, if in the experiment proposed in the paper (2) the half transparent mirror ***is*** tilted at exactly 45 degrees, as presented in the paper (2) , then, in such a case, the two Electromagnetic Waves **do *consolidate*** completely into a Null Electromagnetic Wave which ***seems*** to embed no Energy at all, when it leaves the half transparent mirror.

Thus, in that case, the ***net*** Energy flowing out of that volume through its surface area S per unit time ***seems to be not zero***, because the two Electromagnetic Waves which embed Energies, in this scenario, enter this volume, but no Energy ***seems*** to exit from this volume.

The new Energy Pairs Theory complements, in such a scenario, the result provided by the Pointing Theorem, by stating that the Null Electromagnetic Wave created, which leaves the volume, does contain the exact amount of Energy that enters this volume, but the Energy that exits the volume is Untraceable (or Dark) Energy.

Thus, the new Energy Pairs Theory was required in that case, to complement the result provided by the Pointing Theorem, and to present that also in this scenario, which contains consolidations of Electromagnetic Waves from separate sources, the Energy Conservation Principle is still ***not*** violated.

5. Summary and Conclusions

The study presented in this paper focuses initially on scenarios of consolidating Electromagnetic Waves from separate sources. The study provides, on one hand, sound argumentations that

Electromagnetic Waves, from separate sources, can consolidate. The study also proposes a physical experiment that is intended to implement the scenario of consolidations of Electromagnetic Waves, from separate sources. On the other hand, the study acknowledges that consolidations of Electromagnetic Waves, from separate sources, ***seem*** to embed paradoxes, because such scenarios ***seem*** to violate the Energy Conservation Principle. Thus, if consolidations of Electromagnetic Waves, from separate sources, do occur, as this study presents, this paradox need to be addressed and resolved.

The study also analyses additional paradoxes relating to the Mutual Annihilation and the Pair Production processes.

The study proposes a new theory, which resolves all these paradoxes, the Energy Pairs Theory, which complements the Pointing Theorem.

The Energy Pairs Theory provides the following predictions:

1. Electromagnetism is the source of most of the Dark Energy.
2. Electric Charges are also forms of Energy.
3. While Mass can be converted into Traceable Energy, and Traceable Energy can be converted back into Mass, Electric Charges can be converted only into Dark Energy and only Dark Energy can be converted back into Electric Charges.
4. While Traceable Energy can be converted back into any amount of Mass, Dark Energy can be converted only into a pair of Positive and Negative Electric Charges, where the amount of the Positive Electric Charge created equals exactly the amount of the Negative Electric Charge created, to keep the amount of all the Positive Electric Charges in the Universe, equal to the amount of all the Negative Electric Charges in the Universe.
5. While any amount of Mass can convert into Traceable Energy, only an amount of Positive Electric Charge can convert into Dark Energy with an exact same amount of Negative Electric Charge, to keep the amount of all the Positive Electric Charges in the Universe, equal to the amount of all the Negative Electric Charges in the Universe.
6. Space is an ingredient of a form of Energy.

As already mentioned, because the conclusions provided by the study, presented in this paper, are based only on thinking experiments, logic, and reason, and this might not be sufficient in providing convincing validity to the conclusions presented in this paper, the study also proposes a physical experiment that is intended to implement the scenario of consolidations of Electromagnetic Waves, from separate sources.
If this experiment will be executed, and its results will be accepted as successful, this will provide the required validity, for the conclusions presented in this paper.
However, this experiment might be very difficult to implement, and requires proper means and funds, which are beyond the reach of the author of this paper, and thus, the author of this paper hopes that this paper will help in achieving the goal of implementing this experiment.

References

(*1*). Does Destructive Interference Destroy Energy? Kirk T. McDonald Joseph Henry Laboratories, Princeton University http://kirkmcd.princeton.edu/examples/destructive.pdf

(*2*). Energy Analysis of a Null Electromagnetic Wave, Moshe Segal, Theoretical Physics Letters (PTL). That paper is under PTL copyright and consent form, signed by the author Moshe Segal with PTL.
https://2edd239a-21aa-41cc-a45e-84832f36b982.filesusr.com/ugd/04176b_f8d75fc7c61d455d8bda102055d6b92d.pdf

(*3*). A Discussion relating to the feasibility of a Null Electromagnetic Wave. Moshe Segal. Academia Letters, Article 3600. https://doi.org/10.20935/AL3600

(*4*). Consolidating Electromagnetic Waves might embed more traceable Energy than the combined traceable Energies embedded in the waves before consolidation. Moshe Segal. Academia Letters, Article 3768. https://doi.org/10.20935/AL3768

(*5*). Consolidating Electromagnetic Waves from separate sources. Moshe Segal. That paper is under AIRCC Publishing Corporation copyright and consent form, signed by the author Moshe Segal with AIRCC Publishing Corporation.
https://wireilla.com/engg/eeeij/papers/11222elelij01.pdf

(*6*). The Energy Pairs Theory. Moshe Segal. Electrical Engineering: An International Journal (EEIJ) vol. 9, No. 1/2, June 2022. That paper is under AIRCC Publishing Corporation copyright and consent form, signed by the author Moshe Segal with AIRCC Publishing Corporation.
https://airccse.com/eeij/papers/9222eeij01.pdf

(*7*). Electromagnetic radiation. Wikipedia. Electromagnetic radiation - Wikipedia

(*8*). Einstein: Ether and Relativity. http://mathshistory.st-andrews.ac.uk/Extras/Einstein_ether.html

(*9*). Electron-Positron annihilation. Wikipedia.
https://en.wikipedia.org/wiki/Electron%E2%80%93positron_annihilation

(*10*). Pair Production. Physics. https://www.britannica.com/science/pair-production

(*11)*. The Nature of Space and Dark Energy, Based on Electric and Magnetic Fields' Behavior in Space, in the Energy Pairs Theory Framework, Moshe Segal, Theoretical Physics Letters (PTL).
https://2edd239a-21aa-41cc-a45e84832f36b982.filesusr.com/ugd/04176b_5e77c3b53281421290d97119d0b90052.pdf
Please note that that paper is under PTL copyright and consent form, signed by the author Moshe Segal with PTL.

(*12*). Gravitational Electromagnetism. https://en.wikipedia.org/wiki/Gravitoelectromagnetim

(*13*). Mass Attraction Forces. ER. services. University Physics Volume 1.

Newton’s Law of Universal (lumenlearning.com)

(*14*). Attraction Force Between Charges 1 meter Apart. The Physics Classroom. Physics Tutorial: Coulomb's Law (physicsclassroom.com)

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