

For Electrically Charged Bodies, Attracted or Repelled under Coulomb's Law, $F=ma$ should be replaced with $F=kqa$

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Abstract

Newton's Laws of Motions are considered a basic corner stone of Physics. Thus, a claim that Newton's Second Law of Motion, $F=ma$, might not be applicable in certain cases, sounds as an out of line, and an incorrect claim.

Nevertheless, this paper presents such a claim, based on arguments resulting from the *structural identities* between Newton's Universal Gravitational Law and Coulomb's Law.

Based on these *structural identities*, this paper presents the prediction, that similar to Newton's Gravitational Field, which is already recognized also as a form of Acceleration, also Electric Fields, might be also forms of Acceleration.

The above also results in the conclusion, that for Electrically Charged Bodies, attracted or repelled under Coulomb's Law, Newton's Second Law of Motion, $F=ma$, might *not be* applicable, and should be replaced with a different Law, namely, $F=kqa$.

Also, based on the above-mentioned *structural identities* between Newton's Universal Gravitational Law and Coulomb's Law, a paper published by the author of this paper, expands Einstein's General Relativity Theory to include Electrically Charged Bodies in addition to Massive Bodies, which also provides an explanation for the *source* of the attraction or the repulsion between Electrically Charged Bodies, which is still a mystery today.

The above presented predictions, presented in this paper, that Newton's Second Law of Motion, $F=ma$, might *not be always* applicable, and that Electric (or Magnetic) Fields are also forms of Acceleration, might sound extraordinary, not correct, and out of line predictions.

However, this paper also proposes a relatively simple experiment, which if implemented, and its results will be successful, it might provide validity, (or disprove), the above presented predictions.

Parts of the materials presented in this paper, were already presented in additional papers, by the author of this paper. Those papers are also mentioned in the body of this paper, and also appear in the references section of this paper.

Introduction

The issue of Massive Bodies attraction was initially investigated by Galileo as well as Kepler, but Newton discovered the inverse-square dependance of the Gravity Force on the Distance.

Newton's measurements concluded that two spherical symmetric Massive Bodies attract each other according to Newton's Universal Gravitational Law, which is formulated as (1):

$$F = G \cdot (m_1 \cdot m_2) / r^2$$

Where G is the Gravitational Constant and is equal to $6.674 \times 10^{-11} \text{ m}^3 \cdot \text{kg}^{-1} \cdot \text{s}^{-2}$, m_1 is the Mass magnitude of the first Massive Body, m_2 is the Mass magnitude of the second Massive Body and r is the distance between the center of Mass of the two Massive Bodies.

The Universal Gravitational Law, presented above, provides the amount and the direction of the Force that attracts these two Massive Bodies.

However, Newton could not provide a complete explanation relating to what causes this force, or what is exactly the *origin* of the attraction between Massive Bodies.

Attempts to explain the *origin* of the attraction force between Massive Bodies introduced the concept of the Gravitational Field.

The Gravitational Field concept stated that a Massive Body creates a Gravitational Field around it, which generates the Force presented in the Universal Gravitational Law.

However, the concept of the Gravitational Field could not explain how any Field, including this Gravitational Field, can cause the attraction forces between bodies.

The Gravitational Field strength, which is defined as the Gravitational Force, of the Gravitational Field, in Newtons, that acts on a Mass of one Kg, is presented by the following equation (2):

$$g = G \cdot m_g / r^2$$

Where g is the Gravitational Field strength magnitude, G is the Gravitational Constant, which was already presented above in the Universal Gravitational Law, m_g is the Mass magnitude of the Massive Body which creates this Gravitational Field strength g and r is the distance between the center of Mass of this Massive Body, and the point in Space, where this Gravitational Field strength g is measured.

Thus, from Newton's Universal Gravitation Law, presented above, the attraction Force between a Massive Body of Gravitational Mass magnitude m_g , which generates its Gravitational Field strength g, at a distant point r in Space, from its center of Mass, and another Massive Body of

Inertial Mass Magnitude m_i , at this distant point r is Space, from the center of Mass of the Massive Body m_g , is presented by:

$$F = G \cdot (m_g \cdot m_i) / r^2$$

Thus, the Universal Gravitational Law can be reformulated as:

$$F = m_i \cdot g$$

Where m_i is the Inertial Mass magnitude of the Massive Body on which the Gravitational Field strength g exerts the force F .

However, as already stated above, the notion of a Field, does not provide a complete answer to the question: how can a Field generate the Forces that it is assumed to create?

Thus, the question:

What is the **origin** of the Force presented by the Universal Gravitational Law?

Remained an unanswered question, until the introduction of Einstein's General Relativity Theory (3).

Einstein succeeded to explain the **origin** of the attraction forces between Massive Bodies by introducing the concept, that Gravitational Forces are related to the Space and the Time entities, which can be also presented as a curved Interwoven Space/Time construct, if Mass can be assumed to induce a curve into that Interwoven Space/Time construct.

It might be also added, that, because an Interwoven Space/Time construct, embeds both the Space and the Time entities in it, which implies that at each point of this curved Interwoven Space/Time construct, an Acceleration can be calculated, the understanding that the Gravitational Field is also a form of Acceleration, helped Einstein to develop this concept, of a curved Interwoven Space/Time construct, which succeeded to explain the **origin** of the attraction between Massive Bodies.

The fact that the Gravitational Field is also a form of Acceleration, was already a well-known fact when Einstein developed his Interwoven Space/Time concept, because it can be derived directly from Newton's work.

Newton's Second Law of Motion (4) states, that a force F exerted on a Massive Body of Inertial Mass magnitude m_i obeys the following equation:

$$F = m_i \cdot a$$

Where a is the Acceleration that this Massive Body of Inertial Mass magnitude m_i acquires because of the force F exerted on it.

However, the above already presented, that a Gravitational Field strength g exerted on a Massive Body of Inertial Mass magnitude m_i also results in a force F exerted on this Massive Body:

$$F = m_i \cdot g$$

Thus, from the above follows that: $g = a$

Thus, the Gravitational Field must also be a form of Acceleration.

From the above, Einstein concluded that this could provide an explanation to the question: how Newton's Gravitational Field can generate the force F expressed by Newton's Universal Gravitational Law?

Or, in other words, what is really the *origin* of the attraction force between Massive Bodies?

Einstein's General Relativity Theory explains the *origin* of the attraction force between Massive Bodies using the following argumentation:

Acceleration is the second derivative of Space as related to Time:

$$a = d^2s/dt^2$$

Where s is the Space point at which the Acceleration a is measured, and t is the Time moment at which the Acceleration a is measured.

Space is a three-dimensional entity, while Time is a one-dimensional entity.

From the above Einstein concluded that if it can be assumed, that Space and Time are not independent entities, and they are always *interweaved* into a four-dimensional construct, which replaces the three-dimensional Space entity, then, this four-dimensional Interwoven Space/Time entity already embeds an Acceleration at each point of it, because the second derivate of Space in relation to Time can be calculated at each point of it, because this four-dimensional Interwoven Space/Time entity already embeds the Space *and* the Time entities at each point of it.

Thus, Einstein concluded, that if a *form* of this four-dimensional Interwoven Space/Time entity can be assumed to be Newton's Gravitational Field, then, this *form* of Interwoven Space/Time entity, will exert an Acceleration, on any Massive Body, residing in it, which is the Acceleration embedded in the point of this *form* of Interwoven Space/Time entity, where this Massive Body resides.

More on what exactly is this *form* of this four-dimensional Interwoven Space/Time entity, and how a Massive Body affect this *form* of this four-dimensional Interwoven Space/Time entity, can be found in Einstein's General Relativity Theory (3).

Additional implications as related to Einstein's Interwoven Space/Time notion

Einstein's four-dimensional **Interwoven Space/Time** notion does succeed to explain the **origin** of the attraction between Massive Bodies, as presented in the previous chapter, above.

However, that notion embeds also important additional implications.

By stating that the Space and the Time notions are **always** interweaved into one four-dimensional entity, this also implies that the Space and the Time notions, are not independent notions, as Humans perceive such notions.

Moreover, because Einstein's four-dimensional Interwoven Space/Time notion replaces the Newton's Gravitational Field, which should be recognized as a form of Energy, then, the Space and the Time notions, are not only not independent notions, but they are also just attributes (or facets) of a form of Energy.

In a speech, in the University of Leiden on May 5th, 1920, (6), 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, Einstein's four-dimensional Interwoven Space/Time notion also implies that the Space and the Time notions are not independent notions, are just attributes (or facets) of a form of Energy (the Gravitational Field Energy), which also implies that the Space and the Time notions, as Humans perceive such notions, do not really exist.

The statement that Space and Time do not really exist sounds as an extraordinary, unbelievable, and out of line statement, at first.

This is because the notions of Space and Time are crucial notions, which Humans need them, to perceive, understand and calculate Motions and Changes.

However, in view of the arguments above, if Space and Time cannot be considered any longer as independent entities, and if Space and Time are just embedded in a form of Energy (the Gravitational Field Energy), the statement that Space and Time might not really exist does not sound so detached any more.

Moreover, the above actually indicates that what **does exist** are Energies which **Interact** with each other, and these **Interactions** cause, what Humans perceive as Motions and Changes.

For example, the attraction (Motions) between Massive Bodies is a result of the **Way** a form of Energy (the Gravitational Field Energy) **Interacts** with another form of Energy (Massive Bodies), which leads Humans to attribute attributes (or facets) of Space and Time to the Gravitational Field Energy, in order to be able to perceive and understand these motions, and be able to perform calculations on what Humans perceive as elements of these motions.

The understanding that Space and Time might not really exist, and what causes Motions and Changes are the **Ways** Energies **Interact** with each other, is used to explain the attraction or the

repulsion between Electric Charges, in the next chapter of this paper, which also results in a proposal for a simple unification of Gravitation and Electricity.

More on the above also appears in the following paper, by the author of this paper, titled: "A Discussion Related to The Existence of The Entities of Space and Time" (13).

An explanation for the origin of the attraction or the repulsion between Electrically Charged Bodies

Analogous to Newton's Universal Gravitational Law, which provides the Force of attraction between Massive Bodies, Coulomb's Law provides the Force of the attraction or the repulsion between Electric Charges.

Coulomb's Law is presented by the following formula (5) :

$$F = Ke \cdot (q_1 \cdot q_2) / r^2$$

Where Ke represents the Coulomb's Constant and is equal to $8.99 \times 10^9 \text{ N} \cdot \text{m}^2 \cdot \text{C}^{-2}$, q_1 is the amount of Electric Charge in the first Electric Charge, q_2 is the amount of Electric Charge in the second Electric Charge and r is the distance between the center of Mass of the bodies that carry these two Electric Charges, assuming that the Electric Charges embedded in the Electrically Charged Bodies used in a Coulomb's Law experiment, are spread uniformly on these Electrically Charged Bodies.

As in the case related to the attraction between Massive Bodies, the *origin*, or the cause of Coulomb's Law is attributed to an Electric Field that each Electric Charge generates, which, as explained already, in relation to the attraction between Massive Bodies, this cannot provide a complete explanation to the question: why Electric Charges attract or repel each other?

It should be noticed that the *structure* of the Newton's Universal Gravitational Law and the *structure* of the Coulomb's Law are *identical*.

Thus, the following question might be asked:

Since the *structure* of the Newton's Universal Gravitational Law and the *structure* of the Coulomb's Law are *identical*, why the *origin* of the attraction between Massive Bodies was resolved via Einstein's General Relativity Theory, and its concept of a four-dimensional Interwoven Space/Time entity, and the *origin* of the attraction or the repulsion forces between Electric Charges, is still a mystery?

The author of this paper published an additional paper (7) which predicts, that Electric (or Magnetic) Fields are also forms of Accelerations, as Newton's Gravitational Field is already recognized as a form of Acceleration.

In the next chapter of this paper, arguments which support the prediction that Electric (or Magnetic) Fields are also forms of Accelerations, as Newton's Gravitational Field is already recognized as a form of Acceleration, will be provided.

Based on that prediction, that paper (7) explains the *origin* of the attraction or the repulsion between Electrically Charged Bodies like Einstein's General Relativity explains the *origin* of the attraction between Massive Bodies.

That explanation is based on the understanding, presented above, that Space and Time do not really exist.

This enabled the prediction that there are two *additional* and *separate* four-dimensional Interwoven Space/Time entities, in *addition* to Einstein's four-dimensional Interwoven Space/Time entity.

One of these *additional* four-dimensional Interwoven Space/Time entity replaces the Electric (or Magnetic) Fields generated by the Positive Electric Charges.

The second of these *additional* four-dimensional Interwoven Space/Time entity replaces the Electric (or Magnetic) Fields generated by the Negative Electric Charges.

And thus, these *three separate* four-dimensional Interwoven Space/Time entities are all forms of Energies, and each of these *three separate* four-dimensional Interwoven Space/Time entities embeds *its own separate* Space and *its own separate* Time attributes (or facets).

The above also might provide a proposal for a simple Unification between Gravity and Electricity, which is still an open issue today. This also appears in another paper by the author of this paper, titled: "A Simple Unification of Gravitation and Electricity" (15).

Additional arguments for supporting the prediction that Electric Fields might also be a form of Acceleration

As already presented above, Einstein concluded that Newton's Gravitational Field is a form of Acceleration, and it was also showed that this conclusion can be also derived directly from a version of Newton's Universal Gravitational Law, $F=mg$, and Newton's Second Law of Motion, $F=ma$.

But this conclusion might be also obvious from analyzing *only* Newton's Universal Gravitational Law, $F = G \cdot (m_1 \cdot m_2) / r^2$, without using Newton's Second Law of Motion, $F=ma$.

During the attraction process between the Massive Bodies the Force F in $F = G \cdot (m_1 \cdot m_2) / r^2$ is dependent only on the distance r between these Massive Bodies, since G is a constant and the Mass magnitudes of the Massive Bodies also do not change, assuming that the velocities in the attraction process are negligible in comparison to the velocity of Light, implying that the Mass increase with velocity, implied from Einstein's Special Relativity Theory, is also negligible.

Thus, during the attraction process, the force F continuously increases, as the distance r between the bodies continuously decreases.

Since this Force F is what causes the attraction between the Massive Bodies, the fact that during this attraction process the Force F continuously increases, this should imply, that during the attraction process, the velocities of the attracting Massive Bodies also continuously increase, which implies that during the attraction process, the Massive Bodies are also Accelerating towards each other.

Since the Gravitational Field is what causes the Force F , and thus, is actually the cause of the attraction between the Massive Bodies which, as concluded above, are Accelerating towards each other, it should be concluded that the Gravitational Field is a form of Acceleration.

And this conclusion is the result from an analysis done **only** on Newton's Universal Gravitational Law, $F = G \cdot (m_1 \cdot m_2) / r^2$, without using Newton's Second Law of Motion, $F = ma$, as presented above.

However, the analysis done only on Newton's Universal Gravitational Law, $F = G \cdot (m_1 \cdot m_2) / r^2$, without using Newton's Second Law of Motion, $F = ma$, reveals more than what was presented above.

Since the Gravitational Field strength itself, presented by the equation: $g = G \cdot m / r^2$, also continuously increases during the attraction process, as the distance r between the bodies continuously decreases, then, the Gravitational Field, which is the cause of the attraction between the Massive Bodies, is not only a form of Acceleration, it is a form of Acceleration which increases continuously, during the attraction process between the Massive Bodies.

The nowadays Science of Physics, does not recognize the Electric Fields as being also a form of Acceleration, as the Gravitational Field is already recognized as a form of Acceleration.

But, similar to what was presented, that Newton's Gravitational Field is a form of Acceleration, which can be derived **only** from analyzing Newton's Universal Gravitational Law, $F = G \cdot (m_1 \cdot m_2) / r^2$, without using Newton's Second Law of Motion, $F = ma$, similar arguments might apply also to the claim, that Electric Fields might also be concluded to be forms of Acceleration, only by analyzing the Coulomb's Law, $F = K_e \cdot (q_1 \cdot q_2) / r^2$.

During the attraction or the repulsion process between the Electrically Charged Bodies the Force F in $F = K_e \cdot (q_1 \cdot q_2) / r^2$ is dependent only on the distance r between these Electrically Charged Bodies, since K_e is a constant and the Electric Charges magnitudes embedded in the Electrically Charged Bodies also do not change.

Thus, during the attraction or the repulsion process, the force F continuously increases or decreases, as the distance r between the Electric Charges continuously decreases or increases (depending if the Electric Charges attract or repel each other).

Since this Force F , presented by Coulomb's Law, is what causes the attraction or the repulsion between the Electrically Charged Bodies, the fact that during this attraction or repulsion process

the Force F continuously increases or decreases, (depending if the Electric Charges attract or repel each other), this should imply, that during the attraction or the repulsion process, the velocities of the attracting or repelling Electrically Charged Bodies also continuously increase or decrease, which implies that during the attraction or the repulsion process, the Electrically Charged Bodies are also Accelerating towards each other, or Decelerating from each other.

Since the Electric Fields involved in the above-described process are the cause of the force F and thus, also the cause of the attraction or the repulsion between the Electrically Charged Bodies which, as concluded above, are accelerating towards each other, or decelerating from each other, it should be concluded that these Electric Fields are also forms of Accelerations or Decelerations (depending if the Electrically Charged Bodies attract or repel each other).

And this conclusion is the result from an analysis done *only* on Coulomb's Law, $F = Ke \cdot (q_1 \cdot q_2) / r^2$, as presented above.

However, the analyzing done only on Coulomb's Law, $F = Ke \cdot (q_1 \cdot q_2) / r^2$, reveals more than what was presented above.

Since the Electric Fields strength involved, presented by the equation: $e = Ke \cdot q / r^2$, also continuously increase or decrease during the attraction or the repulsion process, as the distance r between the Electrically Charged Bodies continuously decreases or increases, then, the Electric Fields, which are the cause of the attraction or the repulsion between the Electrically Charged Bodies, are not only forms of acceleration or deceleration, these Electric Fields are forms of acceleration or deceleration which increases continuously, during the attraction or the repulsion process between the Electrically Charged Bodies.

But since Coulomb's Law *does not* contain any Mass component in its equation, it is reasonable to conclude that the above-described Acceleration or Deceleration property, derived from analyzing *only* the Coulomb's Law, is caused *only* by the Electric Fields created by Electric Charges embedded in the Electrically Charged Bodies presented in the Coulomb's Laws, which implies that Electric Fields are also forms of Acceleration.

A tentative modification to Newton's Second Law of motion

The prediction presented above, that Electric (or Magnetic) Fields are also forms of Accelerations also implies that the Acceleration between Electrically Charged Bodies, attracted to, or repelled from each other, because of Coulomb's Law, is dependent mainly on the amount of the Electric Charge that these bodies carry and not on the Mass magnitudes of these bodies, as Newton's Second Law of Motion ($F=ma$) states.

Electrically Charged Bodies always embed Electric Charge *and* Mass. However, the Coulomb's Force is much more *potent* than the Gravitational Force.

This can be demonstrated by the following:

The Gravitational Force between two 1-kg Mass Objects that are 1 meter apart is

$6.67 \cdot 10^{-11}$ (8) Newtons, while the Attraction or the Repulsion Force caused by the Coulomb's Law, between two 1 Coulomb Electrically Charged Bodies, held 1 meter apart, is $9 \cdot 10^9$ (9) 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, if Electric (or Magnetic) Fields are also forms of Accelerations, the Acceleration between Electrically Charged Bodies, attracted to, or repelled from each other, because of Coulomb's Law, should be dependent mainly on the amount of the Electric Charge that these bodies carry and not on the Mass magnitudes of these bodies, as Newton's Second Law of Motion states.

The above also implies that Newton's Second Law of Motion, $F=ma$, should undergo a suitable modification, in scenarios relating to Electrically Charged Bodies, attracting or repelling each other, under Coulomb's Law, which implies that in such scenarios Newton's $F=ma$ Law should be replaced with a different Law, namely, $F=kqa$, as is described in the paper (7) , and also presented below:

An Electric Field strength e , generated by an Electric Charge q , is defined by:

$$e = Ke \cdot q/r^2$$

Where e is the Electric Field strength magnitude, Ke is the Coulomb's Constant, already presented in a previous chapter of this paper, q is the magnitude of the Electric Charge generating this Electric Field strength e and r is the distance between the center of Mass, of the body which embeds this Electric Charge, and the point in Space where this Electric Field strength e is measured.

Thus, Coulomb's Law can be reformulated as:

$$F = q \cdot e$$

Where F is the Coulomb's Force exerted on an Electric Charge q by an Electric Field strength e .

The above is similar to:

$$F = m \cdot g,$$

Where m (Mass) is replaced by q (Electric Charge),
 g (the Gravitational Field strength) is replaced by e (the Electric Field strength),
and F (the attraction Gravitational Force) is replaced by F (the attraction or repulsion Force under Coulomb's Law).

Thus, as g , the Gravitational Field strength, is already recognized as a form of Acceleration, if e , the Electric Field strength, is also found to be a form of Acceleration, as predicted in this paper, then,

$F = q \cdot e$ can be also presented as:

$$F = q \cdot ka$$

Where a is the Acceleration exerted on an Electric Charge q under Coulomb's Law, which also implies, as stated above, that for Electrically Charged Bodies, attracted or repelled under Coulomb's Law, $F = ma$ should be replaced by $F = kqa$.

It should be also emphasized, that although the Gravitational Field strength g is equated exactly with the Acceleration a , in case of the Electric Field strength, it is not possible, at this stage, to completely equate the Electric Field strength e with the Acceleration a , and all that can be established, at this stage, is that the Electric Field strength e is equal to the Acceleration multiplied by a certain factor k , or, as stated above: $e=ka$. This is because of the following:

The conclusion that the Gravitational Field strength g is also a form of Acceleration, derived from an analysis performed *only* on Newton's Universal Gravitation Law without using Newton's Second Law of Motion ($F=ma$), does imply that the Gravitational Field strength g is a form of Acceleration, but does not establish yet that the Gravitational Field strength g is equal exactly to the Acceleration a .

Only by using also Newton's Second Law of Motion ($F=ma$), the equation $g=a$ can be established.

Similarly, in case of the Electric Field, the conclusion that the Electric Field strength e is a form of Acceleration, derived from analysis performed on the Coulomb's Law, is not sufficient to establish that $e=a$, and all it can be established, at this stage, is that e is equal to the Acceleration a multiplied by a certain factor k , which must be established, by further experimentation, or as stated already above, $e=ka$.

An additional paper, titled: "A tentative modification to Newton's second law of motion" (14) also relate to what was presented in this chapter of this paper.

However, the Acceleration in $F=ma$ is different and separate from the Acceleration in $F=kqa$

In a previous chapter of this paper, the prediction that Space and Time do not really exist was presented.

Humans need the entity of Space to perceive relative positions between objects. Humans also need the entities of Space and Time to calculate values that Humans attribute to Motions, such as Velocity or Acceleration. The entities of Space and Time are also the entities that compose the four-dimensional Interwoven Space/Time entity, introduced by Einstein's General Relativity Theory, which provided an explanation of the *origin* of the attraction between Massive Bodies.

However, this paper also presented the statement that although the notions of Space and Time, as Humans perceive these notions, do provide the significant explanation of the *origin* of the attraction between Massive Bodies, via Einstein's General Relativity Theory, the notions of Space

and Time, as Humans perceive these notions, were not yet sufficient for providing explanations to additional similar unanswered questions, such as: what is the *origin* of the attraction or the repulsion between Electrically Charged Bodies? Or, why the velocity of Light, measured by Humans, always results in a constant value and the maximum velocity that Humans can measure? Thus, as was presented in previous chapters of this paper, this paper presented the following prediction: Electric (or Magnetic) Fields are forms of Accelerations, like the Gravitational Field, which is already recognized as a form of Acceleration.

This prediction also led to the following thesis: Changes and Movements are the result of *Interactions* between Energies, and the entities of Space and Time are not entities that really exist.

The entities of Space and Time are notions (or entities), invented by Humans, because Humans need such notions to perceive Changes and Motions.

For some Interactions between Energies, which result in Changes or Motions, Humans can attribute, to these Interactions, attributes of Space and Time, which will assist in providing explanations to why these Changes or Motions are the result of these Energies Interactions.

However, this paper predicts, that different sets of Interactions between Energies, should be assigned *separate and independent* attributes of Space and Time, *different and independent* from the Space and the Time attributes, assigned to other sets of Interactions between Energies, to provide an explanation for the *origin* of motions which are yet unexplained, such as: what is the *origin* of the attraction or the repulsion between Electrically Charged Bodies?

Because *different and independent* Space and Time attributes should be assigned to different sets of Interactions between Energies, then, Space and Time, as Humans perceive these notions, cannot exist, because the above implies, that there should be *multiple, independent* notions of Space, and *multiple, independent* notions of Time, and not just one universal Space entity, and just one universal Time entity, as Humans perceive the Space and the Time entities.

By abandoning the conclusion that the entities of Space and Time exist, and by concluding that Changes and Motions are only the results of Interactions between Energies, this paper already presented, in a previous chapter of this paper, that the *origin* of the attraction or the repulsion between Electrically Charged Bodies can be explained, in addition to the explanation, already provided by Einstein's General Relativity theory, relating to the *origin* of the attraction between Massive Bodies.

Also, by abandoning the conclusion that the entities of Space and Time exist, and by concluding that Changes and Motions are only the results of Interactions between Energies, a possible *partial, tentative* explanation might be also provided to the question: why the velocity of Light, measured by Humans, always results in a constant value and the maximum velocity that Humans can measure? This can be also found in the following paper, by the author of this paper, titled: "A discussion related to the uniqueness of the velocity of Light " (16).

The prediction that the entities of Space and Time do not really exist sounds as an extraordinary, unbelievable, and out of line statement, at first. This is because, as presented above, the notions of Space and Time are crucial notions, which Humans need them, to perceive, understand and calculate Motions and Changes.

However, in a following chapter of this paper, this paper also proposes a relatively simple experiment, which if implemented, and its results will be successful, as this paper predicts, this will validate (or disprove), what is presented in this paper.

Thus, based on the prediction, that Space and Time do not really exist, it should be emphasized, that the Acceleration in $F = ma$ is *different* and *separate* from the Acceleration in $F = kqa$.

In $F = ma$ the Acceleration is the second derivative of the attributes (or facets) of Space and Time that Humans can assign to Newton's Gravitational Field (or Einstein's Interwoven Space/Time entity). And as just facets or attributes, these Space and Time do not really exist, they are just attributes or facets assigned by Humans to the Energy form of Newton's Gravitational Field (or Einstein's Interwoven Space/Time entity Energy form).

Thus, in that case $F = ma$ might also be written as:

$F = ma_g$ where a_g is an Acceleration that Human perceive as the result of the Interaction between two Energy forms, the Energy form embedded in Gravity and the Energy form embedded in Massive Bodies.

On the other hand, In $F = kqa$ the Acceleration is the second derivative of the attributes (or facets) of Space and Time that Humans can assign to Electric Fields. And as just facets or attributes, these Space and Time do not really exist, they are just attributes or facets assigned by Humans to the Energy form of Electric Fields. And these Space and Time attributes, that Humans can attribute to Electric Fields, are *different* and *separate* from the Space and Time attributes, that Humans can attribute to Gravity.

Thus, in that case $F = kqa$ might also be written as:

$F = kqa_e$ where a_e is an Acceleration that Humans perceive as the result of the Interaction between two Energy forms, the Energy form embedded in Electric Fields and the Energy form embedded in Electric Charges.

It should be also emphasized, that although Electric Charges are not completely recognized, by the nowadays Science of Physics, as a form of Energy, similar to how Mass is already recognized as a form of Energy, following the introduction of Einstein's Special Relativity Theory, a paper titled: "Dark Energy and Electromagnetism" (17), by the author of this paper, does present the prediction that Electric Charges are indeed also a form of Energy.

A proposed experiment for validating (or disproving) what was presented in this paper

The paper (7) also suggests a physical experiment that might prove (or disprove) the prediction that the Acceleration between Electrically Charged Bodies, attracted to, or repelled from each other, because of Coulomb's Law, is dependent mainly on the amount of the Electric Charge that

these bodies carry and not on the magnitudes of the Mass that these bodies embed, as Newton's Second Law of Motion ($F=ma$) states.

That experiment suggests letting two Electrically Charged Bodies, at a specific distant L apart, being attracted to each other under Coulomb's Law.

In the first phase of the experiment the bodies should be of equal Mass magnitudes, embedding equal amounts of Electric Charges, each of a different polarity, to enable the attraction between the bodies under the Coulomb's Force. The experiment should measure the time it takes for these bodies to collide.

Then, the experiment is repeated with two additional Electrically Charged Bodies with the same amount of Electric Charge but with a much bigger Mass magnitude (for example, twice the Mass magnitude that the Electrically Charged Bodies had in the first phase of the experiment).

Newton's Second Law of Motion predicts that the time to collision, in that second phase of the experiment, would be different (bigger), because the Forces exerted on the bodies will be the same, as in the first phase of the experiment, because the Electric Charges are the same in both phases of the experiment, (and thus, the Coulomb's Force will be the same, and the Gravitational Force is negligible in comparison with Coulomb's Force), but the Mass magnitudes of the bodies are bigger in the second phase of the experiment, which will result in a smaller Acceleration.

This paper, on the other hand, predicts that the time to collision in both phases of the experiment would be virtually the same, because the Acceleration between Electrically Charged Bodies, attracted to, or repelled from each other under the Coulomb's Law, is dependent mainly on the amount of the Electric Charge that these bodies carry and not on the Mass magnitudes of these bodies, as Newton's Second Law of Motion ($F=ma$) states.

If the experiment will prove that the time to collision will be virtually the same, in both phases of the experiment, this will provide validity to what is presented in this paper.

What about $F = ma$ in cases where the Force F , exerted on a Body, is *not* a result of Gravity or Coulomb's Law?

In the previous chapters of this paper, the prediction was presented, that for Electrically Charged Bodies, attracted or repelled under Coulomb's Law, $F = ma$ should be replaced by $F = kqa$.

However, the above discussions related only to the cases where the Force F exerted on Uncharged Massive Bodies is the result of Gravity, or the Force F exerted on Electrically Charged Bodies is the result of Coulomb's Law.

What about other cases?

What about cases in which a Force F is exerted on a Massive Body, which does not originate from Gravity, or a Force F exerted on an Electrically Charged Body which does not originate from Coulomb's Law?

It might be that Newton arrived at his Second Law of Motion, $F = ma$, from acknowledging that Gravity is also a form of Acceleration. But Newton expanded this Law, $F = ma$, to any Force F exerted on any Massive Body, and it seems, that every day's experience does indicate, that Newton was right about that.

In view of the above, and in view of what was already presented in this paper, the following question might be presented:

If Space and Time do not really exist, as is speculated, and predicted by this paper, to which Space and Time might the Acceleration, a , in $F = ma$, relate, in cases in which a Force F is exerted on a Massive Body, which does not originate from Gravity?

This paper already pointed out that Space and Time should be attributes, or facets, attributed by Humans to certain forms of Energy.

It was already presented, in this paper that the Acceleration, a_g , relates to the Space and Time that Humans can attribute to the Energy embedded in Newton's Gravitational Field (or Einstein's Interwoven Space/Time entity).

It was also already presented, in this paper that the Acceleration, a_e , relates to the Space and Time that Humans can attribute to the Energy embedded in Electric Fields.

Thus, based on the above, the Acceleration, a , in $F = ma$, in cases in which a Force F is exerted on a Massive Body, which does not originate from Gravity, should be related to the Space and the Time attributes, which Humans should attribute to the Energy embedded in the Work done by the Force F , exerted on this Specific Massive Body, which does not originate from Gravity, which is also the cause of the motion of this Specific Massive Body. Thus, in such a case that Acceleration should be assigned as a_f , where f stands for Force.

But, again, these attributes are needed only in order to define where and when this Specific Massive Body exists, and might not be real Space and Time entities, because the motion of this Specific Massive Body is the result of the Interaction between the Energy embedded in this Specific Massive Body and the Energy embedded in the Work done by the above-mentioned Force F , which does not originate from Gravity, and these Space and Time attributes, that might be assigned by Humans to this Specific Energy, embedded in the Work done by this Specific Force F , are only required by Humans to perceive the elements embedded in the movement of this Specific Massive Body.

A similar question might be asked in cases of a Force F exerted on an Electrically Charged Body, which does not originate from Coulomb's Law.

It might be that in such cases, the Electric Charge embedded in that Specific Electrically Charged Body, is not affected by the above-mentioned Force, F , and in such cases only the Mass of that Specific Electrically Charged Body is affected by the above-mentioned Force, F , which might imply, that in such cases, Newton's $F = ma$ Law *does* apply, although, it might be, that in such cases, involving Electrically Charged Bodies, that issue was not yet fully established by experimentations.

Thus, in such cases, as in the above-mentioned Uncharged Massive Body, the Acceleration, a , in $F=ma$, should be related, again, to Space and Time attributes, which Humans should attribute to the Energy embedded in the Work done by the Force F , exerted on this Specific Electrically Charged Body, which does not originate from Coulomb's Law, which is also the cause of the motion of this Specific Electrically Charged Body. Thus, in such a case that Acceleration should be assigned also as a_f , where f stands for Force.

Summary and Conclusions

This paper assumes that Newton's Second Law of Motion was never checked to see if it complies with the Acceleration in scenarios of attraction or repulsion between Electrically Charged Bodies, under Coulomb's Law.

Instead, this paper assumes that Newton developed his Second Law of Motion based on the trajectories existing in the Solar System (10), (11), (12).

Newton used these trajectories to prove that his laws are valid, by showing that his laws of motion forecasted these trajectories.

Thus, this paper predicts that Newton's Second Law of Motion, $F=ma$, is valid only for very massive bodies (such as planets) and Uncharged Bodies, or Electrically Charged Bodies that *do not* attract or repel each other under Coulomb's Law, and for Electrically Charged bodies which *do* attract or repel each other under Coulomb's Law, Newton's Second Law of Motion, $F=ma$, should undergo a suitable modification.

That prediction is based on another prediction that Electric (or Magnetic) Fields are also forms of Acceleration, as the Newton's Gravitational Field is already recognized as a form of Acceleration.

The prediction that Electric (or Magnetic) Fields are also forms of Acceleration, was used by the author of this paper, to explain the *origin* of the attraction or the repulsion between Electrically Charged Bodies (which is still a mystery today) like Einstein's General Relativity explains the *origin* of the attraction between Massive Bodies.

However, the prediction that Electric (or Magnetic) Fields are also forms of Acceleration also implies that the Acceleration between Electrically Charged Bodies, attracted to, or repelled from each other, because of Coulomb's Law, is dependent mainly on the amount of the Electric Charge that these bodies carry and not on the magnitudes of the Mass embedded in these bodies, as Newton's Second Law of Motion ($F=ma$) states.

This paper also proposes a physical experiment to validate (or disprove) the prediction that the Acceleration between Electrically Charged Bodies, attracted to, or repelled from each other, because of Coulomb's Law, is dependent mainly on the amount of the Electric Charge that these bodies carry and not on the magnitudes of the Mass embedded in these bodies.

(13) A Discussion Related to The Existence of The Entities of Space and Time. Moshe Segal.

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