Like Gravity, the Electric Field should be also recognized as a form of Acceleration

Moshe Segal[1][*][†][‡]

[1]Independent Researcher.

[*]Email: moshe_segal@yahoo.com

[†]Moshe Segal's address is: Ravutzky st. #78 Ra'anana ISRAEL 4322141
[‡] Moshe has a B.Sc Graduated with distinction (Cum Laude) and a M.Sc in Electronics and
  Electrical Engineering from the Technion, Haifa, Israel.

Abstract

Gravity is already recognized as form of Acceleration, but the nowadays Science of Physics does not recognize (yet) the Electric Field also as a form of Acceleration.

Based on **structural identities** between Newton's Universal Gravitational Law and Coulomb's Law, this paper provides arguments which indicate that the Electric Field should be also recognized as a form of Acceleration.

This paper also proposes a relatively simple experiment, which if implemented, it might prove, (or disprove), the above presented statement that the Electric Field should be also recognized as a form of Acceleration.

If this experiment will be implemented, and its results will be successful, such that the Electric Field will be also recognized as a form of Acceleration, this will also result in significant implications.

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 6.674×10^{-11} $m^3 \cdot kg^{-1} \cdot s^{-2}$, 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 spherical symmetric Massive Bodies.

The Universal Gravitational Law, presented above, provides the amount and the direction of the Force of attraction between 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 the 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, G is the Gravitational Constant, which was already presented above in the Universal Gravitational Law, m_g is the Gravitational 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, m_g, 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 Stace/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.

Arguments which imply that the Electric Field should be also recognized as a form of Acceleration

As already presented above, the fact that the Gravitational Field is already recognized as a form of Acceleration, can be derived directly from a version of Newton's Universal Gravitational Law, $F = m_i \cdot g$, and Newton's Second Law of Motion, $F = m_i \cdot a$.

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 strength, 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 (yet) 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.

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 8.99×10^9 N·m²·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.

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, as already stated above, similarly to the arguments presented above, that Gravity can be recognized as a form of Acceleration *only* by analyzing Newton's Universal Gravitational Law, without using also Newton's Second Law of Motion, similar arguments apply, which imply, that the Electric Field should be also recognized as a form of Acceleration, only from analyzing Coulomb's Law.

These arguments are:

During the attraction or the repulsion process between the Electrically Charges Bodies the Force F in $F = Ke \cdot (q_1 \cdot q_2)/r^2$ is dependent only on the distance r between these Electrically Charged Bodies, since Ke 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 strength, 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 strength 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 simpler presentation that the Electric Field should be also recognized as a form of Acceleration

In the previous chapter of this paper, detailed arguments were provided, which result in the conclusion that the Electric Field should be also recognized as a form of Acceleration.

This presentation was provided in order to point out all the details which are required to arrive at the conclusion that the Electric Field should be also recognized as a form of Acceleration.

But the **obvious structural identities** between Newton's Universal Gravitational Law, $F = G \cdot (m_1 \cdot m_2)/r^2$ and Coulomb's Law, $F = Ke \cdot (q_1 \cdot q_2)/r^2$ can be used to provide a somewhat simpler presentation of the claim that the Electric Field should be also recognized as a form of Acceleration.

Because the Gravitational Field, is already recognized, by the nowadays Science of Physics as a form of Acceleration, and because this Gravitation Field, presented in Newton's Universal Gravitational Law, is the cause of the attraction between the Massive Bodies, then, the following can be concluded:

Because the **structure** of the Coulomb's Law is **identical** to the **structure** of Newton's Universal Gravitational Law, and the Electric Field is the cause of the attraction or the repulsion of the Electrically Charged Bodies presented in the Coulomb's Law, then, it should be concluded, that like the Gravitational Field in Newton's Universal Gravitational Law, which is already

recognized by the nowadays Science of Physics as a form of Acceleration, also the Electric Field, in Coulomb's Law, should be also concluded to be a form of Acceleration.

Because the discussion in this paper relies heavily on Coulomb's Law, the following should be also added:

Coulomb's law relates to Electrical Charges at rest.

Coulomb's law is indeed considered completely correct only for Electrically Charged Bodies at rest, mainly because moving Electric Charges manifest additional phenomena, such as Magnetic Fields, when the Electrically Charged Bodies move without Acceleration, and also emission of Electromagnetic Waves, when the Electrically Charged Bodies accelerate.

However, the discussion in this paper refers to Electric Charges which are not at rest, and thus, the use of Coulomb's Law, in the discussion presented in this paper, might imply that the conclusions derived, in this paper, are completely wrong.

But additional phenomena occur also in Gravity

Also, the Mass magnitudes of Massive Bodies, monitored by a spectator external to the moving Massive Bodies, is measured as an increase in the Mass magnitudes of these moving Massive Bodies, and Accelerating Massive Bodies also emit Gravitational Waves, and there are also the GEM phenomena (Gravitational Electromagnetism).

And, all these phenomena, which do occur also in Gravity, do not cancel the recognition that attracting Massive Bodies accelerate.

What these additional phenomena implies is that attracting Massive Bodies, because of Gravity, seem to be a complex process, which might also be, that it is still, not fully understood.

Similarly, the Magnetic Fields, and the Electromagnetic emissions, in scenarios of attracting Electrically Charged Bodies, does not necessarily imply that the component presented by Coulomb's Force (which is indeed completely correct only for rest bodies), might not be still a significant factor in this attraction movement between Electrically Charged Bodies.

What the above does imply, is that also the process of attracting (or repelling) Electrically Charged Bodies, seem to be a complex process, which might be also not fully understood.

But the above-mentioned additional phenomena existing in scenarios of attracting Electrically Charged Bodies, does not necessarily render the conclusions of this paper to be completely unjustified, and does not completely cancel the possibility, presented in this paper, that Electric Fields might also be a form of Acceleration, as the additional phenomena presented above, regarding to Gravity, does not cancel the recognition that the Gravitational Field is a form of Acceleration.

This makes the execution of the experiment presented in the next chapter of this paper, which might prove (or disprove) the conclusions presented in this paper, that the Electric Field might be also a form of Acceleration, an important endeavor.

Despite the fact that Coulomb's law is completely correct only for rest bodies, this paper states, that there is a possibility, that the experiment presented in my paper, might bring about new findings, as presented in this paper.

A proposed experiment for validating (or disproving) the statement that the Electric Field should be also recognized as a form of Acceleration

This paper also suggests a physical experiment that might prove (or disprove) the prediction that the Electric Field should be also recognized as a form of Acceleration.

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 $6.67 \cdot 10^{-11}$ (6) 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 $9 \cdot 10^9$ (7) 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 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.

Thus, this paper proposes a relatively simple experiment which might check if 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.

Additional comments related to the proposed experiment

If the experiment will be conducted in a laboratory residing on our planet, Earth, then, in each of the two phases of the proposed experiment, Vertical **and** Horizontal Forces will be exerted on the Electrically Charged bodies under test.

The experiment intends to prove that in the Horizontal axis, the Acceleration of the Electrically Charged bodies is affected mainly by their Electric Charge magnitudes and not by their Mass magnitudes.

In addition to the Horizontal Forces, exerted on the Ellectrically Charged Bodies under test, an additional Vertical Force will be exerted on the Electrically Charged Bodies under test, if the experiment will be conducted in a laboratory residing on our planet, Earth, attracting the bodies towards the center of our planet, Earth. This is the Gravitational Force acting between the bodies and the Earth Mass.

Because this experiment aim is to check what happens only in the Horizontal axis, the above-mentioned Vertical Force should not affect the experiment results.

But, an additional Horizontal Force, affected by the attraction Gravitational Force between the bodies and the Earth Mass, might have significant effect on the experiment. This additional Horizontal Force is the Friction between the bodies and the surface on which the bodies reside.

The size of this Friction Force is affected by the bodies Mass and the Friction Coefficient of the Horizontal surface on which the bodies reside.

Thus, the bodies should be kept as Light as possible, and the Horizontal surface should have a remarkably small Friction Coefficient.

Actually, the best environment for conducting the proposed experiment, might be a laboratory in a Space Station, because in such an environment, it might be possible to conduct the experiment

without any surface under the bodies, because, the Earth Gravitational Force will be virtually absent in such an environment.

An immediate implication if the Electric Field will be recognized as a form of Acceleration.

Thus, as presented in the previous chapter of this paper, if Electric 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 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·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.

Summary and Conclusions

This paper presents the prediction that Electric Fields are also forms of Acceleration, as the Newton's Gravitational Field is already recognized as a form of Acceleration.

The prediction that Electric Fields are also forms of Acceleration, is supported by arguments relying on the *structural identities* between Newton's Universal Gravitational Law and Coulomb's Law.

However, the prediction that Electric 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.

This experiment is relatively simple to implement, but still requires means and funds which are beyond the reach of the author of this paper, thus, the author of this paper hopes, that this paper will bring about the execution of this experiment, and, hopefully, the validation of what is presented in this paper.

If this experiment will be implemented, and its results will be successful, such that the Electric Field will be also recognized as a form of Acceleration, this will also result in significant implications.

One immediate implication would be the realization, that for Electrically Charged bodies, attracted or repelled under Coulomb's Law, F=ma should be replaced by F=kqa, as described in the body of this paper.

Also, additional, more significant implications, will result if the Electric Field will be recognized as a form of Acceleration. Such implications are presented in additional papers by the author of this paper.

References

(*1*). Newton's Law of Universal Gravitation. Wikipedia.
https://en.wikipedia.org/wiki/Newton%27s_law_of_universal_gravitation

(*2*). Gravitational Field formula
Gravitational Field Formula: Concept, Important Formulas, Examples (toppr.com)

(*3*). Einstein's Theory of General Relativity. Space.com site.
https://www.space.com/17661-theory-general-relativity.html

(*4*). Newton's Laws of Motion. Wikipedia.
https://en.wikipedia.org/wiki/Newton%27s_laws_of_motion

(*5*). Coulomb's Law, Wikipedia. https://en.wikipedia.org/wiki/Coulomb%27s_law

(*6*). Mass Attraction Forces. ER. services. University Physics Volume 1.
Newton's Law of Universal (lumenlearning.com)

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