

## **Electric Charges might be a form of Energy**

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### **Abstract**

After the presentation of the Special Relativity Theory, Mass was discovered to be a form of Energy (Ref 1). Thus, after the presentation of the Special Relativity Theory, the Electric Charge remained the only distinct entity that is not a form of Energy.

This article claims that Electric Charges might be considered also as a form of Energy.

This claim is **initially** based on an analysis, presented in several articles, which analyze the energies embedded in electric and magnetic fields, and show that such energies, which are dependent on the existence of a force field (electric or magnetic) in order to exist, can annihilate each other, in certain situations, an annihilation that seems to violate the Energy Conservation Principle. In light of the above such energies are grouped as Energy Pairs.

Then, because energies in electric and magnetic fields are generated initially from electric charges, the Energy Pairs Theory is also used to explain the issue of charge disappearance in electron positron collisions.

This provides additional support to the assumption that Charge is Energy. Because, as electric or magnetic energies are shown to annihilate each other and disappear, in certain situations, positive and negative charge might also annihilate each other in certain situations, such as, in electron positron collisions, which strengthen the claim that Electric Charges are also a form of Energy.

In addition to using the above, the claim, that Electric Charge might be a form of Energy, is discussed in this article from additional angles.

As will be shown in this article, there are similarities between Mass and Charge which might lead us to conclude that Charge should also be considered as a form of Energy.

Thus, this article does claim that **Charge might also be recognized as a form of Energy, as Mass turned to be.** This claim will make Energy as the only distinct entity (in addition to Time and Space), **a simpler and cleaner view of nature.**

## **Introduction**

After the presentation of the Special Relativity Theory, Mass was discovered to be a form of Energy (Ref 1). Thus, after the presentation of the Special Relativity Theory, the Electric Charge remained the only distinct entity that is not a form of Energy.

This article claims that Electric Charges might be considered also as a form of Energy.

This claim is **initially** based on an analysis, presented in several articles, such as: "Consolidated Waves might create Dark Energy" that can be found at <http://viXra.org/abs/1909.0496> and "Energy Pairs Theory" that can be found at <http://viXra.org/abs/1910.0523>, which analyze the energies embedded in electric and magnetic fields, and show that such energies, which are dependent on the existence of a force field (electric or magnetic) in order to exist, can annihilate each other, in certain situations, an annihilation that seems to violate the Energy Conservation Principle.

Actually, in "Consolidated Waves might create Dark Energy" that can be found at <http://viXra.org/abs/1909.0496>, a scenario is presented, which describes two one dimensional electromagnetic traveling waves, which collide and then consolidate and continue to travel in the same direction. In that article it was shown that in this scenario energy is indeed lost such that it appears to violate the Energy Conservation Principle.

In "Energy Pairs Theory" that can be found at <http://viXra.org/abs/1910.0523> the Energy Pairs theory is presented which claims that some energies, for example, electric or magnetic fields energies can annihilate each other in certain conditions, and, thus, such energies, for example, energy in electric field generated by positive charges and energy in electric field generated by negative charges should be grouped as an Energy Pair. The Energy Pairs Theory explains the energy loss described in the above two waves scenario. And, the above described scenario is presented as a proof of this Energy Pairs Theory.

Then, because energies in electric and magnetic fields are generated initially from electric charges, the Energy Pairs Theory is also used to explain the issue of charge disappearance in electron positron collisions.

When an electron and a positron collide they annihilate each other and gamma ray photons are emitted, with energy equal to the sum of the energies embedded in the masses of the electron and the positron. However, the charges of the electron and the positron are not converted to any new substance (such as energy) and they simply disappear without leaving any trace of their previous existence. This charge disappearance seem to be an unusual, strange and unexpected mystery, although this charge disappearance obey the charge conservation principle. This charge disappearance is strange, because charge seem to be a basic element in physics, and such basic elements should not disappear.

The Energy Pairs Theory mentioned above provides a reasonable and logic explanation also to this charge disappearance mystery. This is done by assuming that Charge is Energy and energy embedded in positive charge and energy embedded in negative charge belong to one set of Energy Pairs that might annihilate each other. This can be also presented, the other way around, as providing extra support to the assumption that Charge is Energy. Because, as electric or magnetic energies are shown to annihilate each other and disappear, in certain situations, positive and negative charge might also annihilate each other in certain situations, such as, in electron positron collisions, which strengthen the claim that electric charges might also be a form of energy.

In addition to using the above described colliding waves scenario, that proves the Energy Pairs Theory, which is used to support the claim that Electric Charges might be Energy, the claim that Electric Charge might be Energy is discussed in this article from additional angles.

As will be shown in this article, there are similarities between Mass and Charge which might lead us to conclude that Charge should also be considered as a form of Energy.

Thus, this article does claim that **Charge might also be recognized as a form of Energy, as Mass turned to be.** This claim will make Energy as the only distinct entity (in addition to Time and Space), **a simpler and cleaner view of nature.**

## Review of Energy densities equations

In addition to using the above described colliding waves scenario, that proves the Energy Pairs Theory, which is used to support the claim that electric charges might be energy, the claim that Electric Charge might be Energy is discussed in this article from additional angles.

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

The embedded energy per unit volume in the electric field  $u_e$  is provided by the following formula: (Ref. 5)

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

Since, for a non moving point charge  $q_0$ ,

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

(Ref 2), then,

$$u_e = (1 / (32 \epsilon_0 \pi^2)) (q_0^2 / r^4)$$

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

$$u_e = (K q_0^2) / r^4$$

Because  $K$  is a constant and  $r^4$  is dependent only on the unit volume in space where  $\vec{E}$  resides, then,  $u_e$ , the embedded energy per unit volume in the electric field, is directly dependent and is directly proportional only to the square of the magnitude of the non moving point charge  $q_0$  that generated  $\vec{E}$ .

Similarly, the embedded energy per unit volume in the magnetic field  $u_m$  is provided by the following formula: (Ref. 4)

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

Since, for a moving point charge  $q$ ,

$$|\vec{B}| = (\mu_0 / (4\pi)) (qv \sin \alpha / r^2) \quad (\text{Ref 3}).$$

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

$$u_m = (\mu_0 / (32\pi^2)) (q^2 v^2 \sin^2 \alpha / r^4) \quad \text{and since } \mu_0 = 1 / (\epsilon_0 c^2) \quad (\text{Ref 3}), \text{ and,}$$

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

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

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

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

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

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

Also, it turns out that what generates  $u_e$  is  $q_0^2$  and what generates  $u_m$  is a fraction of  $q^2$  because  $x$  spans from 0 for  $v=0$  to a maximum of 1 when  $v=c$ . Thus, these equations already imply that charge should be the energy embedded in the electric and magnetic fields.

Because, the only components in these equations that can be considered as containing the energy are  $q_0^2$  and  $q^2$ . Because, all the other components in these equations are either constants, or components that depend only on the location in space where these energy densities reside.

## **More arguments why charge might be also Energy**

At this point we can supply more arguments why we claim that charge might also be considered as a form of energy.

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

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

But, according to Ref 6 "The gravitational field of a point mass and the electric field of a point charge are structurally similar" and when analyzing "the energy density for the electric field, and a similar expression" which "represents the energy density for the magnetic field, no such energy density term has ever been defined for the gravitational field. But one suspects that it could be, and possibly even should be".

Also, Ref 6 does provide an expression for the energy density in the gravitational field in which  $m^2$  (the square of the mass magnitude) can be considered as the only component containing the energy, as  $q^2_0$  and  $q^2$  (the square of the charge magnitude) are the only components that can be considered as containing the energy densities  $u_e$  and  $u_m$  in the energy density equations for the electric and magnetic fields.

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

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

In addition to that, modern physics sees the detection of magnetism by a spectator external of a charge moving at a constant velocity, as a combination of maxwell equations and special relativity. And, analogous to the detection of magnetism by a spectator external to such a moving charge, a spectator external to a mass moving at a constant velocity sees a phenomenon denoted as gravitational electromagnetism (GEM), which is the analogy of magnetism in gravitation (Ref 7).

Thus, structural similarities between mass and charge extends beyond the case of stationary masses and stationary charges, as described above.

These strong similarities between mass and charge, strongly implies that charge might also be a form of energy, as mass turned to be.

Indeed, there are also differences between mass and charge.

An external spectator to a moving mass sees an increase of this mass. On the other hand, because of the charge invariance principle, charge does not increase by velocity.

Also, masses are usually positive entities and always attract each other, while charge comes as positive and negative charges and different signed charges attract each other while similar signed charges repel each other.

Also, masses can be converted to energy, while, according to the charge conservation principle, the total number of positive and negative charges must balance each other, such that only one type of charges cannot be eliminated alone.

Also, equations such as  $P = m V$  or  $F = m a$  do not exist in the case of charges.

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

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



Indeed, the above arguments are reasonable but **are not a proof** that charge **might** be also considered as being a form of energy.

But the strong **structural similarity** (or even **structural identity**) between a **point mass** and a **point charge**, and the structural identity between the **coulomb force law** and the **universal gravitation force**, strongly implies that if one entity (mass) was already discovered to be energy, the other entity (charge) might also be energy, because the **basic equations governing the forces they create have identical structure**.

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

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

For example: since Force multiplied by Distance is Energy, then, in this equation of energy, Force is the component that can be considered to contain the energy, and Distance specify how this energy is dependent on the distance in space.

Moreover, in the equation that defines the Force, further sorting can be done to specify the component that can be considered to contain the energy.

Thus, since Force multiplied by Distance is Energy, then, in the equation of the universal gravitational force, the masses can be already **identified as the energies**, since they are the only components in the equation that can be considered to contain the energy (which will be the result of this force multiplied by distance).

And, indeed, mass is discovered to be energy, by the special theory of relativity.

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

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

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

However, these above arguments why charge might be energy, that might be reasonable arguments, but not a proof, are only supplementary arguments to the argument related to the Energy Pairs Theory, that was also proved by the two consolidating waves scenario mentioned before, in this article.

## **Summary, Results and Conclusions**

Before the presentation of the special theory of relativity, the science of physics recognized actually three distinct entities: Energy, Mass and Charge (apart from Time and Space).

After the presentation of the special theory of relativity, the Mass ceased to be a distinct entity, and it is recognized as a form of Energy. So, now there are only two distinct entities: Energy and Charge (apart from Time and Space).

Thus, in regard to the above, the question of why Charge is still a distinct entity remains open.

In an article titled : "Consolidated Waves might create Dark Energy" that can be found at <http://viXra.org/abs/1909.0496>, a scenario is presented which describes two one dimensional electromagnetic traveling waves, which collide and then consolidate and continue to travel in the same direction. In that article it was shown that in this scenario energy is indeed lost such that it appears to violate the Energy Conservation Principle.

In light of the above scenario the concept of Energy Pairs was presented, which claims that some energies, for example, electric or magnetic fields energies can annihilate each other in certain conditions, and, thus, such energies, for example, energy in electric field generated by positive charges and energy in electric field generated by negative charges should be grouped as an Energy Pair. The Energy Pairs Theory explains the energy loss described in the above two consolidating waves scenario. And, the above described scenario is presented as a proof of this Energy Pairs Theory.

Then, because energies in electric and magnetic fields are generated initially from electric charges, the Energy Pairs Theory is also used to explain the issue of charge disappearance in electron positron collisions.

This provides additional support to the assumption that Charge might be Energy. Because, as electric or magnetic energies are shown to annihilate each other and disappear, in certain situations, positive and negative charge might also annihilate each other in certain situations, such as, in electron positron collisions, which strengthen the claim that Electric Charges are also a form of Energy.

Also, as shown in this article, there are similarities between Mass and Charge which might lead us to conclude that Charge should also be considered as a form of Energy.

This article deals with this question, by suggesting that **Charge might be also a form of Energy.**

**Thus, if Charge will be recognized as a form of energy, the Energy remains the only distinct entity (apart from Time and Space), which turns to be a much simpler and cleaner view of nature.**

In several articles, such as: "Electric Charges as Energy Pairs" that can be found at <http://viXra.org/abs/1909.0098> and "Energy Pairs might turn to Dark Energy" that can be found at <http://viXra.org/abs/1909.0149>, some of the issues presented in this article, such as the Energy Pairs Theory, is also presented, with more details.

Also additional implications that might be concluded from the above described scenario are also presented in those articles, such as that Energy Pairs might turn to some sort of Dark Energy that the science of physics seeks a solution to its origin.

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