*IOSR Journal of Applied Physics (IOSR-JAP)*
*e-ISSN: 2278-4861.Volume 10, Issue 5 Ver. I (Sep. – Oct. 2018), 57-73*
*www.iosrjournals.org*

# The Unified Force of Nature: 1-The Electric & Magnetic Forces

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***Abstract:*** *The paper emphasized the difference between electromagnetic radiation and electric/magnetic forces; a formula for field's interaction have been derived; it transformed the attraction and repulsion of any two fields into dynamical force with explainable mechanism; the formula satisfied both the mathematical and mechanical conditions, as it explained the physical mechanism for the magnetic effect of the electric current discovered by Ørsted, the Ampere force between two conductors carrying electric current, the formula also resolved the force between charged bodies and magnetic forces, such as the Catapult force, force between magnetic poles and the Lorentz force; the failure to get this formula in early nineteen century reflected negatively on current scientific developments by transforming the physical science into mathematical based speculation; therefore the solutions obtained using this formula may help realizing scientific knowledge in its common sense.*

***Keywords:*** *Unification of Forces; Field's Formula; Ampere Force; Electrostatic Field; Magnetic Forces; Catapult Force; Magnetic Poles; Lorentz Force; Magnetic Interaction; Ampere, Ørsted.*

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Date of Submission: 03-09-2018 Date of acceptance: 18-09-2018

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## I. Introduction

Although electricity, magnetism and light was unified as electromagnetic radiation by James Clerk Maxwell in 1861, and physicists are working hard to develop a fundamental theory [1], we realized that, the concept of radiation is confused with force; and as the laws of science contain many unpredicted fundamental constants, like the size of electric charge [2], determinations of astronomical unit, Avogadro's number, Joule's coefficient, and so on [3], physicists hoped to find a complete, consistent, unified theory to form the unification of physics [2], Einstein spent his last years obsessed with the unified field theory [4], there are others who are trying to unify forces of nature [5].

The four forces operate in nature are, the gravity which stabilized objects on planets and it's rotation around the stars, derived by Sir Isaac Newton in 1687, it controls long distance objects, but it's the weakest [6], second in strength is the weak force, responsible for radioactivity or the decay of atomic nuclei, such as beta decay [7], third is the electromagnetic force, which is an attractive and repulsive force, it bonds atoms and molecules [8], the last and strongest is the nuclear force, which is responsible about the structure of the nucleus [9], the gravitational force is also interpreted by Einstein's general theory of relativity [1]; while Electromagnetism and the weak forces are thought as two aspects of a unified electroweak, as suggested by 1979 Nobel Laurent Abdus Salam, Steven Weinberg and Sheldon Glashow **[**5**]**, it's the main theory of the standard model.

The Standard Model (SM) is a quantum field theory; it's basic ingredients are fields, including the electric and magnetic fields of the $19^{th}$ century electromagnetic; little ripples in these fields carry energy and momentum, and according to quantum mechanics, these ripples come in bundles, or quanta, that are recognized in the laboratory as elementary particles, the quantum of the electromagnetic field is photon [10]; both the theory of Quantum Chromodynamics (QCD), which is the theory for quark interactions, constructed by analogy with Quantum Electrodynamic (QED), postulated the existence of massless particles called gluons by which the quarks are held or glued together, and the theory of electroweak, form the standard model (SM) of elementary particles, which aimed at unifying the strong, electromagnetic and weak forces [1]. Unifications in the Standard Model is thought to be possible, where particles of matter, known as fermions, do not directly interact with each other, rather they carry a charge, and exchange virtual particles, as gauge bosons, which is the interaction carriers or force mediators, where the massive gauge bosons called the W and Z bosons mediate weak force, gluons mediate the interaction of color charges in the strong interaction, and photon mediates the electromagnetic interaction [11], some theorists are working on quantum gravity (QG) by quantized the gravitational field and introduced a force carrier named the graviton [5]; while string theorists hoped, string theory would unify all the four fundamental forces of nature [1]; thus in SM, strong relation existed between electromagnetic radiation and force, as will be seen, this link could be traced back to nineteen century physics.

The concept of force carrier or particles mediating interaction of forces is very important in standard model, and unification of two forces required complicated mathematical manipulation, that transformed the physical study into prestigious field, where disputes among physicists are common, as interpretation no longer based on common sense; while the discovery of Higgs boson (H), thought by SM as an important mechanism (Higgs mechanism) for acquiring mass, thought to fill the gaps in SM and lead to unification [1], for that, it was nicknamed "God particle" [12], three years elapsed physicists are quite, reflecting on that efforts! But why this didn't happen? Is the path taken by SM is correct? And from where did this complication and the concept of force carrier emerged? Is there any truth to justify it or it's just that imagination which seeks '*God particle?*'

On July 21, 1820, while lecturing, Hans Christian Ørsted observed a wire connected to ends of voltaic battery affected a magnet in its vicinity [13], discovering the magnetic effect of the electric current [14], Ampere interpreted that as "*due to a direct interaction between the current flowing in the conductor and a supposed currents existed inside the magnet,*" he experimentally derived a formula for a force between two conductors carrying electric current [15], although Oersted also discovered a Circular Magnetic Field (*CMF*) surrounded conductor carrying electric current [16], but Ampere interpretation of the interaction between two helices, led him to derived his important law and generalized it, he draw a geometrical representation of two small electric current interacted to derive the force [15], this complicated unrealistic perception formulated the current fundamental physics in early nineteen century, although greatly modified by Maxwell [17], but it's the concept of the force, understood by Ampere and Maxwell that, the '*electric conflict acts in a revolving manner*,' that is, when a magnet placed near a wire transmitting an electric current, it tends to set itself perpendicular to the wire, and with the same end always pointing forwards as the magnet is moved round the wire [13], although the interpretation recognized the role of magnetic field, but the Ampere's force between current elements which has a much more complex structure than the gravitational, electric and magnetic forces, conceived as resulted from the flow of macroscopic currents flowing in magnets and in the Earth, he later adopted the idea that magnets and the Earth were composed of assemblies of particles, where electric currents would be circulating perpetually round these particles, these microscopic electric currents should flow especially around magnetized particles or molecules of iron or steel [15], Ampere's work was criticized by his contemporary scientists, namely, Ørsted, Biot, Savart and Faraday, and later by researchers, like Grassmann [15], several key aspects of Ampere's interpretations are against the current electromagnetic theory, even some controversies which started during Ampere time, have not yet been solved [15], although Ampere's ideas was described as a remarkable, but Faraday who questioned it, then related the flow of electric current with accompanied magnetic action at right angles to the current, [18], but that was neglected; then Orsted presented a concept of attraction and repulsion acting between the electricities flowing outside conductor, shown in Fig. 3-c; later he suggested circles around a current-carrying wire, instead of considering helices or spirals around shown in Fig. 3-a [15], we designated this as the Circular Magnetic Field (CMF) [19]; the CMF is the lines of magnetic force, Maxwell professed knowing it will enlarged human knowledge [20], while Faraday was interested in the *physical* existence of *these lines* [21, 22], unfortunately Maxwell connected the lines of force with his vortices [23], the vortices was introduced by Lord Kelvin in 1856 [24], and Faraday was eager to know *if the lines of magnetic force* are *static or dynamic* [25], scholars believed Faraday realized that since 1838, others thought in 1852, while Maxwell initially took an agnostic approach in his mathematization of Faraday's theories [26], representation of lines by the filings, convinced Faraday with its physical existence, but failed to conceived the curved lines due to direct action at a distance, leading him to suggest a medium as a vehicle for both the magnetic force, electric force, and the light [27], it's how he connected it with his ether theories [22], although Faraday, believed "*the lateral or transverse forces of the current,*" achieved by Oersted, Arago, Ampère, Davy, De la Rive, and others, "*was highly simplified by Ampere's theory, and it only advanced this branch of knowledge, but it protected itself as an ideal theory from any review, but other alternative exist, the discovery of which would be rewarded*" [18], unfortunately, that was not taken seriously; the failure to understand the nature of CMF by these scientists compounded with the lack of new ideas and the need to resolve challenges at hand, lead to the acceptance of the formula of force, based on action at a distance, similar to gravity [22], without regard to role CMF can achieve. Therefore, investigating the Circular Magnetic Field (*CMF*) [19], defined by Faraday and Maxwell as a region of space with magnetic field in the neighborhood of magnetized body [22], a formula based on Field's Interaction was derived; it utilized the CMF characteristics, and given by

$$F = F_1 F_2 r^2 k \qquad (A)$$

Where, $F_1$ is the first Field, $F_2$ is the second field, r is the radial distance between the two fields, k is constant which differs from case to other and the force F in Newton.

The failure by Orsted, Ampere, Biot, Savart, Faraday, Grassmann, Maxwell and their contemporaries to properly interpret the CMF factor in Ørsted's experiment, during the early structure of fundamental physics, and as a physical entity that created the force [19], and formed the main structural component in the mechanism of electromagnetic radiation [28], deepened with Faraday's physical lines of magnetic force been assumed as currents [25], among many hindered the realization and understanding of the nature and mechanism of the

magnetic force, regardless of that, Maxwell articulated a theory for the production of electromagnetic radiation [20], later conceived as due to charged particle acceleration [29], a mechanism rectified by the "*The Electromagnetic Radiation Mechanism*" [28] and "*Electromagnetic Radiation Energy and Planck' Constant*" [30] a phenomenon different from electric and magnetic forces, while the misinterpretation of the Planck' energy formula [31], and the introduction of quanta (photon) by Einstein in 1905 to remove electron from atom [32], initiated the creation of quantum mechanics [33, 34], but as Planck' formula in essence showed the radiation energy embedded electromagnetic radiation, thus the failure to get the Radiation Magnetic Force ($F_{mR}$) formula [36], resembled the Ultraviolet Catastrophe situation [35], resolved by Planck's energy formula [31], the unnecessarily usage of quanta (photon) is rectified by formulated the Radiation Magnetic Force ($F_{mR}$) given by Eq. (24) in "*The Photoelectric Effects: Radiation Based With Atomic Model*" [36], while the momentum formula used by Compton to justify the photon and wave particle duality was showed to be merely a false usage, in "*Compton was Greatly Mistaken Using the Quantum*" [37], it was odd near the end of his life Einstein wrote "*All the fifty years of conscious brooding have brought me no closer to the answer to the question: What are light quanta? Of course today every rascal thinks he knows the answer, but he is deluding himself*" [38], Compton Effect is explained in "*The Compton Effect Re-Visited*" [39], the double slit is explained in "*The Double Slit Experiment Re-Explained*" [40], the last experiment that endorsed photon and duality is explained in "*Electron Diffraction Re-Explained (The Intense Magnetic Field Interaction with Crystals)*" [41].

Therefore, the introduction of excellent formula by Ampere in 1821, lacked rational mechanism, reflected in the failure to understand the nature of the magnetic force, and mark the second stage for encroachment of mathematical formula over logic in physical mechanism, started earlier by Newton's gravity Formula [6], which showed to be wrong [42]; while the usage of photon by Einstein in 1905, eradicated any sign of physical theory which finally lead to the adoption of photon as carrier for electromagnetic force [43], mixing radiation with force, followed by the heavy force carrier particles by the electroweak, and the subsequent discovery of both the $W^{\pm}$ and $Z^0$ by CERN in 1983 [1], the usage of both particles is a good example of how the failure by scientists to understand the nature of magnetic force in nineteen centaury resulted in the creation of photon to become carriers of force, then complicated with both the $W^{\pm}$ and $Z^0$, and gluons to mediate the interaction of color charges in the strong interaction, ended with quantized gravitational field and graviton as force carrier [5], how this can be justified with the recent findings about gravity? [42] Therefore both the attempt to construct a unified theory which can be expressed within a common mathematical framework, and that of string theorists [1], were based on non physical structure, introduced due to wrong interpretation of the nature of the interaction, contrary to fields interaction as given by Eq. (A); thus the accumulation of many mistakes led to the current state of forced interpretation or invented claims, which created false mechanism that required to be memorized, it enforced the role of mathematics as an important tool to explain different phenomena, with ability of physicists to introduce particle such as photon, change the roles or characteristics (as with spins) to suit mathematical structure, such as the construction of the theory for quark in analogy with quantum chromodynamics (QCD) [1], all these led to the current state of complication; which distorted the truth and the emergence of Quantum Mechanics (QM) and Quantum Electrodynamic (QED), created great confusions lacking common sense; early described by Boham, that "*If you look at what they said (Copenhagen) about wave particle duality, you think you don't understand because you are not clever enough; you don't understand it because it is not understandable*" [44], even J. J. Thomson realized the shortage in nineteenth century physical science saying, "*the detection of a train of waves associated with the movement of electrons was not predicted by Maxwell's equations, emphasizing that, such a view of the electron had to be wrong*" [45], thus the complication of electro-magnetism, required enrich in explanation [20].

In this paper, the interaction of two fields given by Eq. (A) is used to resolve both the electrostatic force and magnetic force; it also resolved the Ampere's Force, force due to Magnetic Poles, the Catapult Force or the Motor Effect, the Electromagnetic Interaction; while the Nuclear force, Weak force and Gravity based on Eq. (A) will follow soon. David Gross was once asked, if it's possible to falsify string theory/quantum field theory? Or is that a purely philosophical question? He replied "The question of how we decided whether our theories are correct or wrong or falsified has a philosophical aspect. But in the absence of empirical data, can we really judge the validity of a theory? [46], this paper tried to remove the link between electromagnetic radiation and electric-magnetic forces, and attained the missing link of the force; its absence had shaped the current physical world.

As this attempt is a comprehensive theory, thought sensible to replace the current QM and QCD, it's the role of UNISCO, physicists, Universities, Science Association, Physical Societies, National Academies of Sciences and Royal Societies of Science, to study these papers, as it could mark the end of a certain kind of physics [1], and the start of new paradigm, which may reflects positively on the future of the planet and human existence.

## II. Action at Distance, Good Mathematic Versus Bad Mechanism

The universal gravitation law by Isaac Newton in 1687 [15], is given by

$$F_G = G\,\frac{M_1\,M_2}{r^2} \qquad (1)$$

Where, $M_1$ is the first mass, $M_2$ the second mass, r is the distance between the two masses, the gravitational constant $G = 6.67408 \times 10^{-11}$ $m^3$. $kg^{-1}$ ($N\text{-}m^2/kg^2$), but the gravitational constant G is found to have a formula, transforming the law into centripatil formula [42].

In 1785, Augustin Coulomb derived the force between electrified bodies, which followed the above inverse square law, the electric action, is either a repulsive or attractive force, "*its in the ratio compounded of the densities of the electric fluid of the two electrified molecules and inversely as the square of the distances*" [47], the electrical force on a charged particle (known as a point charge) exerts a force on a second point charge, is proportional to the product of their charges, inversely proportional to the square of their separation distance, and directed along the line joining the two particles, given by [48]

$$\boldsymbol{F_e} = k_e\,\frac{q_1\,q_2}{r^2} \qquad (2)$$

Where, $q_1$ and $q_2$ are the charge in Coulomb's, $k_e$ is the Coulomb constant (for vacuum $k_e = \frac{1}{4\pi\varepsilon_0}$ = equal $8.9875\text{x}10^9$ $N.m^2/C^2$), $\varepsilon_0 = \frac{1}{4\pi(8.85\text{x}9\ N.m^2/C^2)} = 8.85\text{x}10^{-12}\,\frac{C^2}{N.m^2}$; [49] Coulombic forces are long-range, decreasing as $1/r^2$, in principle its always nonzero [48].

Coulomb also derived in 1785, the force between magnetic poles considered as concentrated on particles or material points, these poles are the North pole and South pole of the magnet, with the North pole being considered positive, by convention [15], the law with air being the medium between them, is defined as; "*The repulsion between two like magnetic poles is in the straight line joining them, and is numerically equal to the product of the strengths of the poles divided by the square of the distance between them*" [13], it's given by

$$F_P = \frac{M_1 M_2}{r^2} \qquad (3)$$

Where, $M_1$ and $M_2$ are the strength of the two magnetic poles, r is the radial distance between them and the Pole's Magnetic Force $F_P$ is in Newton.

The inverse square law pause serious question on how bodies interacted, this also evolved on "whether the magnetic force is transferred through bodies or through space? Or whether it's merely action at a distance, like gravity" [22], while investigating the action of one electric circuit upon another, Ampere was guided by direct action at a distance, he determined the action of the first due to the magnetic field produced by the second [13], as shown in Figs. 5-a [50]; upon reading Ampere's papers, Faraday felt something was wrong, and he perceived the Ampere's force as complicated [15], Faraday was not satisfied with the action at a distance between charges, thinking *there must be some mechanism for electric and electromagnetic actions to communicate from point to another* [27], this means he was not convinced with both Eq. (2) and Eq. (3), he worked very hard on magnetic lines of force seeking alternative formula, but challenged with, "*whether the lines of magnetic force have or hasn't physical existence; and if they have, whether its static or dynamic*" [25], he also considered interaction via the lines of force as direct action at a distance [24], he urged the magnetic action at a distance to be compared with the propagation of line or ray for radiation or the electricity, where the propagating process has intermediate existence, like a ray, but at the same time depends upon both extremities of the line of force [25], for Maxwell "*The comparison, from a philosophical point of view, of the 'direct action at a distance' and 'action through a medium' so completely opposite in their first principles must lead to valuable data for the study of the conditions of scientific speculation*" [13]; that circumstances led Faraday to questioned "our *awareness regarding different physical methods or forms under which force is communicated?* It has been assumed, however, by some, *to be a pure case of force at a distance, and so like that of gravity;* whilst others *have considered it as better represented by the idea of streams of power*" [25], but Maxwell tried to concealed the debate by stating that "*a remarkable course of speculation and investigation founded on the direct action at a distance was carried by Gauss, Weber, F. F. Neumann, Riemann, Betti, C. Neumann, Lorenz and others, with remarkable results both in discovery of new facts and in the formation of a theory of electricity*" [13]; but Faraday concentrated on "*the question of physical existence of lines of force*" [25], thinking it could have an answer to these questions, even Maxwell stated that "*in every place where we find these lines of force, some physical state or action must exist in sufficient energy to produce the actual phenomena*" [51]; therefore the physical existence of the line of force and the *direct action at a distance* verses the *action through a medium* was one of the greatest debates engaged by physicists in nineteen centaury; while currently many started realizing its existence, as Newman wrote "*the electric field is a real physical quantity that can carry energy, momentum, and angular momentum*" [48], implay the same for magnetic lines of force; as Faraday demanded since 1852, that "*The magnet is evidently the sustaining power" urging for a "beautiful idea about it like that of Ampere*" [25], graphic representation of lines of force by the filings, convinced Faraday with its physical existence, but failed to conceived the curved lines due to direct action at a distance, he suggested a

medium as a vehicle for both the magnetic and electric force, also for transmission of light [27], while initiators of direct action at a distance like Gauss, Weber, F. F. Neumann, Riemann, Betti, C. Neumann, Lorenz and others, formed the current theory of electricity [13], contrary to Maxwell ideas on action through a medium from one portion (section) to the contiguous (neighboring) portion [13], thus regardless of efforts by Faraday on lines of force; but lacking mathematical modeling, necessitate intervention of James Clerk Maxwell, who perceived his work as a mathematical theory of Faraday's lines of force [52], stating that his "*action through a medium*" were much employed by Faraday, while developing them in mathematical form, and compared the results with known facts, he published these in several papers [13], although Faraday understood importance of the lines of force; but he couldn't expressed it theoretically, particularly with the existence of the law of force given by Eq. (3), and since the expression of law of force between given quantities of Magnetism has exactly the same mathematical form as the law of force between quantities of Electricity of equal numerical value, much of the mathematical treatment of magnetism must be similar to that of electricity [13], thus all known forces till nineteen century, has similar formulas, that is gravity by Eq. (1), electrostatic by Eq. (2) and magnetic poles by Eq. (3) imply "*action at a distance*" due to the structure of these formulas, signifying the failure of early atomistic and mechanistic theories which sought to reduce all physical interaction to collision, the resolution of that led to significant developments in physics, from the concept of a field, to descriptions of quantum entanglement and the mediator particles of the Standard Model [53]; Maxwell expressed the whole saga saying, "*the mathematical theory of attraction had, prior to the time of Faraday, attained a very high degree of development in the hands of Laplace, Lagrange, Poisson and others, and could be applied to solution of many very interesting problems in electricity, but Faraday was not satisfied with the hypothesis of direct action at a distance between charges of electricity, and held that there must be some mechanism by which electric and electromagnetic actions can be communicated from point to point*" [27], realizing the missing link, in Eq. (A), which suggested interaction of two fields, it showed the role of lines of magnetic force or magnetic line of force, or magnetic curve, defined by Faraday as "*that exercise of magnetic force which exerted in the lines usually called magnetic curves, and which equally exist as passing from or to magnetic poles, or from concentric circles round an electric current*" [54], the formula restored fields' interaction, believed by Faraday, which exposed the "*action at a distance*," incorrectness, and eliminate the need for both the quantum entanglement [55] and the mediator particles [56], both were senseless results diverted the Physical Based Theory (PT) transforming it into Mathematical Based Theory (MT), hence the following pages are based on the *interaction* of *fields*, where all forces of nature are derived using Eq. (A).

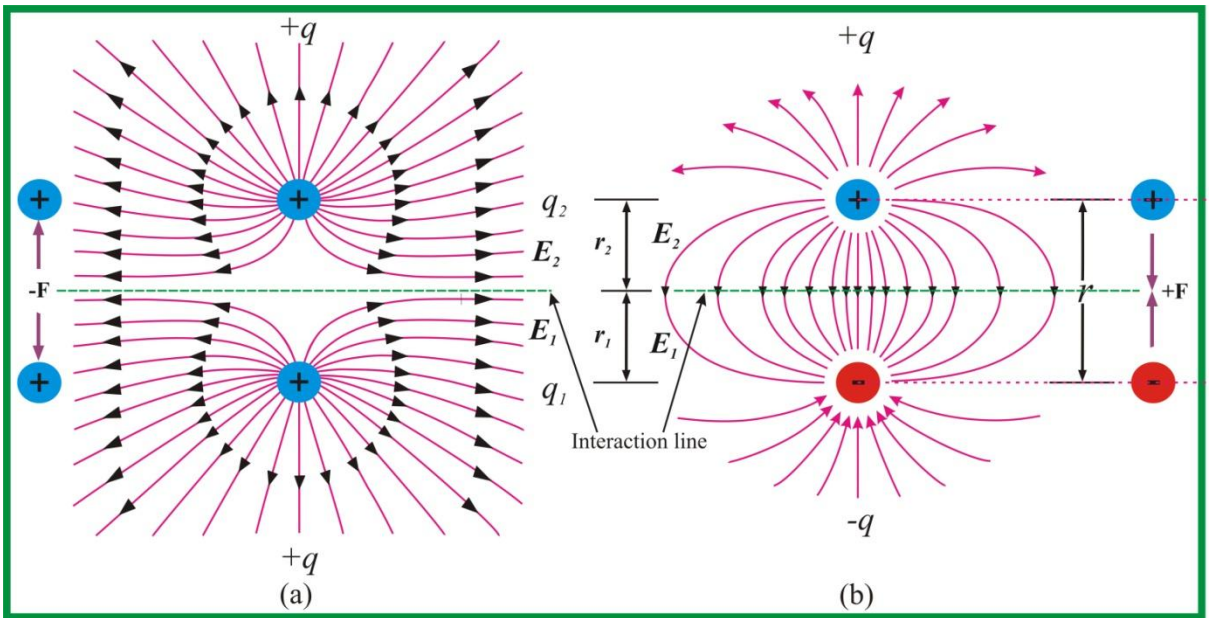


**Fig.1.** Two electric fields [57], in (a) two protons produced similar electric lines of force, producing repulsive force, while in (b) lines of force of opposite directions from an electron and proton shorten each other, produced an attractive force, both the repulsion and attraction of lines of force are carried along the interaction line.

## III. The Field's Formula for the Electrostatic Force

A pairs of two charged particles are shown in Fig.1, [57], both created electrostatic fields, the two protons in Fig.1-a, have a similar electric lines of force emanating from each proton, while Fig.1-b shows an electron and proton, their properties are summarized as follows [49]:

- The number of lines per unit area through a surface perpendicular to the line is devised to be proportional to the magnitude of the electric field in a given region.
- The direction of the electric field vector E at a point is tangent to the field lines.
- The field lines must begin on positive charges (or at infinity) and then terminate on negative charges (or at infinity).
- The number of lines that originate from a positive charge or terminating on a negative charge must be proportional to the magnitude of the charge.
- No two field lines can cross each other; otherwise the field would be pointing in two different directions at the same point.

From these, the interaction of two fields along the interaction lines, shown in Fig. 1-a repel each other as envisioned by Faraday [25], created a repulsive force; while Fig. 1-b shows an electron and a proton, the electric lines of force from each particle interacted with line of force from the proton, along the interaction line, with radial distance r from each particle, since different lines shorten each other as stated by Faraday [25], thus the interaction of two different electric fields produced an attractive force; relating this to the definition of Coulomb's law, *which related magnitude of the force to product of charge and inversely to the square of the distance* [58], as given by Eq. (2); in which, the electric field created by the charges in the Coulomb force is conceived as vector field associated to each point in space the Coulomb force experienced by a test charge, the field in the simplest case is considered to be generated solely by a single source point charge [58], from this definition, and the mechanism shown in Figs. 1-a&b, two points are odd, these are:

1- The *product of the charges* can't explain how the force interacts and works

2- The two electric field lines are either repelling each other to give repulsive force as in Fig. 1-a, or shortened themselves to give an attractive force as in Fig.1-b.

As the *product of the charges* and the inverse square law, can't explain the mechanism on how electrostatic force given by Eq. (2) is produced, while as shown in both Figs. 1-a&b, the "lines of force" or "field lines" draw by Faraday as a way of representing the fields, and to gain insight into the stresses that the fields transmit, suggesting that, these fields, transmit the stresses that result in forces between the objects [49], hence the electric fields interaction as shown in Fig. 1, is the main mechanism leading to the production of the electrostatic force, but as stated in the explanation of the force that, "*the strength and direction of the Coulomb force* $\boldsymbol{F}$ *on a test charge* $q_t$ *depends on the electric field* $\boldsymbol{E}$ *that it finds itself in, such that* $\boldsymbol{F} = q\,\boldsymbol{E}$" [58], it's a true statement lacking formula; therefore a formula for electrostatic force, shown in Figs. 1-a&b, derived from the Magnetic Interaction [19], as given by Eq. (A); thus since an electric field is a vector field that associated to each point in space the Coulomb force experienced by a test charge [58], hence b**y** using the notion of a test point charge, taken by convention to be positive, the definition of the electric field $\vec{E}$ at some point in space is given by **[**48**]**

$$\vec{E} = \frac{\vec{F}}{q_1 q_2} \qquad (4)$$

Where, $\vec{F}$ is the force on the test charge $q_2$, the electric field at the site of $q_2$ is independent of the magnitude of the test charge, depending only on the charges producing $\vec{E}$ and their location with respect to $q_2$, E is in Newton (N) / Coulomb (C) **[**48**]**, its thought, $q_1$ detected the presence of $q_2$ through experiences a force by direct interaction with the electric field arriving at its location from $q_1$ [48], but as shown in Fig.1- (a&b), the field of each particle interacted at the interaction line in Fig.1, then information is transmitted to its charge about the existence of the field, its intensity and distance to the relevant charged particle, while the example given by Newman in his FIGURE 14.8 [48], is re-explained in Fig.2, where charge $q_1$ and $q_2$ with equal charge, interacted at center at radial distance $r_1$ and $r_2$, the electric fields at interaction line are $E_1$ and $E_2$, where $E_1$ transmit information to $q_1$ and $E_2$ to $q_2$, if $q_2$ changed position to $q_{22}$, from $r_2$ to $r_{22}$, $q_1$ will detect this information at the interaction line between $r_{11}$ and $r_{22}$, having $E_{11}$ and $E_{22}$, thus each line of force will transmit information to its relevant particle; therefore, charges experinace electric forces by direct interaction of its electric field with the electric field of the other charges rather than by action at a distance; therefore, the mutual "stresses" transmitted by electric field, is the really mechanism behind the repulsive and attractive force, this stressed is transmitted by electric lines of force, and as stated "*the Coulomb force between the two charges is not "action at a distance," rather, the stress is transmitted by direct "contact* [49], hence concentration will be on the fields; and since the definition of electric field given in Eq. (4) and the Coulomb's law given by Eq. (2), can determined the electric field at a distance r from a point charge q **[**48**]**, the electric field $E_1$ of a point charge $q_1$ at a distance r away, is derived from Eq. (2) **[**48**,** 60], this is given by

$$E_1 = \frac{1}{q_2}\left(\frac{q_1\, q_2}{4\pi\varepsilon_0 r^2}\right) = \frac{q_1}{4\pi\varepsilon_0 r^2} \qquad (5)$$

Where, $q_1$ is the first electric charge in Columb, and $E_1$ is the electric field due to the first charge in N/C or V.m$^{-2}$, hence from Eq. (5), $q_1$ is given by

$$q_1 = E_1 4\pi\varepsilon_0 r^2 \qquad (6)$$

While the second electric field $E_2$ due to the second charge $q_2$, is

$$E_2 = \frac{1}{q_1}\left(\frac{q_1\, q_2}{4\pi\varepsilon_0 r^2}\right) = \frac{q_2}{4\pi\varepsilon_0 r^2} \qquad (7)$$

From Eq. (7), $q_2$ is given by

$$q_2 = E_2 4\pi\varepsilon_0 r^2 \qquad (8)$$

| No | $r_1 = r_2$ | $E_1 = E_2$ | $F_E$ | r | $F_e$ |
|---|---|---|---|---|---|
| 1 | 1 nm | 1.441959597x10$^{9}$ | 2.3102749770893360 1x10$^{-10}$ | 1 nm | 2.3102749770893360 1x10$^{-10}$ |
| 2 | 0.001 | 1.441959597x10$^{-3}$ | 2.3102749771x10$^{-22}$ | 0.001 | 2.3102749770893360 1x10$^{-22}$ |
| 3 | 0.01 | 1.441959597x10$^{-5}$ | 2.3102749770893360 1x10$^{-24}$ | 0.01 | 2.3102749770893360 1x10$^{-24}$ |
| 4 | 0.10 | 1.441959597x10$^{-7}$ | 2.3102749770893360 1x10$^{-26}$ | 0.1 | 2.3102749770893360 1x10$^{-26}$ |
| 5 | 1.0 | 1.441959597x10$^{-9}$ | 2.3102749770893360 1x10$^{-28}$ | 1.0 | 2.3102749770893360 1x10$^{-28}$ |
| 6 | 10.0 | 1.441959597x10$^{-11}$ | 2.3102749770893360 1x10$^{-30}$ | 10.0 | 2.3102749770893360 1x10$^{-30}$ |
| | 8.2x10$^{-8}$ | 8.566073024x10$^{-5}$ | 1.3701468898188536 1x10$^{21}$ | | |

Table.1. The parameters of electric force ($F_E$), $r_1$=$r_2$, $E_1$=$E_2$ using Eq. (10), compared with electric force ($F_e$) using Eq. (2).

Substituting $q_1$ in Eq. (2) with the right hand side of Eq. (6), and replace $q_2$ in Eq. (2) with the right hand side of Eq. (8), the following is derived

$$F = \frac{(E_1 4\pi\varepsilon_0 r^2)\ (E_2 4\pi\varepsilon_0 r^2)}{\pi\ \varepsilon_0 r^2} \qquad (9)$$

Rearangment of Eq. (9), therefore, the Electrostatic force is

$$F_E = E_1\ E_2\ r^2\ k_e \qquad (10)$$

Where, $k_e = 4\pi\varepsilon_0$ =1.11111111111111111111111111111111x10$^{-10}$ N/V$^2$.m$^{-2}$ .m$^2$.

Table.1. showed the derived electric force ($F_E$), using Eq. (10), and electric force ($F_e$) using Eq. (2), given parameters $r_1$=$r_2$, $E_1$=$E_2$, although the magnitues of both forces are equal, but the mechanism created the forces are different.

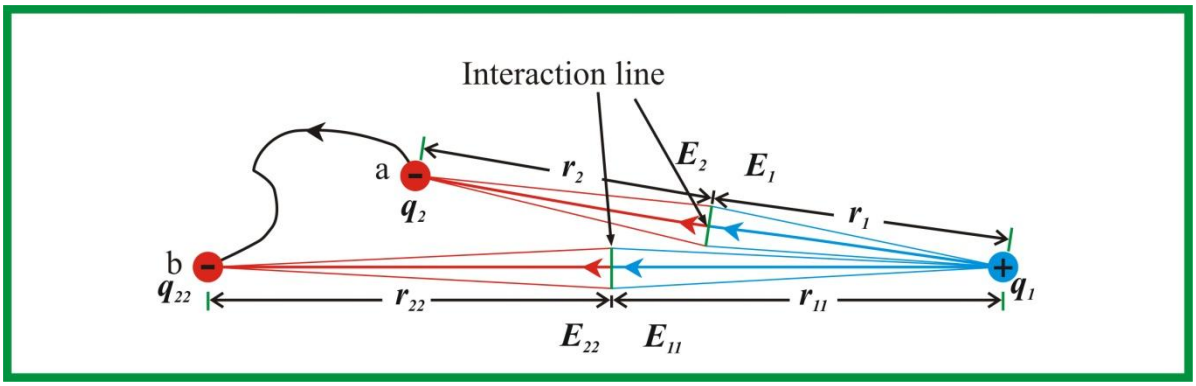


**Fig.2.** The nature of fields interaction, a positive charge ($q_1$) and negative charge ($q_2$) [48], with radial distances $r_1$ and $r_2$ at central interaction line; the electric field by each at the line is $E_1$ and $E_2$ respectively, if electron moved from point (a) to point (b), the radial distance increased and become $r_{11}$ and $r_{22}$, changing the interaction line, decreasing the intensity of the electric field to $E_{11}$ and $E_{22}$, and the related electric force is decrease, as given by Eq. (10).

## IV. The Field's Formula for the Ampere's Force

Ampere interpreted Ørsted's experiment as due to interactions between current carrying conductors, he explained the torque exerted by the current-carrying wire "*as due to a direct interaction between the macroscopic current in the wire and the microscopic currents he supposed to exist inside the magnetic needle*" [15], the idea was odd even with early nineteen centaury perspective he thought *"the force acting along the line connecting these two current elements and following the principle of action and reaction*" [15], laying out such argument at the emergence of modern science, he suggested, "*if electric currents are the cause of the directive action of the Earth, then it could also cause the action of one magnet on another magnet*," therefore a magnet could be regarded as an assembly of electric currents [15], analyzing this argument, there is truth in its core, as

magnetic field is produced by moving electrons in conductor [61], but was not taken to its final analysis, Ampere work was criticized by his main contemporary specialized in the field, those were, Ørsted, Biot, Savart and Faraday, among many others and Grassmann [15], thus Ampere should have thought about interaction of the magnetic fields from the two currents; this odd in the theoretical setup, is the reason why nowadays Ampere's force between current elements usually does not appear in the textbooks [15], but still its considered as the bases of fundamental physics; and as Ørsted criticized Ampere, he showed the magnetic action of a straight current-carrying conductor as shown in Fig. 3-(a), his experiment is shown in Fig. 3-(b), and his interpretation in Fig. 3-(c), he supposed a positive and negative electricities describing helical paths around the wire and propelling the magnetic poles of the magnet, where the arrows indicated the directions of motion of the supposed positive and negative charges moving inside the wire in (b) and outside in (c) [15], which is different from Ampere's description, currently explained as magnetic, electromagnetic and electrodynamic interactions; textbooks usually utilize the concept of a "magnetic field" [15], many scholars don't know that, [62], and the current mechanism doesn't explain the nature of the magnetic force between straight current-carrying conductor.

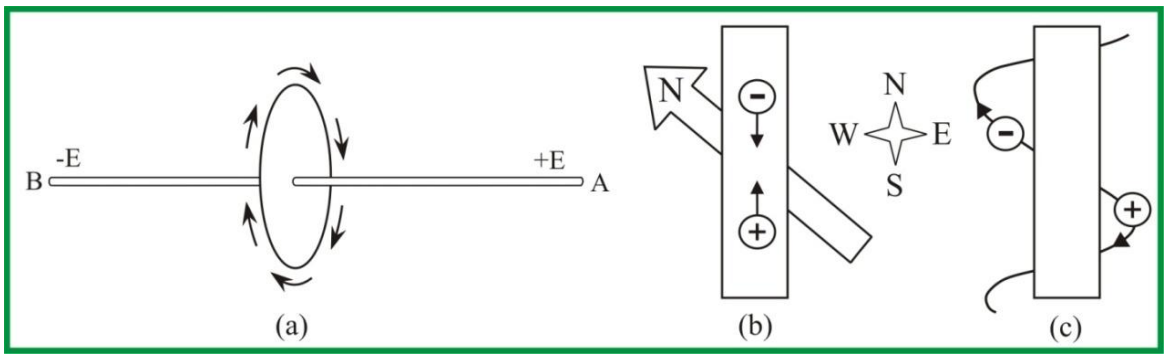


**Fig.3.** The magnetic action of a straight current-carrying conductor envisioned by Ørsted in (a), representing a Circular Magnetic Field (*CMF*), while Ørsted's experiment is shown in (b), and his interpretation of this observation in (c), he supposed a positive and negative electricities describing helical paths around the wire and propelling the magnetic poles of the magnet; arrows indicate directions of positive and negative charges, inside in the wire (b) and outside it in (c) [15].

The present interpretation of the two current-carrying wires is showed in Fig. 5-a [50], stated that "Two current-carrying wires attract each other magnetically, the left wire has current $I_1$, which creates magnetic field $B_1$, the right wire carries a current $I_2$ through the magnetic field $B_1$, so (by the Lorentz force) the wire experiences a force $F$, (Not shown is the simultaneous process where the right wire makes a magnetic field which resulted in a force on the left wire), Ampere derived it experimentally [63, 60]; based on the definition of the magnetic field generated by a wire carrying a steady current (Oersted's experiment), stating "*It appears therefore that in the space surrounding a wire transmitting an electric current a magnet is acted on by forces dependent on the position of the wire and on the strength of the current*" [22], where the attractive and repulsive forces between two conductors $\boldsymbol{C_1}$ and $\boldsymbol{C_2}$ carrying electric currents $\boldsymbol{I_1}$ and $\boldsymbol{I_2}$ separated by distance r metre, adopted for the definition of electric current [63], is

$$F_{e.e.} = \frac{2\ k\ l\ I_1\ I_2}{r} \qquad (11)$$

Where, $\boldsymbol{I_1}$ and $\boldsymbol{I_2}$ are currents on conductors $\boldsymbol{C_1}$ and $\boldsymbol{C_2}$, *r is* distance separating both conductors in metre, $\boldsymbol{l}$ is the length of the conductor in metre, and *k* a constant [62], and $\boldsymbol{F_{e.e.}}$, is the force in Newton. Faraday, was not satisfied with this mechanism assumed Ampere theory is a simple interpretation which protected itself from any review [18], and since Eq. (11) was an outstanding formula, described by Maxwell as "*The mathematical laws of the attraction and repulsions of conductors have been most ably investigated by Ampere, and his results have stood the test of subsequent experiments*" [51]; but its mechanism was and can't be explained properly, due to shortage in the formula itself, relating this with the ambiguous structure in Newton's gravitational force, recently disclosed as internally transformed itself into centripetal force [42]; that Ampere interpretation is very complicated, and fields interaction suggested by Biot and Savart was a brilliant, it supposed "*the wire became magnetized by the current flowing through it, there would be then an interaction between the magnetic poles of this wire and the magnetic poles of the compass needle,*" but Ampere ideas prevailed [15]; Faraday described the produced magnetic fields around a wire, like rings around conductor carrying electric current, if a small magnetic needles lie placed as tangents to it, the needle will be deflected by the field [18], Maxwell thought lines of force play big role, while comment on the above, stating satisfaction with the attractive and repellent forces directed at magnetic poles, stating that, "*anywhere the lines of force exist, some physical state or action must exist in sufficient energy to produce the actual phenomena*" [51], Faraday

showed how the passing of electric current in wire produced magnetic curves in induction, diminished with distance, can be linked another rings perpendicular to the wire or related to current within it, he resemble these curves with magnetic poles [18], if Faraday, supposed the second wire carrying electric current, then he may obtained the shape shown by Fig. 5-b and Fig. 6-a, hence what is the importance of this in fields interaction?

In conductors, electricity produced lines of magnetic force around it, its direction depends on the direction of electric circulation [20], fields interaction given by Eq. (A), generalized for all fields as given by Eq. (10) for electrostatic fields; while for two conductors carrying electric current, showed in Fig.5-b, conductor one ($C_1$), carrying current ($\boldsymbol{I_1}$), produced Circular Magnetic Field (*CMF*-$\boldsymbol{B_1}$), conductor two ($C_2$), carrying current ($\boldsymbol{I_2}$), produced *CMF*-$\boldsymbol{B_2}$, and since both currents are moving in the same direction, thus the produced CMF $\boldsymbol{B_1}$ and $\boldsymbol{B_2}$ are as Michael Faraday perceived they shorten themselves [25], thus producing magnetic force, its mechanism for attractive force is shown by cross-section of two attractive fields in Fig. 6-a, while Fig. 6-b shows two fields similar in direction, produced repulsive force, the direction of produced *CMF* is related to current flow [61], the *CMF* is clockwise for inward current in Fig. 6-a, and counterclockwise for an outwards current in left part of Fig. 6-b.

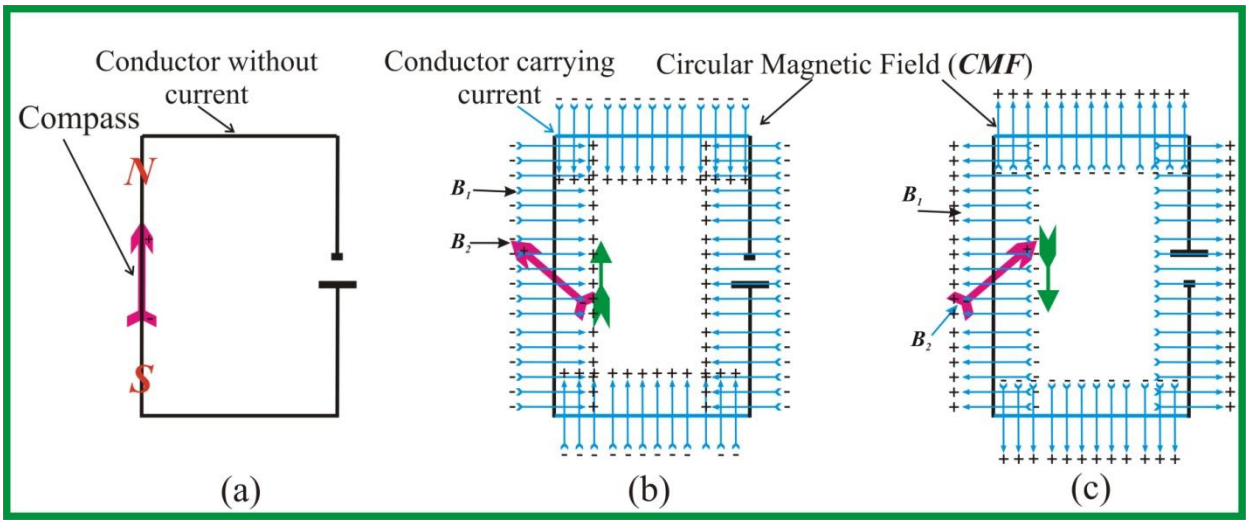


**Fig.4.** Reinterpretation of Ørsted's experiment, in (a) the conductor doesn't carrying electric current, when the current is switched on as in (b), the magnet on the needle of the compass interacted with the Circular Magnetic Field (CMF) produced by the current and attracted towards it, hence deflected towards the negative pole, and in (c) when current is reversed, the positive part of the needle attracted by the CMF hence directed to the right.

The attractive and repulsive force between two conductors carrying electric current is due to the shortened and repulsion of the Circular Magnetic Field (*CMF*) [61], shown in Fig.6, the CMF discovered by Oersted on July 21, 1820 [ 15] is produced by ***charged in motion***, constituting currents flow [61], by the *line of magnetic force, or magnetic line of force, or magnetic curve*, Faraday meant that exercise of magnetic force, exerted in the lines usually called magnetic curves, its equally exist as passing from or to magnetic poles, or forming concentric circles round an electric current (the *CMF*), it's the force exerted in the lines joining two bodies, acting on each other according to the principles of static electric induction, which may also be either in curved or straight lines [22], thus the CMF represents a determinate and unchanging amount of force [21], caused an attractive or repulsive force between two conductors carrying electric current, and since each conductor produced CMF along the conductor as shown in Fig. 5-b, therefore each two ***CMF*** or -$\boldsymbol{B_1}$ and -$\boldsymbol{B_2}$ shorten one another, as in Fig. 6-a, numbers of CMF shorten themselves thus attracts each other, fields of opposite directions repelled each other [25], shown in Fig. 6-b, the two CMF or +$\boldsymbol{B_1}$ and -$\boldsymbol{B_2}$ by currents of opposite direction, repelled each other, produced repulsive force; attraction and repulsion by two bar magnets, aligned along their axes, was reproduced by Ampere electrodynamically using two planar current-carrying spirals, placed in front of one another in parallel vertical planes, which he also replicated using the two helices wires shown in Fig. 7-a, he thought the repulsive force due to the direction of current shown in Fig. 7-b, and supposed the interaction of the helices AB and CD of Fig. 7-a, which he supposed as a fourfold interaction, namely: (I) The rectilinear component of AB interacting with the rectilinear component of CD; (II) the rectilinear component of AB interacting with the azimuthal current of CD; (III) the azimuthal current of AB interacting with the rectilinear current of CD; and (IV) the azimuthal current of AB interacting with the azimuthal current of CD, thus straight wires carrying currents in the same sense attract one another [15], this odd interpretation is clearly a shortage by Ampere and due to an odd of Eq. (11). Fig. 7-c, shows the interaction of the two magnetic fields -$\boldsymbol{B_1}$ and -$\boldsymbol{B_2}$, at the interaction line, they shorten themselves, producing the attractive

force, an opposite fields in direction shown in Fig. 6-b produced repulsive force, therefore attractive and repulsive forces can be infer as, the continuation of the lines of force between poles, indicating an attraction between poles; and where lines of force from poles avoid each other, dispersed into space, the poles repel each other, in both cases they are drawn in the direction of the resultant of the lines of force [20], or across the interaction line; hence shortened field can explained Ørsted's experiment, in Fig. 4-a, which shows a conductor without current, a compass bellow it directed northward; when current is switched on as in Fig. 4-b, and since Ørsted's experiment showed the orientation of the magnetic needle is influenced by a nearby current-carrying wire [15], which in reality is the production of ***CMF***, drawn by Oersted and shown in Fig. 3-a, hence ***CMF*** are produced along the conductor, with negative (-ve) poles on the exterior, which interacted and shortened lines of force on the positive (+ve) pole of the compass, which deflected towards the west or left as shown in Fig.4-b, when the current is reversed as in Fig.4-c, negative (-ve) poles are on the interior, which interacted and shortened the positive (+ve) pole of the compass, it deflected eastwards to the right as in Fig.4-c.

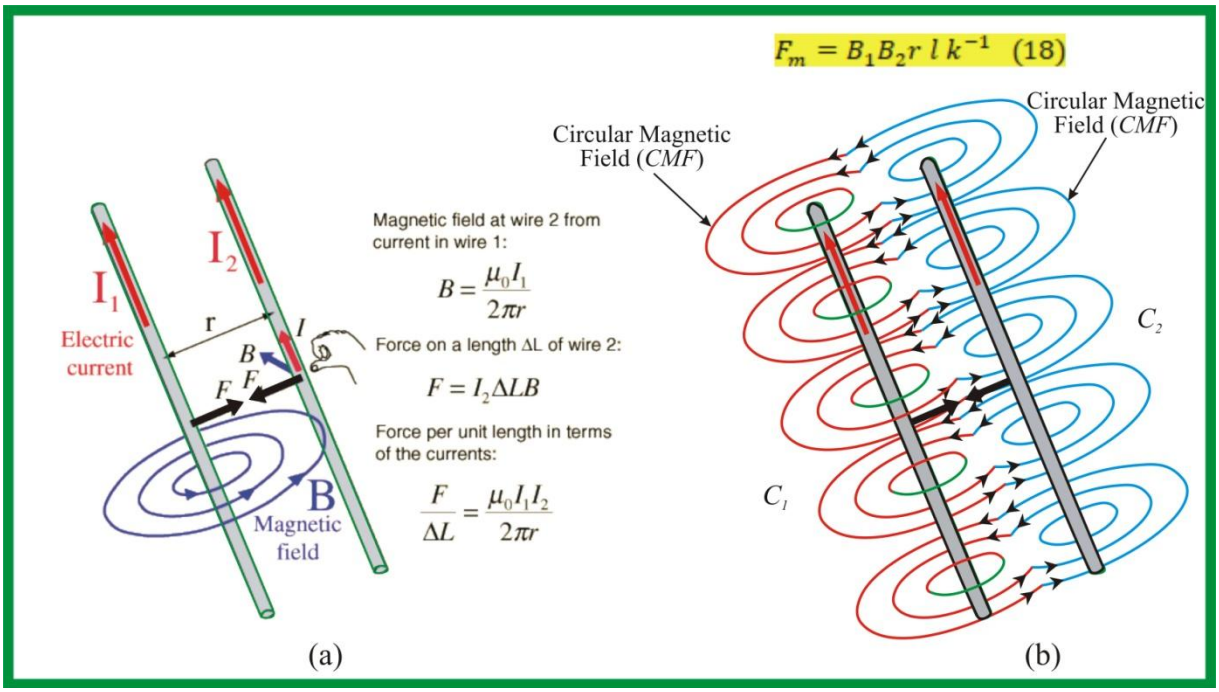


**Fig.5.** Two conductors carrying electric current, the force produced in (a) is explained based on Ampere's, stating that, magnetic field by conductor C2 interacts with current in conductor C1 [50], we suggested conductor $C_1$ produced Circular Magnetic Field ($CMF_1$) or $B_1$ and conductor $C_2$ produced $CMF_2$ or $B_2$, the interaction of both $B_1$ and $B_2$, shortened or repelled both CMF and produced the magnetic force given by Eq. (18).

Therefore, the force between two conductors carrying electric currents shown in Fig.8-a&b, where the currents in both conductors in Fig.8-a are in one direction, they produced CMF of opposite direction, they shortened and attracted the wire, while currents in Fig.8-b are opposite in direction, hence they repel each other. Although the concept of field interaction was difficult to attain since the mathematical laws of attractions are not analogous in any respect to those of undulations [20], as perceived by Eq. (3), which hindered creation of a formula, fortunately derived in the "Magnetic Interaction" [19], then developed and used in the electric field interaction, hence the CMF $\boldsymbol{B_1}$ produced around the conductor carrying electric current $\boldsymbol{I_1}$ shown in Fig. 5-b, is a CMF [48], (or Fig. 8-a&b for $\boldsymbol{I_1}$ & $\boldsymbol{I_2}$) therefore $B_1$ due to $I_1$ in Fig. 5-b, is

$$B_1 = \frac{2\,k\,I_1}{r} \qquad (12)$$

Where, $\boldsymbol{B_1}$ is magnetic fields in Tesla, k= $2x10^{-7}$ Newton per square ampere [61], from Eq. (12), the electric current $I_1$ is

$$I_1 = \frac{B_1 r}{2\,k} \qquad (13)$$

The CMF or $\boldsymbol{B_2}$ produced around conductor carrying electric current $\boldsymbol{I_2}$ in Fig. 5-B, is

$$B_2 = \frac{2\,k\,I_2}{r} \qquad (14)$$

From Eq. (14), the electric current $I_2$ is

$$I_2 = \frac{B_2 r}{2\,k} \qquad (15)$$

Therefore, substituting $I_1$ and $I_2$ in Eq. (11) with $I_1$ and $I_2$ given by Eq. (13) and Eq. (15) respectively, the force is given by

$$F = \left(\frac{B_1 r}{2\,k}\right)\left(\frac{B_2 r}{2\,k}\right)\ \frac{2\,k\,l_1}{r} \qquad (16)$$

Rearrangement Eq. (16) the force is

$$F_m = \frac{B_1 B_2 r\,l_1}{2\,k} \qquad (17)$$

Where, $\boldsymbol{B_1}$ and $\boldsymbol{B_2}$ are magnetic fields produced by currents $I_1$ and $I_2$ on conductors $C_1$ and $C_2$ in Tesla, k= $2x10^{-7}$ Newton per square ampere [61]. Changing the constant 2k to a positive number, therefore Eq. (17) becomes

$$F_m = B_1 B_2 r\,l\,k^{-1} \qquad (18)$$

Where, $k^{-1}$ = $5.0x10^6$, N/ $T^2$. $m^2$, and the electromagnetic force $\boldsymbol{F_m}$ in Newton [19]. Eq. (17) shows, Faraday was correct believing that the attraction and repulsion between two current-carrying wires, can be explained in terms of simpler configurations not the direct interaction between current-carrying conductors [15], therefore Eq. (18) satisfied Faraday's prediction.

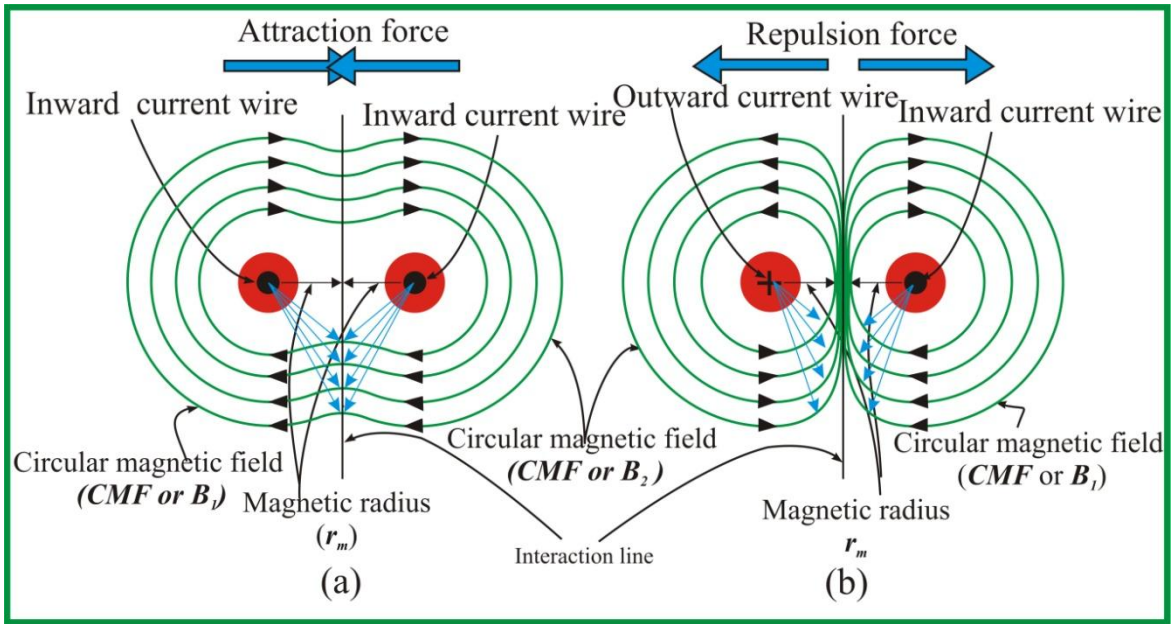


**Fig.6.** Two conductors [19] in (a) as in Fig.1-a, carrying currents with similar direction, each produced Circular Magnetic Field (CMF), with similar directions, shorten each other, producing attractive force, while current in (b) due to two opposite currents, similar to Fig.1-B, each produced CMF opposite to the other, they repel each other, and producing repulsive force, given by Eq. (18).

## V. The Field's Formula for the Magnetic Poles

The magnetic dipole consists of two equal and opposite magnets, M+ and M-, force between magnetic poles is given by Eq. (3), and since the expression of the law of force between given quantities of 'Magnetism' has exactly the same mathematical form as the law of force between quantities of 'Electricity' of equal numerical value, much of the mathematical treatment of magnetism must be similar to that of electricity [13], and since, Eq. (3) is similar to Eq. (2), therefore the magnetic field generated by a magnetic pole is analogous to the electrostatic field produced by charge at rest, hence Eq. (10) is similar to Eq. (18), thus in vector notation and in the International System of Units, the magnetic field $\overrightarrow{B_1}\,(\vec{r})$ at a certain point $\vec{r}$ of an inertial coordinate system, generated by a magnetic pole $M_1$ located at the origin of this coordinate system is given by [15]

$$B_1 = \frac{\mu_0}{4\pi}\frac{M_1}{r^2} \qquad (19)$$

From Eq. (19), the strength of the first pole $M_1$ is

$$M_1 = \frac{4\pi r^2 B_1}{\mu_0} \qquad (20)$$

While, magnetic field $\boldsymbol{B_2}$, due to magnetic pole $M_2$ located at the radial distance *r* is

$$B_2 = \frac{\mu_0}{4\pi}\frac{M_2}{r^2} \qquad (21)$$

From Eq. (21), the second pole $M_2$ is

$$M_2 = \frac{4\pi r^2 B_2}{\mu_0} \qquad (22)$$

Substituting both $M_1$ and $M_2$ given by Eq. (20) and Eq. (22) respectively by $M_1$ and $M_2$ in Eq. (3), the following is derived

$$F_P = \left(\frac{4\pi r^2\ B_1}{\mu_0}\right)\left(\frac{4\pi r^2 B_2}{\mu_0}\right)\frac{1}{r^2} \qquad (23)$$

Since the greatest manifestation of force occurs when the end of one magnet is held near the end of another one [13], therefore different magnitudes of force are obtained before reaching that greatest manifestation, all of these formed by the magnetic force due to the magnetic fields by two magnet, therefore solving Eq. (23), the force is given by

$$F_P = B_1 B_2\ r^2 2k \qquad (24)$$

Where, k=$\frac{4\pi}{\mu_0}$=1.000029493423457978183238383982x10$^7$ N/T$^2$ . m$^2$.

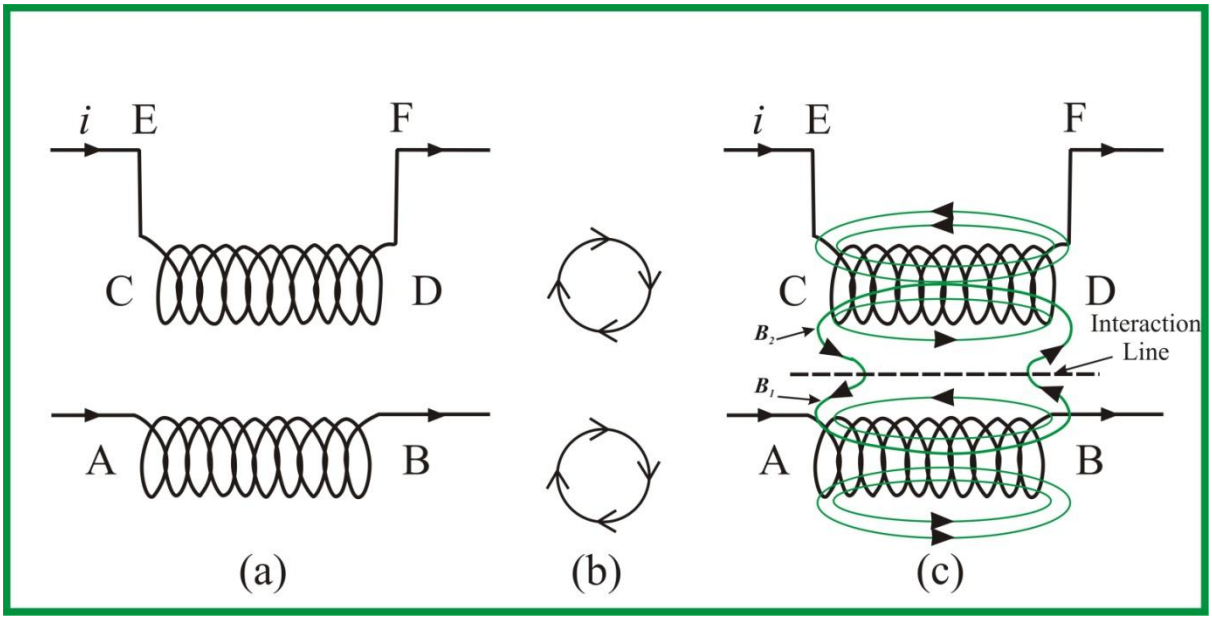


**Fig.7.** (a) Shows Ampere's experiment to reproduced the attraction and repulsion force between two spiral wires, he interpreted it as due to the rotation of the two currents in (b) [15]; but as shown in (c), a similar direction of currents, produced magnetic lines of force of opposite direction in both wires, they shortened each other producing attractive force.

## VI. The Field's Formula for the Catapult Force (the Motor Effect)

The Catapult force or the motor effect [61], or torque produced by current carrying wire [15], the formula of which is given by

$$F_{e.m.} = B_1\ I_2\ l \qquad (25)$$

Where, $\boldsymbol{B_1}$ is the magnetic field, $\boldsymbol{I_2}$ is the current in the conductor, $\boldsymbol{l}$ is the length of the conductor cutting the field in metre and the magnetic force $\boldsymbol{F_{e.m.}}$ is given by electric-magnetic parameters is in Newton. Thus the magnetic field $B_2$ produced around the conductor carrying electric current $\boldsymbol{I_2}$ in Eq. (25), is given by [61]

$$B_2 = \frac{2\ k\ I_2}{r} \qquad (26)$$

Where, $\boldsymbol{B_2}$ is CMF in Tesla, k= 2x10$^{-7}$ Newton per square ampere, from Eq. (26), $I_2$ is given by

$$I_2 = \frac{B_2 r}{2\ k} \qquad (27)$$

Replace $I_2$ in Eq. (25) with $I_2$ given by Eq. (27), the force is given by

$$F = B_1\left(\frac{B_2\ r_m}{2\ k}\right) l \qquad (28)$$

Where, $\boldsymbol{B_1}$ is a general magnetic field, $\boldsymbol{B_2}$ is the ***CMF*** produced by the current $I_2$, $r_m$ is the magnetic radius of the ***CMF***, $\boldsymbol{l}$ is the length of the conductor producing the ***CMF*** ($\boldsymbol{B_2}$) that interacted with $\boldsymbol{B_1}$, the magnetic force $\boldsymbol{F}$ is in Newton [19]. It's clear, Eq. (25) doesn't expressed the dynamical characteristics of the

rotational effect, therefore, the repulsive and attractive nature and mechanism of magnetic lines of force causing Catapult force, is express magnetically by [19]

$$F_{cm} = 2\,B_1\,B_2\,r_m\,l\,k^{-1} \qquad (29)$$

Where, $k^{-1}$ = 5.0x10$^6$, N/ T2 . m, and the electromagnetic Catapult force $F_{cm}$ is in Newton [19].

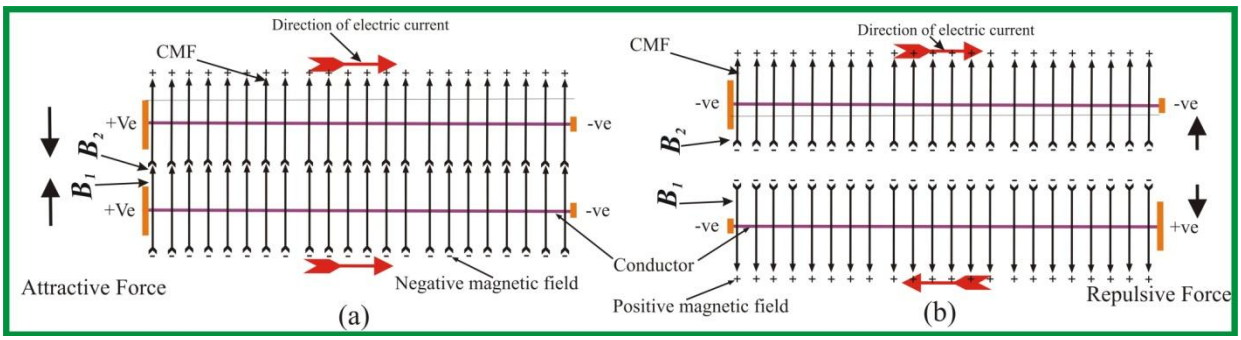


**Fig.8.** Interaction of two Circular Magnetic Fields (CMF) produced by two conductors carrying electric current with similar direction in (a), produced an attractive force; while in (b) the currents of the conductors are opposite in direction, they produced CMF of opposite direction, repelling each other and producing repulsive force, both are given by Eq. (18).

## VII. The Electromagnetic Interaction (The Field's Formula for the Lorentz Force)

The Lorentz force ascribed to the existence of electrostatic field, used in explaining the characteristics of the magnetic force [64], while the magnetic force as associated with moving source charges is related to interaction of current bearing wire [65], the force is given by

$$F_L = q(E + v\,B_1\,\sin\theta) \qquad (30)$$

Where, $F_L$ is Lorentz force. A moving charged particle while moving in free space, produced what is designated as the Circular Magnetic Field (CMF) [19], which was derived using Maxwell's and Einstein's theories [66], the magnitude of the ***CMF*** for both electrons and protons $\boldsymbol{B_e}$ and $\boldsymbol{B_p}$ respectively (or $B_2$) [67, 68, 69], is given by

$$B_2 = \frac{q\,v}{r_m^2\,c} \qquad (31)$$

Where, $\boldsymbol{B_2}$ (or $\boldsymbol{B_{e/p}}$) is the magnitude of CMF in Tesla, *v* is charged particle (electron or proton) velocity in $m.s^{-1}$, c is the speed of light in m.s$^{-1}$, $r_m$ is the magnetic radius in *m*eter. The intensity of such ***CMF***, created by nucli in High-energy Ion Colliders (HICs) moving close to the speed of light are much stronger than any fields, including the critical magnetic field for electrons $B_c = \frac{m_e^2}{e} = 4 \times 10^9$ Tesla, and the ~10$^{11}$ Tesla at neutron stars, this field reached ~10$^{13}$ Tesla, at the *Relativistic Heavy Ion Collider* (RHIC) in Brookhaven National Laboratory (BNL) and ~10$^{14}$ Tesla at *Large Hadrons Collider* (LHC) in CERN-HIC [70]; from Eq. (31), the product of the charge and velocity, is given by

$$q\,v = B_2\,r_m^2\,c \qquad (32)$$

Replacing qv in Eq. (30) by the right hand side of Eq. (32), therefore, the magnetic force obtained due to interaction of ***CMF*** by charged particle's CMF, is given by [19]

$$F_L = (qE) + (B_1\,B_2\,r_m^2\,c\,\sin\theta) \qquad (33)$$

Where, $B_2$ is electron's or proton's CMF given by Eq. (31) $\boldsymbol{\theta}$ is the angle between the two fields, and the magnetic force $\boldsymbol{F_m}$ is in Newton. The similarity between forces in the line of electrodynamics force (by electric current) and the line of magnetic force or the CMF, was described by Faraday as "*an axis of power having contrary forces exactly equal in amount in contrary direction*" [25], taking this as a background, the mechanism by which charged particles interacted with Magnetic field ($B_1$) has been suggested [19]; in which the interaction of charged particles' *CMF* ($\boldsymbol{B_2}$) with the general magnetic field ($\boldsymbol{B_1}$) shown in Fig.9, for electron and proton, produced magnetic force and caused both the electron and the proton to gyrate oppositely; therefore, Eq. (33) truly expressed the dynamical charged mechanism shown in Fig.9, while in the "*Magnetic Interaction (MI)*" the force is given as [19]

$$F_m = B_1 B_2\,r_m^2\,c\,\sin\theta \qquad (34)$$

In the "*Magnetic Interaction (MI)*" [19], Eq. (34) was showed to be equivelant to Lorentez force given by Eq. (30) [19], and as given by the above three steeps, hence Eq. (34) shows the true interaction between two magnetic fields, and both formulas are given by

$$F_m = B_1 B_2\,r_m^2\,c = F_L = B_1 q\,v \qquad (35)$$

Where, $\boldsymbol{B_1}$ is the strong magnetic field around which electron/proton gyrate, as shown in Fig.9 or nucleus Spinning Magnetic Field (SMF) in Tesla [19].

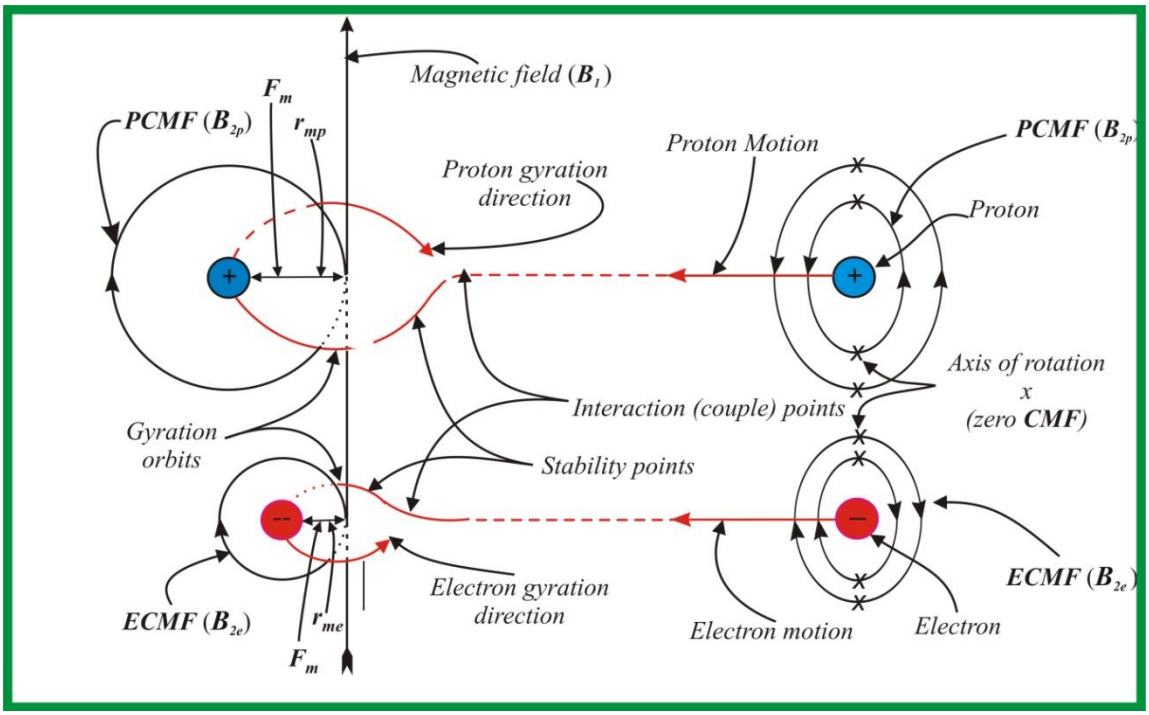


**Fig.9.** The interaction and capturing of both Electron's Circular Magnetic Field (ECMF-$B_{2e}$) and Proton's Circular Magnetic Field (PCMF-$B_{2p}$), by Magnetic Field ($B_1$), energies of the particles are equal [19], this resulted in Magnetic Force (Fm), it caused electron and proton to gyrate oppositely at Magnetic Radius ($r_m$).

## VIII. Results and Discussion

- The inverse square law of gravity derived by Newton in 1665 was the bases upon which similar laws for forces between electrified bodies and magnetic poles were derived by Augustin Coulomb in 1785 [15].
- Newton's and Coulomb's laws are directed along the straight line connecting the two bodies; they follow the law of action and reaction and vary as the inverse square of the distance between the bodies [15].
- The discovery by Hans Christian Ørsted on July 21, 1820, that a wire connecting the ends of a voltaic battery affected a magnet in its vicinity [13], led Ampere to derive a formula for two conductors carrying electric current [15], the formula was a good mathematical structure, but it was bad in its mechanism, and denounced by most of his contemporary scientists.
- Newton's gravitational law is similar to the Ampere law, it has good formula with vague mechanism, the formula was discovered to change its status through an internal mechanism by the gravitational constant G [42], thus the inverse square law is not the perceived perfect mathematical formula.
- The claim that gravitational wave was detected and required to be boosted with quantum tricks [71], showed how far misinterpretation lacking logic can go, they first need to solve the paradox in gravitational formula [42] before interpreting any wave.
- Ampere was guided by direct *action at a distance* while investigating the action of one electric circuit upon another, by determining action on the first due to the magnetic field produced by the second [13]
- The debate on the nature of Ampere force and the *action at a distance* led to the consolidation of the concept of action at distance [15].
- Ampere's work was criticized by his main contemporary scientists working on the subject, namely, Ørsted, Biot, Savart and Faraday, and later by researchers, like Grassmann [15].
- Both *action at a distance* and Ampere's works signaled the start of transformation in the concept of truth in physical world, where real mechanism was exchanged by a mathematical concept of the truth.
- The second main diversion that formed the current physical science, when an attempt to resolve the photoelectric effect in 1905, led Einstein to introduce quanta (photon) as massless particle to knock electrons from atom [32], it was opposed by most prominent scientists like Planck, Lorenz and Millikan [72], till photon was endorsed by Compton experiment in 1923 [73].

- The photon led to the emergence of Quantum Mechanics (QM) in early twenty century [33], and started the domination of mathematical based interpretation (theory) over the physical based interpretation (theory), started with the *inverse square laws*, Ampere complicated works and *action at a distance* assumption in which there is a disconnection between the mathematical formula and mechanism of the phenomenon.
- Forces in nature exhibited itself in four different groups, classified according to their strength into four forces, these are the gravity, the weak, the electromagnetic and the strong respectively [74].
- The unification of electricity, magnetism and light by Maxwell as constituting electromagnetic radiation [1], doesn't mean the unification of electric and magnetic forces.
- Since there is no link between two masses in gravitational force, the same for charges in electrostatic force, the magnet poles in magnetic force and two conductors carrying currents in Ampere force, therefore the *action at a distance* was thought to be carried by carrier, and particles are thought to communicate with one another through force carrier, these are particles that acted like messages exchanged between other particles [75], a suggestion led to the integration of radiation with force, found not to be true.
- Based on force carrier, the photon was thought to mediate the electromagnetic interaction, the massive gauge bosons called the W and Z bosons mediate weak force and gluons mediate the interaction of color charges in the strong interaction [43].
- But since the Radiation Magnetic Force ($F_{mR}$), given by Eq. (24) in "The Photoelectric Effects: Radiation Based With Atomic Model" [36], showed the force embedded electromagnetic radiation, while Compton's formula claimed the existence of photon with momentum in electromagnetic radiation was faulty [37], and Compton effect was explained [39], as well as the double slit experiment [40], and the Electron Diffraction [41]; therefore nothing remains that can defend the photon or quantum mechanics, except the claim that, photon was detected [76], which is a clear misinterpretation of experiments.
- The quest by Ørsted, Biot, Savart, Faraday, and Grassmann to get the logical mechanism explaining the magnetic force [15], finally achieved, when Eq. (A) was formulated in 1999, for magnetic interaction, now found relevant for electrostatic field interaction in addition to magnetic fields interaction by shortened or repelling each others as showed by Faraday [25].
- The formula for fields interaction given by Eq. (A) is used to solve the Force between Two Conductors carrying electric current; and the interaction of Electric Fields, force due to the magnetic poles, the Catapult Force or the Motor Effect, the Electromagnetic Interaction or Lorentz force.
- Although the unification of electromagnetic force and the nuclear force was suggested [77], a modified version of the Spinning Magnetic Force (SMFc) or the Nuclear Force ($F_N$) of magnetic origin [78], will be out soon.
- The electromagnetic force and weak force are unified as the Weak Spinning Magnetic Force ($F_W$) or the Weak Interaction of magnetic origin [79], with modified version [78].
- Finally, a suggestion for inter-earth gravity was given in "The Hydrostatic Force ($F_H$) of Gravity (The Atmospheric Force of Gravity)" [80] and planets rotational gravity will be coming in "The Interaction Between Both the Earth' and Solar' Magnetic Fields" [81].
- Therefore the four forces of nature are unified as Electric and Magnetic Force in origin; using Eq. (A), each is taken a similar form and shape.
- The constant of electrostatic force is $k_e = 9.0x10^9$ ,$1.11111111111111111111111111111111x10^{-10}$ $N/V^2.m^{-2}.m^2$, and for magnetic force of Ampere is $k^{-1} = 5.0x10^6$, $N/T^2.m^2$, for magnetic pole $k = 1.000029493423457978183238383982x10^7$ $N/T^2 . m^2$., for Catapult force $k^{-1} = 5.0x10^6$ , N/ T2 . m, and for Lorentz force $k=c= 3x10^8$ m/s.
- It's very sad, with the current technological advancement; scientists couldn't know the real cause of Hurricanes, Earthquakes and Tsunami, and how to minimize their destructive force; above all they don't want others to figure it out!

## IX. Conclusion

We analyzed the history of the *inverse square laws* started with Newton's gravitational law, then Coulomb's forces between electrified bodies and the magnetic poles, the acceptance of these forces were boosted when Ørsted discovered the influence of electric current on magnetic field, investigated experimentally by Ampere and led to the establishment of the laws of the mechanical action between electric currents; the lack of sensible mechanical explanation led to critics by his main contemporary scientists and later by many, namely, Ørsted, Biot, Savart, Faraday, Grassmann and other researchers, the long known attraction or repulsion characteristic exhibited by electrostatic and magnetic lines of force, led us to suggested the field's formula, it attained the force between two electric charges, two conductors carrying electric current, force due to the magnetic poles, the catapult force (the motor effect), the electromagnetic interaction or Lorentz force; although

the formula was used to explained the nuclear (Strong) force and Weak force, but a modified version of both forces will be out soon with the Gravitation force between planets; these forces of nature are unified as an electric and magnetic force, the knowledge of which will help in the understanding of the physical world.

**Acknowledgment**

"*Thanks to the Almighty God, without whom this works will never see the light*"

## References

[1]. S Sahoo and M Goswami, UNIFICATION AFTER 150 YEARS, arXiv:1210.0154 [physics.gen-ph], 2012.
[2]. S Hawking, A Brief History of Time, Bantam Press, 1988.
[3]. T S Kuhn, The Structure of Scientific Revolutions, INTERNATIONAL ENCYCLOPEDIA of UNIFIED SCIENCE, VOLUMES I AND II, FOUNDATIONS OF THE UNITY OF SCIENCE, VO II, 1970.
[4]. C N Yang, Einstein's Impact on Theoretical Physics in the 21st Century, Lecture delivered on March 14, 2004 at the University of Ulm, AAAPPS Bulletin, 2004.
[5]. S K Kenneth Introductory Nuclear Physics, Wiley & Sons, ISBN 0-471-80553X, 1988.
[6]. Wikipedia.org, Gravity, the free encyclopedia, 2018. https://en.wikipedia.org/wiki/Gravity
[7]. Wikipedia.org, Weak interaction, the free encyclopedia, 2018. https://en.wikipedia.org/wiki/Weak_interaction
[8]. Wikipedia.org, Electromagnetism, the free encyclopedia, 2018. https://en.wikipedia.org/wiki/Electromagnetism
[9]. Wikipedia.org, Nuclear force, the free encyclopedia, 2018. https://en.wikipedia.org/wiki/Nuclear_force
[10]. S Weinberg, A Unified Physics by 2050? Scientific American, pp. 68 – 75, 1999.
[11]. Wikipedia.org, Fundamental interaction, the free encyclopedia, 2018. https://en.wikipedia.org/wiki/Fundamental_interaction
[12]. Q C Charles, Did Gravity Save the Universe from 'God Particle' Higgs Boson?, Space.com, 2015. https://amp.space.com/28181-gravity-higgs-boson-universe-destruction.html
[13]. J C M, A Treatise On Electricity And Magnetism, UNABRIDGED THIRD EDITION, VOLUME TWO, DOVER PUBLICATIONS, INC. NEW YORK 1953, CLARENDON PRESS, 1891.
[14]. E Nightingale, Magnetism and Electricity, G. Bell and Sons Ltd. London, 1958.
[15]. A K T Assis, J P M C Chaib; A M Ampère, Ampère's electrodynamics: analysis of the meaning and evolution of Ampère's force between current elements, together with a complete translation of his masterpiece: Theory of electrodynamics phenomena, uniquely deduced from experience *(PDF). Montreal: Apeiron.* ISBNs: 978-1-987980-04-2, *2015.*
[16]. Wikipedia.org, Hans Christian Orsted, the free encyclopedia, 2018. https://en.wikipedia.org/wiki/Hans_Christian_%C3%98rsted
[17]. Wikipedia.org, Ampère's force law, the free encyclopedia, 2018. https://en.wikipedia.org/wiki/Amp%c3%a8re%27s_force_law#Equation
[18]. M FARADAY, Experimental Researches in Electricity, VOL. I., Second Edition Reprinted from the PHILOSOPHICAL TRANSACTIONS of 1831−1838, Release Date: February 9, 2005 [eBook #14986], London: Richard and John Edward Taylor, the University of London, 1849.
[19]. M E Yousif, The Magnetic Interaction, *Comprehensive Theory Articles, Journal of Theoretics*, vol. 5, 2003a.
[20]. J C Maxwell, On Physical Lines of Force, Philosophical Magazine and Journal of Science, Fourth Series, March 1961.
[21]. M Faraday, On lines of magnetic force ; their definite character; and their distribution within a magnet and through space, EXPEEIMENTAL RESEARCHES IN ELECTEICITY, Vol. III, London: Bernard Quaritch, Piccadilly, p447-452, 1855.
[22]. A K T Assis, J E A Ribeiro and A Vannucci, The field concepts of Faraday and Maxwell, in: Trends in Physics, São Paulo, 2009.
[23]. J C Maxwell, XXV. On Physical Lines of Force, Philosophical Magazine and Journal of Science, 1861.
[24]. G Miano, The concept of field in the history of electromagnetism, University of Naples Federico, II ET2011-XXVII Riunione Annuale dei Ricercatori di Elettrotecnica Bologna, 2011.
[25]. M Faraday, "On the physical character of the lines of magnetic force", Philosophical Magazine, 1852.
[26]. Wikipedia.org, Line of force, the free encyclopedia, 2018. https://wikipedia.org/wiki/line_of_force
[27]. L Campbell and W Garentt, The life of James Clerk Maxwell, With a Selection from his Correspondence and Occasional Writings and A sketch of his contributions to science, Macmillan and Co. London, (1882), Sonnet Software, Inc., 1997.
[28]. M E Yousif, The Electromagnetic Radiation Mechanism, *International Journal of Fundamental Physical Sciences* (*IJFPS*), vol. 4, 2014a.
[29]. G P Thomson, Proc. Roy. Soc. 117, 600., 1928.
[30]. M E Yousif, Electromagnetic Radiation Energy and Planck' Constant, International *Journal of Innovative Research in Advanced Engineering* (*IJIRAE*), vol. 1, 2014b.
[31]. M Planck, Ann. Phys., 4, 553, 1901.
[32]. A Einstein, Concerning an Heuristic Point of View toward the Emission and Transformation of Light, Ann. Phys. 17, 132, 1905.
[33]. R H Stuewer, Einstein's Revolutionary Light-Quantum Hypothesis, Christian Joas, Christoph Lehner, and Jürgen Renn (eds.), Conference on the History of Quantum Physics, Max Planck Institute for the History of Science, 2008.
[34]. Wikipedia.org, History of physics the free encyclopedia, 2018. http://en.wikipedia.org/wiki/History_of_physics
[35]. Wikipedia.org, Ultraviolet Catastrophe, the free encyclopedia, 2018. (2018). http://en.wikipedia.org/wiki/Ultraviolet_catastrophe
[36]. M E Yousif The Photoelectric Effects-Radiation Based With Atomic Model, International Journal of Fundamental Physical Sciences (IJFPS), vol. 5, 2015.
[37]. M E Yousif, Compton was Greatly Mistaken Using the Quantum, OSR Journal of Applied Physics (IOSR-JAP) e-ISSN: 2278-4861.Volume 10, Issue 1 Ver. I (Jan.-Feb. 2018), PP 30-40.
[38]. M F Shih, Developing Ideas about Photons: since the First Paper about Photoelectric Effect by Einstein in 1905, AAAPPS Bulletin-Vol.15-1, ISSN: 0218-2203, 2005.
[39]. M E Yousif, The Compton Effect Re-Visited, *J Adv Appl Phys*, 1:004, 2016.
[40]. M E Yousif, The Double Slit Experiment Re-Explained, IOSR Journal of Applied Physics (IOSR-JAP), vol. 8, no. 4, pp. 86– 98 doi:10.9790/4861-0804038698, 2016.
[41]. M E Yousif, Electron Diffraction Re-Explained (The Intense Magnetic Field Interaction with Crystals), IOSR J. of Appl Phys (IOSR-JAP) e-ISSN: 2278-4861.Volume 8, Issue 5 Ver. II, PP 99-116, DOI: 10.9790/4861-08050299116, 2016.
[42]. M E Yousif, "Newton"s Gravitation Law is Wrong!" IOSR J. of Appl Phys (IOSR-JAP), e-ISSN: 2278-4861.Volume 10, Issue 4 Ver. I, 34-38, DOI: 10.9790/4861 - 100401 3438, 2018.
[43]. Wikipedia.org, Fundamental interaction, the free encyclopedia, 2018. https://en.wikipedia.org/wiki/Fundamental_interaction

[44]. D Bohm, Quantum theory versus Copenhagen Interpretation.mov, 2009. http://www.youtube.com/watch?v=9gFCj5PPEyw
[45]. J Navarro, Planck and de Broglie in the Thomson Family, Christian Joas, Christoph Lehner, and Jürgen Renn (eds.), Conference on the History of Quantum Physics, Max Planck Institute for the History of Science, 2008.
[46]. P Byrne, Noble Laureate Says Physics is in Need of Revolution, WIRED, From Simons Science News, 2013
[47]. J C Maxwell, A Treatise On Electricity And Magnetism, UNABRIDGED THIRD EDITION, VOLUME ONE, DOVER PUBLICATIONS, INC. NEW YORK 1953, CLARENDON PRESS, 1891.
[48]. J Newman, Physics of the life sciences: Springer, 2008.
[49]. MIT, Chapter 2 Coulomb's Law, http://web.mit.edu/viz/EM/visualizations/coursenotes/modules/guide02.pdf
[50]. HyperPhysics, Magnetic Force Between Wires, Electricity and Magnetism, 2018. http://hyperphysics.phy-astr.gsu.edu/hbase/magnetic/wirfor.html
[51]. W D Niven, Edt., THE SCIENTIFIC PAPERS OF JAMES CLERK MAXWELL, Two Volumes Bound as One, Dover Publication, INC., New York
[52]. W G Brown, On Faraday-Tube Theory of Electro-Magnetism, C. G. Knott, Proceeding of the Royal Society of Edinburgh, 1922.
[53]. Wikipedia.org, the free encyclopedia, 2018. https://en.wikipedia.org/wiki/Action_at_a_distance
[54]. M Faraday, Experimental Researches in Electricity. Nineteenth Series, Phil. Trans. R. Soc. Lond. 1846 136, 1-20 doi: 10.1098/rstl.1846.0001
[55]. Wikipedia.org, https://en.wikipedia.org/wiki/Quantum_entanglement, the free encyclopedia, 2018.
[56]. Wikipedia.org, Gauge Boson, the free encyclopedia, 2018. https://en.wikipedia.org/wiki/Gauge_boson
[57]. V Veena, Electric Field, LinkedIn Learning, Sep 12, 2014
[58]. Wikipedia.org, the free encyclopedia, 2018. https://en.m.wikipedia.org/wiki/Coulomb%27s_law
[59]. https://physics.stackexchange.com/questions/200890/in-the-case-of-two-equally-charged-particles-is-the-electric-field-between-them
[60]. A, Wolski, Theory of Electromagnetic Fields, arXiv:1111.4354v1 [physics.acc-ph], 2011.
[61]. F ETrinklein, Modern Physics, Holt, Rinehart and Winston Inc., New York, 1990.
[62]. Wikipedia.org, the free encyclopedia, 2018. https://en.wikipedia.org/wiki/Amp%C3%A8re%27s_force_law
[63]. D S Parasnis, Magnetism From Load Stone To Polar Wendering, Hutchinson & Co. Ltd. London, 1961.
[64]. R Plonsey, and R E Collin 1961 Principle Applications of Electromagnetic Fields, Tata McGraw-Hill Publ. Cop. Ltd. New Delhi.
[65]. A P French, 1968 Special relativity, Nelson, Sunbury, UK.
[66]. S T Butler, and H. MESSEL, The Universe of Time and Space, Pargman Press, London, pp 185-191, 1963.
[67]. M Alonso, and E J Finn, Fundamental University Physics Vol. II Field and Waves, Addison and Wesley, Massachusetts, 1967.
[68]. J R Ballif, Conceptual Physics, John Wiley & Sons, New York, 1969.
[69]. W R Fuch, Modern Physics, Weidenfield and Nicolson (Educational) Ltd., and The Macmillan for Translation, Zurich, 1967.
[70]. K Itakura, STRONG FIELD DYNAMICS IN HEAVY-ION COLLISIONS, (K. Itakura, in "Proceedings of International Conference on Physics in Intense Fields (PIF2010)," edited by K. Itakura, et al., 2010.
[71]. PHYS.ORG, Boosting gravitational wave detectors with quantum tricks, Niels Bohr Institute, 2018.
[72]. R A Millikan, A Direct Photoelectric Determination of Planck's "h" Physical Review, vol. 7, 1916.
[73]. A H Compton: "A Quantum Theory of the Scattering of X-Rays by Light Elements". *Physical Review* vol **21** No 5, p 484 (1923).
[74]. P C W Davis, The Forces of Nature, Cambridge University Press, Cambridge, 1979.
[75]. K Izlar, Force Carrier, Symmetry Magazine, an Online Magazine about Particle Physics, A joint Fermilab/SLAC Publication, 2013.
[76]. PHYS.ORG, The first ever photograph of light as both a particle and wave, 2015
[77]. M EYousif, THE SPINNING MAGNETIC FORCE, Comprehensive Theory Articles, Journal of Theoretics, vol. 5, 2003b.
[78]. M E Yousif, The Grand Unification of Natural Forces-2, the Nuclear Force ($F_N$) and Weak Force ($F_W$) of magnetic origin, Unpublished.
[79]. M E Yousif, The Weak Spinning Magnetic Force ($F_W$) (The Weak Interaction), IOSR J. of Appl Phys (IOSR-JAP) e-ISSN: 2278-4861.Volume 8, Issue 6 Ver. III, 77-88, DOI: 10.9790/4861-0806037788, 2016.
[80]. M E Yousif, "The Hydrostatic Force ($F_H$) of Gravity (The Atmospheric Force of Gravity)" IOSR J. of Appl Phys (IOSR-JAP), e-ISSN: 2278-4861.Volume 10, Issue 4 Ver. II, 45-53, DOI: 10.9790/4861-1004024552, 2018.
[81]. M E Yousif, "The Interaction Between Both the Earth' and Solar' Magnetic Fields", Unpublished.


IOSR Journal of Applied Physics (IOSR-JAP) is UGC approved Journal with Sl. No. 5010, Journal no. 49054.

Mahmoud E. Yousif. "The Unified Force of Nature: 1-The Electric & Magnetic Forces" IOSR Journal of Applied Physics (IOSR-JAP), vol. 10, no. 5, 2018, pp. 57-73.