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Concerning an Heuristic Point of View Toward a New System of Electromagnetic Equations Inspired by Logical Experiments

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Abstract: With logical experiments and the physical experiment results in published papers, this study carried out a re-examination of the fundamental laws and fundamental theories of electromagnetism, and it is discovered that: Oersted's law of electromagnetism does not hold true; Ampère's circuital law does not hold true; Ampère-Maxwell's law that covers displacement currents does not hold true; Faraday's conclusion that an open coil with the change of magnetic flux in it produces an electromotive force does not hold true; The component of the closed loop generating an electric current due to the change of internal magnetic flux does not generate an electromotive force; A changing magnetic field (/a time-varying magnetic field) cannot form a changing electric field (/a time-varying electric field) or a vortex electric field in an empty space (vacuum). Inspired by these findings, two new systems of equations are proposed to replace Maxwell's equations to better explain the electromagnetic nature of the world. These equation systems include These equation system includes the electric field property equation, the magnetic field property equation, the electromagnetic force field property equation, the equation explaining how electric fields and electromotive force are induced by magnetic fields, the equation explaining how magnetic fields are induced by electric fields and electric currents, the equation explaining what are the interaction relations among electric fields, magnetic fields and the electromagnetic force fields, the equation explaining how electromagnetic force field is induced by electric current, and the equation explaining how electromagnetic force field is induced by magnetic fields.

Keywords: Logical experiments; Basic electrical engineering logic; Paradigm challenging; Re-examination on Oersted's law of electromagnetism; Re-examination on Faraday's conclusion of the electromotive force generation of an open coil; Re-examination on Ampère-Maxwell's law; Some fundamental laws and fundamental theories of electromagnetism being not true; A new system of equations explaining the nature and interaction relations of electric field, magnetic field and electromagnetic force field being proposed.

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1. Introduction

Maxwell's equations[1], which comprise four fundamental equations, are the cornerstone of classical physics and modern physics, such as electromagnetism, electrodynamics, quantum mechanics and the theory of relativity, and have made an immense contribution to human scientific and technological civilization. However, it seems to me that there are several logical flaws in Maxwell's equations. In the following I wish to present the line of thought and the facts which have led me to this point of view, hoping that this approach may be useful to some investigators in their research. Given that this paper challenges the fundamental laws and fundamental theories of electromagnetism, it is necessary to

elaborate on the relationship between the stability of physical laws and natural science theories and the civilization of science and technology. The physical laws and natural science theories must be actually stable and irresistible. However, the stability and the irresistibility here do not mean that the physical laws and natural science theories cannot be replaced or falsified, but that they must be consistent with the facts, that is, they must be consistent with physical experiment results, otherwise they will not be true and be falsified. A longtime tried and tested physical law or natural science theory can only show that it has been proven to be correct by many experiments and practices, but it does not mean that it cannot have counterexamples, or it cannot be falsified.

In fac, human scientific and technological civilization is not based on consistently stable physical laws or consistently stable natural science theories, but on the continuous evolution of physical laws and natural science theories. The falsified physical laws and theories and their founders are not losers, but the great founders and great contributors of the existing scientific and technological civilization, but the solid shoulders of the great giants for those who will create new physical laws or new theories.

The recurring cycle that the existing physical laws and natural science theories are falsified and the new physical laws and new natural science theories are formulated is a kind of natural law, the fundamental form of scientific development and technological progress, and is the foundation of the continuous development of human scientific and technological civilization.

This paper includes the following special sections:

Section 2: Critiques Ampère-Maxwell's law;

Section 3: Critiques Maxwell's equation of explaining how an electric field, an electromotive force and an electric current being generated by magnetic field.

Section 4: Explains the unique properties and indispensability of electromagnetic force field and introduces the electromagnetic force field equations up to the system of electromagnetic equations;

Section 5: Formulates the new system of electromagnetic equations including six equations.

2. Concerning the logical flaws in the Maxwell equation explaining how electric currents and electric fields produce magnetic fields

If magnetic field is not generated by a current-carrying closed loop as a whole, but generated by a current-carrying conductor as described in Oersted's law[2] of electromagnetism, then the Ammeter 5 shown in Figure 1 must detect a significant current. This is because that in the device shown in Figure 1, the rotation direction of the magnetic field in the transformer core and the rotation direction of the magnetic field generated by the current-carrying conductor segment corresponding to the measurement loop (assuming that a current-carrying conductor segment generates magnetic fields) are opposite, the magnetic field generated by the current-carrying conductor segment corresponding to the measurement loop cannot form closed magnetic loops through the transformer core, but can only pass through the measurement loop to form closed magnetic loops. Therefore, if the current-carrying conductor segment corresponding to the measurement loop generates a

magnetic field, the measurement loop must generate a significant induced current, and the Ammeter 5 must detect a significant current.

However, basic electrical engineering logic (the fact) tells us that as long as the transformer core shown in Figure 1 is large enough, it is impossible for the Ammeter 5 to detect an electric current. This shows that in the process of electromagnetic induction, the magnetic field is generated by a current-carrying closed loop as a whole, but not by the current-carrying conductor itself.

Not only that, if magnetic field is not generated by a current-carrying closed loop as a whole, but generated by a current-carrying conductor as described in Oersted's law of electromagnetism, then all transformers and all other devices that rely on winding cores cannot work, because in this case, the rotational topology of the magnetic field through the core is contrary to the rotational topology of the magnetic field generated by the winding conductor, so there must be no magnetic fields in the core. This is clearly contrary to the facts and absurd, therefore, there cannot possibly be any possibility for magnetic fields to be generated by a current-carrying conductor as described in Oersted's law of electromagnetism. That is, there cannot possibly be any possibility for Oersted's law of electromagnetism to hold true. Therefore, there cannot possibly be any possibility for Ampère's circuital law to hold true. Therefore, there cannot possibly be any possibility for Ampère-Maxwell's law that covers displacement currents to hold true.

Not only that, according to published papers[3], physical experiments have proved that the Oersted's law of electromagnetism is not true. That is, in the process of producing a magnetic field by a time-varying electric current (representing a time-varying electric field), the magnetic field is not generated by the current-carrying conductor itself, but by the current-carrying closed loop as a whole, and the smallest physical unit that is indispensable for generating a magnetic field is a closed loop of one turn as a whole, not the conductor itself of an open coil or conductor segment itself.

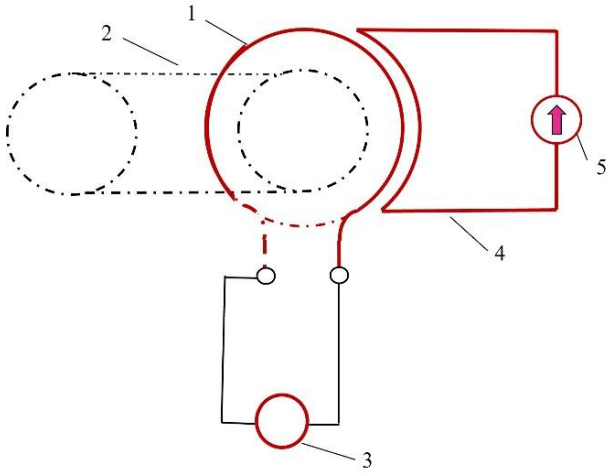

Figure 1. A schematic illustration of the device for the physical experiments to determine if magnetic fields are produced by a current-carrying closed loop as a whole or by current-carrying conductor segments.1. Multi-layer coils, 2. The transformer core with changing magnetic field inside, 3. AC power supply, 4. Measurement loop for changing magnetic field, 5. Ammeter.

What stated above shows that Ampère's circuital law is not true, and Ampère-Maxwell's law[4] that covers displacement currents is not true either. This further shows that the

following Maxwell's equation, explaining how magnetic fields are generated by an electric current and by an electric field, is not true.

This is, the integral form equation of Ampère-Maxwell's law described below:

$$\oint_L B \cdot dl = \mu_0 I + \mu_0 \varepsilon_0 \frac{d}{dt} \iint_S E \cdot ds$$

fails to capture the true electromagnetic nature of the world, so it does not hold true.

Therefore, the equation of its differential form described below is not true either.

That is, the differential form equation of Ampère-Maxwell's law described below:

$$\nabla \times H = J_f + \frac{\partial D}{\partial t}$$

fails to capture the true electromagnetic nature of the world, so it does not hold true.

In summary, the magnetic field is generated by a current-carrying closed loop as a whole, not by the current-carrying conductor itself, and the closed loop as a whole is the smallest physical unit that is indispensable for generating the magnetic field, and the electric current on the closed loop must change to generate the magnetic field. In other words, the conduction current on the closed loop must change, the displacement current on the closed loop must change (i.e., the electric field must change), and the convection current on the closed loop must change before the magnetic field can be generated. Therefore, the equation for generating a magnetic field from an electric current (representing an electric field with displacement current) should be the one shown in Figure 2, i.e., magnetic fields are generated by a current-carrying closed loop as a whole. Specifically, the time integral of the time rate of the change in total current of a closed loop is equal to the integral of the magnetic flux density inside the closed loop to the area of the closed loop divided by the inductance of the closed loop, that is, it is equal to the amount of change of magnetic flux in the closed loop divided by the inductance of the closed loop, furthermore, it is equal to the magnetic flux inductance density of the closed loop. The magnetic flux inductance density of the closed loop is the magnetic flux per unit inductance of the closed loop.

$$\frac{1}{L} \oiint_S B \cdot ds = -\int_c \frac{\partial}{\partial t} (I_c + I_d + I_v) dt$$

Or

$$\frac{1}{L} \oiint_S B \cdot ds = \int_c \frac{\partial}{\partial t} (I_c + I_d + I_v) dt$$

Figure 2. The equation explaining how electric currents generate magnetic fields. B is the magnetic flux density, S is the area of the closed loop, C means that all currents are in closed loops, L is the inductance of the closed loop, I_c is the conduction current, I_d is the displacement current, I_v is the convection current, t is the time.

The closed loop here can be a closed loop consisting solely of conductors, a closed loop consisting solely of non-conductors, a closed loop consisting of a mixture of conductors and non-conductors, or a closed loop including displacement current and convection current. In a word, the closed loop here is a closed loop consisting solely of matters or a closed loop composed of matter and empty spaces (vacuum), collectively named as the closed loop of matters. Because as long as there is matter, the charge will at least deflect under the action of an electromotive force (representative of the electric field), and then form a closed loop effect to convert the electromotive force (electric field) into electric current in the closed loop, which in turn into a magnetic field. The current here refers to the total current, that is, it includes conduction current, displacement current and convection current. Since Lenz's law is fundamental in nature, a negative sign is theoretically required in the left or right side of this equation, but in some cases, it can still be validly applied without it.

3. Concerning the logical flaws in the Maxwell equation explaining how a magnetic field produces an electric field

In 1831, through physical experiments as shown in Figure 3, Michael Faraday proposed Faraday's law of electromagnetic induction[5] which stating that a closed loop with a change in magnetic flux inside it produces an electric current. In 1832 in the physics experiment as shown in Figure 4, he connects the ends of a multi-layer coil with wires to the metal ball and housing (ground) of a gold-leaf electroscope. This appears to be the construction of an open coil, since this coil includes one end of the multi-layer coil, wires, gold-leaf electroscope metal balls, gold leaf, air gaps, gold-leaf electroscope housings, and the other end of the multi-layer coil. Then, as Michael Faraday quickly inserted or pulled out a bar magnet into or out of the multi-layer coil, he observed the gold leaf of the gold-leaf electroscope opening and closing. Therefore, Michael Faraday made a conclusion that an open coil with a change in magnetic flux inside it also generate an electromotive force. This is why the physics community has always believed that an open coil with a change in magnetic flux in the open coil also generates an electromotive force, and furthermore it has always been believed that when a closed loop with a change in magnetic flux inside it generates an electromotive force, each section of the closed loop generates some electromotive force, and the electromotive force of the whole closed loop is the integral of the electromotive force generated by each constituent parts of the closed loop.

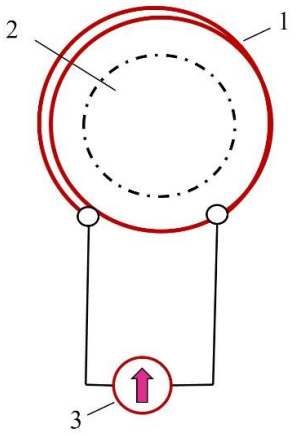

Figure 3. A schematic illustration of the device for the physical experiments by which Michael Faraday obtains the Faraday's law of electromagnetic induction, stating that the change of magnetic flux in a closed loop produces an electric current. 1. Multi-layer coils, 2. The zone of time-varying magnetic fields, 3. Ammeter.

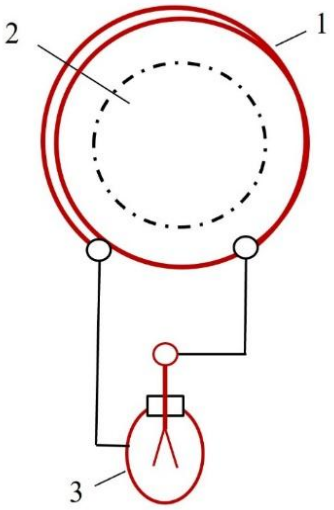

Figure 4. A schematic illustration of the device for the physical experiments by which Michael Faraday obtains the conclusion that a change in magnetic flux within an open coil also generate an electromotive force. 1. Multi-layer coils, 2. The zone of time-varying magnetic fields, 3. Gold-leaf electroscope.

However, I think that Michael Faraday's experiment of proving that an open coil with the change of magnetic flux inside it generating an electromotive force with a gold-leaf electroscope has a fatal logical error, and the conclusion that an open coil with the change of magnetic flux inside it produces an electromotive force is not true.

I believe that the circuit design for Michael Faraday's experiment on this issue, shown in Figure 4, contradicts the purpose of the experiment, since this circuit design results in an experimental scenario that made the experiment was still completed under the condition of changing magnetic flux inside a closed loop, it's just that this closed loop includes an air gap.

However, because the matter in the air of the air gap contains electric charges, although these electric charges are not free to move to form an electric current, but under the action of the changing magnetic field (/the time-varying magnetic field), these electric charges can still form a certain amount of deflection which makes the loop including the air gap equivalent to the closed loop as a whole.

In fact, the circuit Michael Faraday used in this experiment is a closed loop containing displacement currents, because the gold-leaf electroscope is also essentially a capacitor, and the conductors on either side of the air gap are equivalent to the two plates of the capacitor.

In fact, Michael Faraday should have used the circuit setup shown in Figure 5, which can avoid the effect of the electromotive force generated by the change of magnetic flux in the closed loop composed of an electroscope, and then fundamentally determine the major scientific question whether an open coil with a change in the magnetic flux inside it can generate an electromotive force or not. If the opening and closing of the gold-leaf of the gold-leaf electroscope is observed in the experiment shown in Figure 5, then it can be concluded without controversy that an open coil with the change of magnetic flux inside it generates an electromotive force.

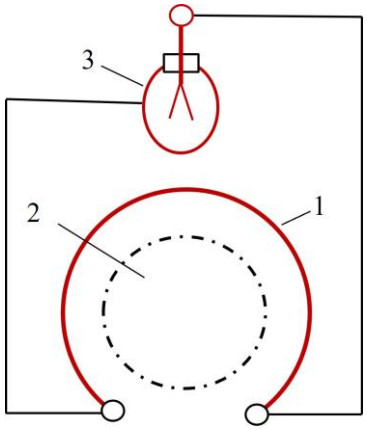

Figure 5. A schematic illustration of the device which should be used to test if an open coil with changes in magnetic flux within it generates an electromotive force or not. 1. An open coil of less than one turn, 2. The zone of time-varying magnetic fields, 3. Gold-leaf electroscope.

Now, with profound analyses shown below, the major scientific question of whether an open coil with the change of magnetic flux inside it can generate an electromotive force or not will be resolved. Why it is called a major scientific problem, because it reveals a totally different electromagnetic nature of the world, by whether an open coil with the change of magnetic flux inside it can generate an electromotive force or not.

In fact, the device used by Michael Faraday in his experiment to conclude that an open coil with changes in magnetic flux inside it produces an electromotive force (shown in Figure 4) is equivalent to the device shown in Figure 6.

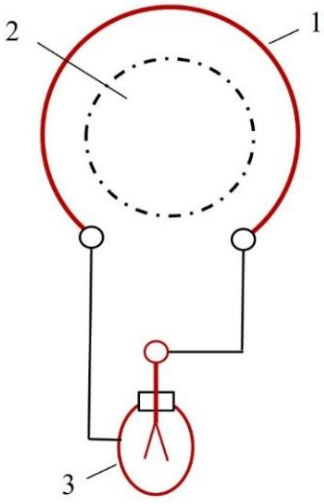

Figure 6. A schematic illustration of the device which is equivalent to the device for the physical experiments by which Michael Faraday obtains the conclusion that an open coil with changes in magnetic flux within it generates an electromotive force. 1. An open coil of less than one turn, 2. The zone of time-varying magnetic fields, 3. Gold-leaf electroscope.

Therefore, if the Faraday's conclusion that an open coil with a change in magnetic flux inside it produces an electromotive force holds true, then there must be voltage between these voltage measurement point pairs C_1 and C_2, $C_1$and C_3, C_1 and C_4, and D_1 and D_2, shown in Figure 7. However, there cannot possibly be voltage between these voltage

measurement point pairs C_1 and C_2, $C_1$and C_3, C_1 and C_4, and D_1 and D_2, shown in Figure 7. Because if there is voltage between these voltage measurement point pairs, then power can be delivered with a single wire. That is, a single wire can be used to transport electricity from the electric generator to a distance, and then according to the required voltage, two points of the corresponding distance are taken on this wire for voltage matching and power supply, so that even the transformer is replaced. This is obviously and absolutely ridiculous and absurd. Therefore, there cannot possibly be voltage between these voltage measurement point pairs.

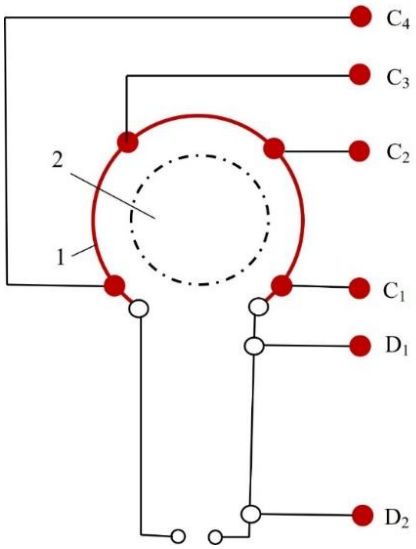

Figure 7. A schematic illustration of the device which is to test the validity of the Michael Faraday's conclusion that open coil with changes in magnetic flux within it generates an electromotive force. 1. An open coil of less than one turn, 2. The zone of time-varying magnetic fields, C_1, C_2, C_3, C_4, D_1, and D_2 are the voltage measure points.

Therefore, the conclusion that an open coil with a change in magnetic flux inside it generates an electromotive force does not hold true. The fatal logic error of Faraday's experiment on this issue is that the logic error of the circuit setting of his experiment leads to an illusion that the generation of electromotive forces is under the change of magnetic flux in an open coil, but in fact, it is under the change of magnetic flux in a closed loop as a whole.

In short, an open coil with a change in magnetic flux within it does not generate an electromotive force. Again, only a closed loop with the change of magnetic flux inside it can generate an electric field, an electromotive force, and an electric current. A time-varying magnetic field can only generate an electric field, an electromotive force, and an electric current through a closed loop. However, in an empty space (vacuum) where there is no closed loop, in an empty space where there is no matter, a time-varying magnetic field cannot possibly generate an electric field or a vortex electric field. Because once a time-varying magnetic field can generates a vortex electric field in an empty space, there must be voltage difference between any two points on a conductor segment which exists in the vortex electric field or at the edge of the vortex electric field, and there must be voltage difference between any two points on the less than one turn conductor segment of an open coil which exists in the vortex electric field or at the edge of the vortex electric field.

Not only that, there must be voltage difference between any two points on any matter

segment (which can be non-conductor) which exists in this vortex electric field or at the edge of the vortex electric field, and there must be voltage difference between any two points of any matter which exists in this vortex electric field or at the edge of the vortex electric field. Once a time-varying magnetic field can generate an electric field in an empty space (vacuum), the things are the same.

Then, there must be voltage between these voltage measurement point pairs C_1 and C_2, C_1 and C_3, C_1 and C_4, and D_1 and D_2, shown in Figure 7, but in fact, there cannot possibly be voltage between these voltage measurement point pairs, as stated above. This shows that a time-varying magnetic field cannot generate an electric field, cannot generate a vortex electric field, cannot generate an electromotive force, and cannot generate an electric current, if there is no matter involved, which forms closed loops. In fact, it is not true that a time-varying magnetic field generates a vortex electric field first, or a time-varying magnetic field generate a vortex electric field in an empty space (vacuum). Therefore, the Maxwell's equation that the negative value of the time rate of the change of magnetic flux density is equal to the curl of the electric field, which indicates that a time-varying magnetic field can induce a vortex electric field in a place where nothing exists, is not true.

That is, the Maxwell's equation described below:

$$\nabla \times E = -\frac{\partial B}{\partial t}$$

fails to capture the true electromagnetic nature of the world, so it does not hold true.

Although this equation can be obtained by applying Stokes' theorem to the equation below, however, the equation below does not hold true. Consequently, this equation does not hold true from the perspective of applying Stokes' theorem either. In the following, why the equation below doesn't hold true is discussed in detail.

$$\oint_L E \cdot dl = -\frac{d}{dt}\iint_S B \cdot ds$$

Whether the electromotive force (representing the electric field) generated by a closed loop with a change in magnetic flux inside it is generated by the closed loop as a whole, or is the accumulation of the electromotive force generated by the conductor segment of the closed loop is another major scientific question. In other words, whether the smallest indispensable physical unit that generates an electromotive force from a magnetic field is a closed loop as a whole, or is the conductor or material segment itself is another major scientific question. It is called a major scientific problem because it explains a totally different electromagnetic nature of the world, by this difference. If the electromotive force generated by a closed loop with a change in magnetic flux in it is not generated by the closed loop as a whole, but is generated by the conductor segment of the closed loop and is the accumulation of the electromotive force generated by the conductor segment of the closed loop, that is, if the smallest indispensable physical unit that generates an electromotive force by magnetic field is not the closed loop as a whole, but is the conductor segment of the closed loop, then, there must be voltage between these voltage measurement

point pairs A_1 and A_2, A_1 and A_3, A_1 and A_4, and B_1 and B_2, shown in Figure 8, with the exception for the resistive voltage drop, because it is not in this problem.

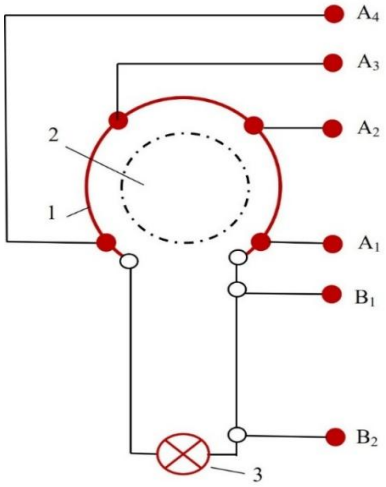

Figure 8. A schematic illustration of the device which is to test the validity of the conclusion which states that the electromotive force generated by a closed loop with a change in magnetic flux inside the closed loop is not generated by the closed loop as a whole, but is the accumulation of the electromotive force generated by the conductor segments that make up the closed loop. 1. An open coil of less than one turn, 2. The zone of time-varying magnetic fields, 3. The lamp, A_1, A_2, A_3, A_4, B_1, and B_2 are the voltage measure points.

However, there cannot possibly be any voltage between these voltage measurement point pairs A_1 and A_2, A_1 and A_3, A_1 and A_4, and B_1 and B_2, shown in Figure 8. Because if there is voltage between these voltage measurement point pairs, then there must be voltage between any two points on any AC transmission power lines, because any AC transmission power lines are part of a closed loop with a change in magnetic flux within it, with exception for the resistive voltage drop, since it is not in the question. However, this obviously and absolutely goes against the basic electrical engineering logic, contradicts the facts, and is absurd. Therefore, the electromotive force generated by a closed loop with the changing magnetic field in it must be generated by the closed loop as a whole, but not by the conductor segment and is not the accumulation of the electromotive force generated by the conductor segment of the closed loop. The conductor segment of a closed loop generating electric fields, electromotive forces and electric currents does not generate an electric field, does not generate an electromotive force, and of course does not generate an electric current. This proves that the smallest indispensable physical unit which generates an electromotive force by a magnetic field is the closed loop as a whole, not the conductor segment, which is a component of the closed loop.

This shows that the changing magnetic field (or say the time-varying magnetic field) can only generate electric fields, electromotive forces, and electric currents through a closed loop as a whole, but not a little portion of them is generated in each section of the closed loop and accumulates into the total of the closed loop as a whole. This further shows that in the process of generating electricity from the magnetic fields, the closed loop as a whole is the smallest indispensable physical unit that generates electric fields, generates electromotive forces, and generates electric currents. Anything smaller than the closed loop as a whole cannot generate an electric field, cannot generate an electromotive force, and cannot generate an electric current. This shows that the following Maxwell's equation explaining how the electric field generated by the magnetic field does not hold true.

That is, the Maxwell's equation described below:

$$\oint_L E \cdot dl = -\frac{d}{dt}\iint_S B \cdot ds$$

fails to capture the true electromagnetic nature of the world, so it does not hold true.

As mentioned above, the differential form of this equation listed below does not hold true either.

That is, the Maxwell's equation described below:

$$\nabla \times E = -\frac{\partial B}{\partial t}$$

fails to capture the true electromagnetic nature of the world, so it does not hold true.

Because only the change of magnetic flux in a closed loop can generate an electromotive force (representing an electric field), and this electromotive force is generated by the closed loop as a whole, but not generated by components of the closed loop. Therefore, the equation explaining the process of generating an electric field and an electromotive force from a magnetic field should be the equation shown in Figure 9. That is, the electromotive force generated by a single turn closed loop is directly proportional to the negative value of the time rate of the change in the magnetic flux inside the closed loop. As described above, the closed loop here can be a closed loop consisting solely of conductors, a closed loop consisting solely of non-conductors, a closed loop consisting of a mixture of conductors and non-conductors, or a closed loop including displacement current and convection current. In a word, the closed loop here is a closed loop consisting solely of matters or a closed loop composed of matter and empty spaces, collectively named as the closed loop of matters. Because as long as there is matter, the charge of the matter will at least deflect under the action of the changing magnetic field, and then form a closed loop effect to convert the magnetic field into an electric field and further convert it into an electromotive force.

$$\frac{U}{N} = -\frac{d}{dt}\oiint_S B \cdot ds$$

Figure 9. The equation representing the Faraday's law of electromagnetic induction which states that the change of magnetic flux in a closed loop produces an electric current. U is the electromotive force of the closed loop as a whole, N is the number of turns of the whole closed loop, B is magnetic flux density, S is the area of the closed loop, t is the time.

Essentially, so far, in order to discover the laws and theories to explain how can we generate an electric field and an electromotive force with magnetic fields, numerous experiments were conducted. However, the only logically correctly conducted experiment among all experiments done by human beings is the experiment by which it is concluded that the change of magnetic flux in a closed loop produces an electric current, that is, the experiment by which Faraday's law of electromagnetic induction is obtained. The only

correct mathematical equation is the following equation, that is, the electromotive force generated on a closed loop is proportional to the negative value of the time rate of change in magnetic flux inside the closed loop.

$$U_C = -\frac{d\Phi_B}{dt}$$

Humans have never logically correctly detected an electromotive force generated on the conductor segment of a closed loop producing an electromotive force under the action of a changing magnetic field, and have never logically correctly detected an electromotive force generated by an open coil with a change in magnetic flux within the open coil. The process of generating an electric field (representing an electromotive force) by magnetic field must meet two necessary conditions, both are indispensable: one is the existence of a closed loop, and the other is the change of magnetic flux in the closed loop. The changing magnetic field (/the time-varying magnetic field) must cause the magnetic flux in the closed loop to change in order to generate an electric field, otherwise, it cannot generate electric field or electromotive force. The changing magnetic field here is with respect to a closed loop and must cause a change in magnetic flux inside the closed loop, but is not with respect to an empty space (vacuum). In other words, even if the magnetic field changes with respect to an empty space, if the magnetic field does not change with respect to the closed loop and cannot cause the change of magnetic flux in the closed loop, it still cannot generate an electric field, a vortex electric field, an electromotive force, or an electric current at all. The changing magnetic field does not generate an electric field, an electromotive force, or a vortex electric field in an empty space. However, the changing magnetic field can cause matter to close a loop including empty spaces (vacuum) to create an electric field and an electromotive force. Since if a change in the magnetic field is with respect to the closed loop and causes a change in its internal magnetic flux, an electric field and an electromotive force will be generated. Therefore, if magnetic field does not change, but the closed loop changes and causes a change in magnetic flux inside the closed loop, an electric field and an electromotive force will also be generated. Therefore, there is no difference between motional electromotive force and induced (transformer) electromotive force in the world, the two are exactly the same thing. The conductor cutting through magnetic field lines itself does not generate electromotive force, so there is no motional electromotive force in the world. The electric field and the electromotive force generated by the change of magnetic flux in the closed loop are generated by the closed loop as a whole, not by its components, and its components do not generate an electric field or an electromotive force at all. The closed loop here is the material closed loop described above.

As shown in Figure 10, in order to discover the physical laws, theories and their mathematical equations about how an electric field and an electromotive force are generated with magnetic field, humans have extrapolated with a broken chain of reasoning for several times:

The step 1 of extrapolation with a broken chain of reasoning:

From the correct Faraday law of electromagnetic induction which states that the change of magnetic flux in the closed loop generates an electric current, according to Faraday's inherently unfounded conclusion that an open coil with the change of the magnetic flux inside it generates electromotive force, it is concluded that the electromotive force generated by a closed loop with the change of the magnetic flux inside it is the integration

(accumulation) of the electromotive force generated by the components of the closed loop. That is, an extrapolation with a broken chain of reasoning was conducted to conclude that the conductor segment of a closed loop generating electromotive force does also generate electromotive force. This means that between the voltage measurement point pairs A_1 and A_2, B_1 and B_2, shown in Figure 10, there must be voltage. In fact, as stated above, there is absolutely no voltage between these voltage measurement point pairs. Therefore, the conductor segment of a closed loop generating electromotive force cannot possibly generate electromotive force.

The step 2 of extrapolation with a broken chain of reasoning:

Since it is believed that the electromotive force generated by a closed loop with the change of magnetic flux inside the closed loop is the integral (accumulation) of the electromotive force generated by the components of this closed loop, then it is believed that the electromotive force generated by an open coil with the change of magnetic flux inside the open coil must also be the integral (accumulation) of the electromotive force generated by the components of the open coil. That is, an extrapolation with a broken chain of reasoning was conducted to believe that any conductor existing in a changing magnetic field or at the edge of the changing magnetic field generates electromotive force. If this is true, then there must be voltage between these voltage measurement point pairs C_1 and C_2, D_1 and D_2, shown in Figure 10. In fact, as described above, there is absolutely no voltage between these voltage measurement point pairs. Therefore, any conductor existing in the changing magnetic field or at the edge of the changing magnetic field cannot possibly generate electromotive force.

The step 3 of extrapolation with a broken chain of reasoning:

Since it is believed that the components of an open coil with the change of magnetic flux in the open coil generate electromotive force, and the conductor in the changing magnetic field or at the edge of the changing magnetic field generates an electromotive force, therefore, it is believed that the changing magnetic field must generate an electric field, that is, a vortex electric field in an empty space (vacuum). That is, an extrapolation with a broken chain of reasoning was conducted to believe that a changing magnetic field (/a time-varying magnetic field) generates a vortex electric field in an empty space (vacuum), no need for a closed loop or matter to be involved. This extrapolation omitted the necessary conditions for the generation of an electric field and an electromotive force from magnetic fields, stated by Faraday's law of electromagnetic induction, and subjectively to determine that the curl of the electric field is equal to the negative value of the time rate of changes in magnetic flux density. If a time-varying magnetic field induces a time-varying electric field in an empty space (vacuum), producing a vortex electric field, that is, if a time-varying magnetic can induce a time-varying electric field, producing a vortex electric field without the participation of any matter (this is of course impossible, because it violates the law that all things cannot act on their own), then there must be voltage between the voltage measurement point pairs C_1 and C_2, D_1 and D_2, shown in Figure 10, and the conductors in the time-varying magnetic field or at its edge of the time-varying magnetic field must generate an electromotive force.

As stated above, there cannot possibly be any voltage between these voltage measurement point pairs, and there cannot possibly be a chance for the conductors in the time-varying magnetic field or at its edge of the time-varying magnetic field to generate an electromotive force. However, even if it is assumed that there is voltage between the voltage

measurement point pairs C_1 and C_2, D_1 and D_2, shown in Figure 10, and even if it is assumed that a conductor in the time-varying magnetic field or at its edge of the time-varying magnetic field generate an electromotive force, the assertion that a time-varying magnetic field induces electric fields in an empty space (vacuum), inducing a vortex electric field, is also logically disturbed. Because this assertion excludes the necessary conditions for the process, i.e., the closed loop or its substitute, or say mater. The substitute can even be an insulator, but it is indispensable, because whether it is a conductor closed loop or other material closed loop only affects the magnitude, but not the existence or absence of the necessary condition, which is indispensable. In fact, a closed loop as a whole is a necessary condition for this process. Up to this point, in the Maxwell's equation explaining how an electric field is induced from a magnetic field, the two necessary conditions of Faraday's law of electromagnetic induction, namely the existence of a closed loop as a whole and the change of magnetic flux in the closed loop, are completely removed. This obviously inevitably leads to a fact that Maxwell's equation explaining how an electric field is induced from a magnetic field cannot hold true.

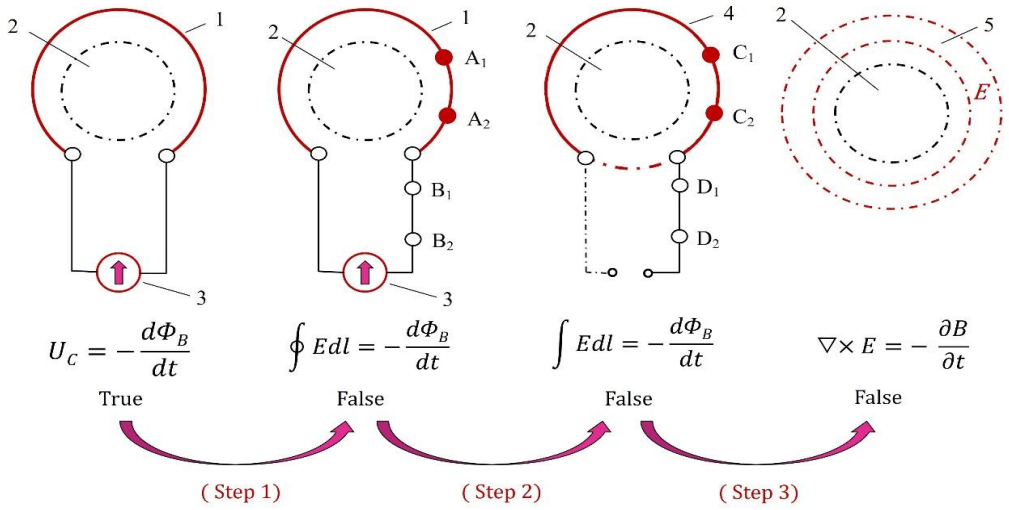

Figure 10. A schematic illustration of humanity's footprint towards the laws, theories and their mathematical equations on how to generate an electric field and an electromotive force from magnetic fields. 1. Closed loop of less than one turn, 2. The zone of a changing magnetic field/ a time-varying magnetic field, 3. The ammeter, 4. An open coil of less than one turn, 5. The curl of electric field, Uc is the electromotive force of the closed loop of one turn, A_1, A_2, B_1, B_2, C_1, C_2, D_1, D_2 are the voltage measure points.

4. Concerning the indispensability of electromagnetic force field equation

The nature of Newton's law of inertia is that if A is not acted upon by C, A will maintain the original state of A and cannot become state B. This means that A cannot become B without C's participation. In nature, Newton's law of inertia reveals a profound law, that is, a process of change requires the participation of at least three subjects, namely the proactive actor, the passive actor and the product. In addition, any energy form must go through a process of action to become another energy form. And this process of action is the process of interacting with another subject to produce another form of energy. And this process must be participated by at least three subjects. For example, what does kinetic energy need to interact with to convert into potential energy, what does potential energy need to interact with to convert into thermal energy, what does solar energy need to interact with to convert into electrical energy, electrical energy needs to interact with resistance to generate thermal energy, and so on, all these need to interact with. Therefore,

all kind of change at least need three beings. In the field of electromagnetism, any experiment that produces electromagnetic phenomena involves at least three subjects. For example, the process of generating electricity by applying a changing magnetic field to a closed loop, generating a magnetic field on loading current on a closed loop, generating electromagnetic waves with an LC oscillating circuit, and so on, all of which involve at least three subjects. Tripartite participation is the necessary condition for any process of change to be realized. The statements, that in an empty space (vacuum), the changing magnetic field produces a vortex electric field, and the changing electric field produces a vortex magnetic field, that is, in an empty space (vacuum), the changing electric field produces a changing magnetic field, and vice versa, the changing magnetic field produces a changing electric field, and electromagnetic waves can propagate in an empty space (vacuum) [6], are completely wrong. However, electromagnetic waves can propagate in an empty space (vacuum) which is in a system where matter and vacuum coexist. Again, in fact, as shown in Figure 11, in any process of change in the world, at least three subjects must be involved, there cannot possibly be a process in the world, in which A can directly become B without the participation of C, unless A includes the immutable tendency to reach B and the immutable tendency has already started. Even if A includes the immutable tendency that has already started and will inevitably reach B, A seems to be directly transformed into B, however, this process is just a continuous phenomenon of the process. This statement is defined as the law that all things cannot act on their own. In any process of change, the proactive actor A, the product B and the passive actor C interact and influence each other, so only a comprehensive explanation of actor A, the product B and the passive actor C can explain this process of change. Just as in the process of studying reversible chemical reactions, the entire chemical reaction can be clarified only when actor, reactant and product are clarified. If the change process is a reversible process, then if the proactive actor A, the passive actor C and the product B cannot be fully explained, the results of the interpretation of the whole process will inevitably deviate from the nature of this process of change. The electromagnetic process may be the most perfect reversible process in the world, and a time-varying electric field, a time-varying magnetic field and a time-varying electromagnetic force field are the three indispensable elements of this reversible process, they influence each other and one changes all change. Electromagnetic force is a representative of the closed loop, and is the indispensable element for a magnetic field induces an electric field, and an indispensable element for an electric field induces a magnetic field.

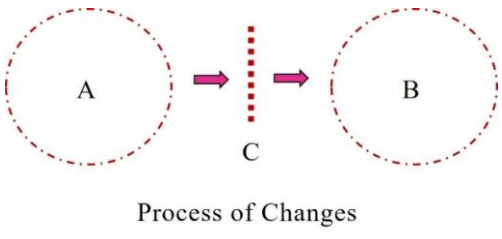

Figure 11. A schematic illustration of the process of changes.

According to published papers[7], it is clarified that all electromagnetic phenomena are produced by a closed loop as a whole, while time-varying magnetic fields, time-varying electric fields, the time-varying electromagnetic force field, the time-varying magnetic flux (or the time-varying magnetic flux density) in a closed loop and the closed loop as a whole coexist. And time-varying magnetic fields, time-varying electric fields and the time-varying electromagnetic force field are fundamentally interdependent; one cannot exist without the others, that is, they coexist, or they together cease to be; any two of the three are

the third one, and vice versa, any one is the other two, they are the same thing. Not only that, but it also be clarified that[7]: The electromagnetic force is essentially different from the magnetic force between the magnetic field and the magnetic field; the nature of the electromagnetic force is the force generated by the current envelope (electric field envelope) of a current-carrying closed loop to change its own area to lower the magnetic flux density within the current envelope of the current-carrying closed loop that generated the electromagnetic force; the electromagnetic force is self-balanced within the current envelope of the current-carrying closed loop, that is, it is self-balanced within the current-carrying closed loop; the electromagnetic force is the internal force inside the current envelope of the current-carrying closed loop, that is, it is the internal force inside the current-carrying closed loop; at each point of the current envelope of the closed loop, the electromagnetic force per unit length of the current envelope is the same, and the direction of the electromagnetic force on the current envelope is perpendicular to the tangent at each point of the current envelope; although the magnitude and direction of electromagnetic force are affected by external magnetic fields, the electromagnetic force has no force on the external magnetic fields. Therefore, the equation explaining the nature of the electromagnetic force field in a space area itself should be the equation shown in Figure 12, that is, the electromagnetic force field is generated by closed loops as a whole, and it is self-equilibrium on the current envelope of the closed loops, self-balanced, and its action is to change the area of the current envelopes of the closed loops to make the magnetic flux density in the current envelope of the closed loops reduce to zero, and the effect force of the electromagnetic force field volume density vector on any volume in the electromagnetic field is equal to zero.

$$\int_V F dV = 0$$

Figure 12. The equation explaining the nature of electromagnetic force field in a space area itself. F is the electromagnetic force field volume density, and V is the volume.

The equation explaining the nature of the electromagnetic force field in a closed loop itself should be the equation shown in Figure 13, that is, the electromagnetic force field is generated by a closed loop as a whole, and it is self-equilibrium on the current envelope of the closed loop, self-balanced, and its action is to change the area of the current envelope of the closed loop to make the magnetic flux density in the current envelope of the closed loop reduce to zero, and the effect force of the electromagnetic force field linear density vector on the current envelope of the closed loop is equal to zero.

$$\oint_c f dl = 0$$

Figure 13. The equation explaining the nature of electromagnetic force field in a closed loop itself. f is the electromagnetic force field linear density, and l is the loop length of the closed loop.

The equation explaining the relationship among electromagnetic force field volume density vector, electric field intensity vector and magnetic flux density vector should be the equation shown in Figure 14. That is, the electromagnetic force field volume density vector is proportional to the value of the product of the conductivity multiplied by the value of the product of the electric field intensity vector cross multiplies the magnetic flux

density vector.

$$F = \gamma(E \times B)$$

Figure 14. The equation explaining the relation among the electromagnetic force field volume density vector, the electric field intensity vector and the magnetic flux density vector. F is the electromagnetic force field volume density vector, E is the electric field intensity vector, B is the magnetic flux density vector, γ is the conductivity of the medium.

The electromagnetic force field can be generated by a change in an electric current within a closed loop as a whole. By logical analysis, it can be realized that: the electromagnetic force field around a closed loop in total should be directly proportional to the vacuum permeability, directly proportional to the square value of the change in the total current of the closed loop, directly proportional to the loop length of the closed loop, and inversely proportional to the quotient of the area enclosed in the closed loop divided by the loop length of the closed loop. That is the equation shown in in Figure 15.

$$f_t = \mu \frac{l}{S/l} \Delta I_t^2$$

Figure 15. The equation explaining the relation between the electromagnetic force field around the closed loop in total f_t and the total current I_t, which include conduction current, displacement current and convection current, S is the area enclosed in the closed loop, l is the loop length of the closed loop, μ is the permeability of the medium.

Therefore, the electromagnetic force field linear density vector should be directly proportional to the vacuum permeability, directly proportional to the square value of the change in the total current of the closed loop, and inversely proportional to the quotient of the area enclosed in the closed loop divided by the loop length of the closed loop. Therefore, the equation explaining the relationship between the electromagnetic force field linear density vector f and the total electric current I_t of the closed loop should be the equation shown in Figure 16. That is, the electromagnetic force field linear density vector f is directly proportional to the value of the product of the square value $(\Delta I_t)^2$ of the change in the total current multiplied by the permeability of the medium μ, and divided by the quotient of the area S enclosed in the closed loop divided by the loop length l of the closed loop.

$$f = \mu \frac{1}{S/l} (\Delta I_t)^2$$

Figure 16. The equation explaining the relation between the electromagnetic force field linear density vector f and the total current I_t, which include conduction current, displacement current and convection current, S is the area enclosed in the closed loop, l is the loop length of the closed loop, μ is the permeability of the medium.

The electromagnetic force field can also be generated by a change in the magnetic flux within a closed loop. By logical analysis, it can be realized that: the electromagnetic force field around a closed loop in total should be directly proportional to the time rate of change in magnetic flux in a closed loop, directly proportional to the amount of change in magnetic flux within the closed loop, inversely proportional to the electric resistance of

the closed loop, and inversely proportional to the quotient of the area enclosed in the closed loop divided by the loop length of the closed loop. Therefore, the equation explaining the relationship between the electromagnetic force field in total f_t and the magnetic flux Φ should be the equation shown in Figure 17. That is, the electromagnetic force field in total f_t is directly proportional to the value of the product of the time rate of the change in magnetic flux in a closed loop multiplied by the amount of the change in magnetic flux within the closed loop, divided by the electric resistance *R* of the closed loop, and divided by the quotient of the area *S* enclosed in the closed loop divided by the loop length l of the closed loop.

$$f_t = \frac{1}{S/l}\frac{\partial \Phi}{\partial t}\Delta\Phi\frac{1}{R}$$

Figure 17. The equation explaining the relation between the electromagnetic force field in total ft and the magnetic flux Φ, *S* is the area enclosed in the closed loop, l is the loop length of the closed loop, *R* is the electric resistance of the closed loop.

The equation shown in Figure 18 can be derived from the equation shown in Figure 17.

$$f_t = \gamma_c \frac{1}{S}\frac{\partial \Phi}{\partial t}\Delta\Phi A$$

Figure 18. The equation explaining the relation between the electromagnetic force field in total ft and the magnetic flux Φ, S is the area enclosed in the closed loop, A is the cross-section area of the member forming the closed loop, γ_c is the conductivity of the closed loop

Therefore, the two equations explaining the relationship between the electromagnetic force field linear density vector *f* and the magnetic flux Φ should be the two equations shown as follows. That is the he equation:

$$f = \frac{1}{S}\frac{\partial \Phi}{\partial t}\Delta\Phi\frac{1}{R}$$

In which, the electromagnetic force field linear density vector f is directly proportional to the value of the product of the time rate of change in magnetic flux in a closed loop multiplied by the amount of change in magnetic flux within the closed loop, and divided by the value of the product of the area *S* enclosed in the closed loop multiplied by the electric resistance *R* of the closed loop.

And the equation:

$$f = \gamma_c \frac{1}{S}\frac{\partial \Phi}{\partial t}\Delta\Phi\frac{A}{l}$$

In which, the electromagnetic force field linear density vector f is directly proportional to the value of the product of the time rate of change in magnetic flux in a closed loop multiplied by the amount of change in magnetic flux within the closed loop, multiplied by the conductivity γ_c of the closed loop, multiplied by the cross-section area *A* of the member forming the loop, and divided by the value of the product of the area *S* enclosed in the closed loop multiplied by the loop length l of the closed loop.

Newtons(N) of force and Amperes (A) of electric current have been linked by Ampère force law which does not hold true. Therefore, coefficients may be needed to balance the above formulas explaining electromagnetic forces. The specific value of these coefficients can be determined by physical experiments.

5. Concerning the formulation of two new systems of equations to replace Maxwell's equations to better explain the electromagnetic nature of the world

Inspired by the above physical experiments and logical experiments, the following two system of equations are formulated to replace Maxwell's equations to better explain the electromagnetic nature of the world. First system of equations includes four equations, and the second system of equations includes nine equations.

(1) Electric field property equation

This equation is the one described below, which is Gaussian theorem of electric fields.

$$\oiint E \cdot ds = \frac{Q}{\varepsilon_0}$$

(2) Magnetic field property equation

This equation is the one described below, which is Gaussian theorem of magnetic fields

$$\oiint B \cdot ds = 0$$

(3) Electromagnetic force field property equation for in a space

For in a space, this equation is the one described below, where, F is the electromagnetic force field volume density vector. The electromagnetic force field is generated by closed loops as a whole, which balances itself on the current envelope of the closed loops, and its direction of action is to change the area of the current envelope of the closed loops to make the magnetic flux density in the current envelope of the closed loops to be zero, and the resultant force of the electromagnetic force field volume density vector on any volume is equal to zero.

$$\int_V F dV = 0$$

(4) Electromagnetic force field property equation for in a closed loop

For in a closed loop, this equation is the one described below, where, f is the electromagnetic force field linear density, and l is the loop length of the closed loop. The electromagnetic force field is generated by a closed loop as a whole, which balances itself on the current envelope of the closed loop, and its direction of action is to change the area of the current envelope of the closed loop to make the magnetic flux density in the current

envelope of the closed loop reduce to be zero, and the resultant force of the electromagnetic force field linear density vector on the current envelope of any closed loop is equal to zero.

$$\oint_c f dl = 0$$

(5) The equation explaining how the electric fields and the electromotive force are induced by the magnetic fields

This equation is the one described below, where, S is the area enclosed in the closed loop, U is the electromotive force of the closed loop as a whole, N is the number of turns of the closed loop.

$$\frac{U}{N} = -\frac{d}{dt}\oiint_S B \cdot ds$$

(6) The equation explaining how the magnetic fields are induced by the electric fields and the electric current

This equation is the one described below, where, B is the magnetic flux density, *S* is the area enclosed in the closed loop, *C* means that all currents are in closed loops, *L* is the inductance of the closed loop, I_c is the conduction current, I_d is the displacement current, I_v is the convection current, *t* is time.

$$\frac{1}{L}\oiint_S B \cdot ds = -\int_c \frac{\partial}{\partial t}(I_c + I_d + I_v)dt$$

Since Lenz's law is fundamental in nature, a negative sign is theoretically required in the equation, but in some cases, it can still be validly applied without it. That equation is as follows.

$$\frac{1}{L}\oiint_S B \cdot ds = \int_c \frac{\partial}{\partial t}(I_c + I_d + I_v)dt$$

(7) The equation explaining the interaction among electric fields, magnetic fields and the electromagnetic force fields

This equation is the one described below, where, *F* is the electromagnetic force field volume density vector, *E* is the electric field intensity vector, *B* is the magnetic flux density vector, and γ is the conductivity of the medium. The content of this equation is that the electromagnetic force field volume density vector is directly proportional to the value of the product of the conductivity multiplied by the product of the electric field intensity vector cross multiplies the magnetic flux density vector.

$$F = \gamma(E \times B)$$

(8) The equation explaining how electromagnetic force fields are induced by electric currents

This equation is the one described below:

$$f = \mu \frac{1}{S/l} (\Delta I_t)^2$$

As stated above, in which: the electromagnetic force field linear density vector f is directly proportional to the value of the product of the square value $(\Delta I_t)^2$ of the change in the total current multiplied by the permeability of the medium μ, and divided by the quotient of the area S enclosed in the closed loop divided by the loop length l of the closed loop.

(9) The equation explaining how electromagnetic force fields are induced by magnetic fields

This equation is the one described below:

$$f = \gamma_c \frac{1}{S} \frac{\partial \Phi}{\partial t} \Delta \Phi \frac{A}{l}$$

As stated above, in which, the electromagnetic force field linear density vector f is directly proportional to the value of the product of the time rate of change in magnetic flux in a closed loop multiplied by the amount of change in magnetic flux within the closed loop, multiplied by the conductivity γ_c of the closed loop, multiplied by the cross-section area A of the member forming the loop, and divided by the value of the product of the area S enclosed in the closed loop multiplied by the loop length l of the closed loop.

Figure 19 shows a newly formulated short system of equations (The first system of equations) that explains the true electromagnetic nature of the world.

$$\oiint E \cdot ds = \frac{Q}{\varepsilon_0}$$ *Gaussian theorem of electric fields*

$$\oiint B \cdot ds = 0$$ *Gaussian theorem of magnetic fields*

$$\frac{U}{N} = -\frac{d}{dt} \oiint_S B \cdot ds$$ *The electromotive force is generated by a closed loop as a whole with a change in magnetic flux inside it, S is the area enclosed in the closed loop, U is the electromotive force of the closed loop as a whole, N is the number of turns of the closed loop.*

$$\frac{1}{L} \oiint_S B \cdot ds = -\int_c \frac{\partial}{\partial t} (I_c + I_d + I_v) dt$$

$$\frac{1}{L} \oiint_S B \cdot ds = \int_c \frac{\partial}{\partial t} (I_c + I_d + I_v) dt$$

The magnetic fields are generated by a current-carrying closed loop as a whole, c means that all currents are in closed loops, S is the area enclosed in the closed loop, t is time, L is the inductance of the closed loop, I_c is the conduction current, I_d is the displacement current, I_v is the convection current. Since Lenz's law is fundamental in nature, a negative sign is theoretically required in the equation, but in some cases, it can still be validly applied without it.

Figure 19. The first system of equations proposed for explaining the true electromagnetic nature of the world.

Figure 20 shows a newly formulated long system of equations (The second system of equations) that explains more true electromagnetic nature of the world. As stated above, Newtons(N) of force and Amperes (A) of electric current have been linked by Ampère force law which does not hold true. Therefore, coefficients may be needed to balance the above formulas explaining electromagnetic forces. The specific value of these coefficients can be determined by physical experiments.

$$\oiint E \cdot ds = \frac{Q}{\varepsilon_0}$$ *Gaussian theorem of electric fields*

$$\oiint B \cdot ds = 0$$ *Gaussian theorem of magnetic fields*

$$\int_V F dV = 0$$ *F is the electromagnetic force field volume density vector, the electromagnetic force is generated by the current envelope of closed loops as a whole, which balances itself on the current envelope, and the effect of the electromagnetic force is to change the area of the current envelope to reduce the magnetic flux density in the current envelope towards to be zero, and the resultant force of the electromagnetic force field volume density vector on any volume is equal to zero. This equation is for in a space.*

$$\oint_c f dl = 0$$ *f is the electromagnetic force field linear density, and l is the loop length of the closed loop. The electromagnetic force field is generated by a closed loop as a whole, which balances itself on the current envelope of the closed loop, and its direction of action is to change the area of the current envelope of the closed loop to make the magnetic flux density in the current envelope of the closed loop reduce to be zero, and the resultant force of the electromagnetic force field linear density vector on the current envelope of any closed loop is equal to zero. This equation is for in a closed loop.*

$$\frac{U}{N} = -\frac{d}{dt}\oiint_S B \cdot ds$$ *The electromotive force is generated by a closed loop as a whole with a change in magnetic flux inside it, S is the area enclosed in the closed loop, U is the electromotive force of the closed loop as a whole, N is the number of turns of the closed loop.*

$$\frac{1}{L}\oiint_S B \cdot ds = -\int_c \frac{\partial}{\partial t}(I_c + I_d + I_v)dt$$

$$\frac{1}{L}\oiint_S B \cdot ds = \int_c \frac{\partial}{\partial t}(I_c + I_d + I_v)dt$$

Magnetic fields are generated by a current-carrying closed loop as a whole, c means that all currents are in closed loops, S is the area enclosed in the closed loop, t is time, L is the inductance of the closed loop, I_c is the conduction current, I_d is the displacement current, I_v is the convection current. Since Lenz's law is fundamental in nature, a negative sign is theoretically required in the equation, but in some cases, it can still be validly applied without it.

$$F = \gamma(E \times B)$$ *F is the electromagnetic force field volume density vector, E is the electric field intensity vector, B is the magnetic flux density vector, γ is conductivity of the medium.*

$$f = \mu\frac{1}{S/l}(\Delta I_t)^2$$ *Electromagnetic force field can be induced by a change in the electric current in a closed loop as a whole. The f is the electromagnetic force field linear density vector, I_t is the total current which include conduction current, displacement current and convection current, S is the area enclosed in the closed loop, l is the loop length of the closed loop, μ is the permeability of the medium.*

$$f = \gamma_c \frac{1}{S}\frac{\partial \Phi}{\partial t}\Delta\Phi\frac{A}{l}$$ *Electromagnetic force field can be induced by a change in the magnetic flux in a closed loop as a whole. The electromagnetic force field linear density vector f is directly proportional to the value of the product of the time rate of change in magnetic flux in a closed loop multiplied by the amount of change in magnetic flux within the closed loop, multiplied by the conductivity γ_c of the closed loop, multiplied by the cross-section area A of member forming the closed loop, and divided by the value of the product of the area S enclosed in the closed loop multiplied by the loop length l of the closed loop.*

Figure 20. The second system of equations proposed for explaining more true electromagnetic nature of the world.

6. Discussion

As stated in introduction, given that this paper challenges the fundamental laws and fundamental theories of electromagnetism, it is necessary to elaborate on the relationship between the stability of physical laws and natural science theories and the civilization of science and technology. The physical laws and natural science theories must be actually stable and irresistible. However, the stability and the irresistibility here do not mean that the physical laws and natural science theories cannot be replaced or falsified, but that they must be consistent with the facts, that is, they must be consistent with physical experiment results, otherwise they will not be true and be falsified. A longtime tried and tested physical law or natural science theory can only show that it has been proven to be correct by many experiments and practices, but it does not mean that it cannot have counterexamples, or it cannot be falsified. In fac, human scientific and technological civilization is not built on consistently stable physical laws or consistently stable natural science theories, but built on the continuous evolution of physical laws and natural science theories.

In essence, any physical experiment is just a specific point, simply because there are deviations in human observation and measurement, so human beings tend to think that physical experiments can prove the validity of a natural science theory or physical law. However, even if we ignore these deviations, physical experiment can only prove the validity of this physical experiment itself, and can only prove the validity of the physical laws whose jurisdiction is exactly the same as this physical experiment, but cannot prove the validity of any physical law whose jurisdiction is larger than this physical experiment.

Physical law needs to explain universal law, so the jurisdiction of physical law must be larger than the jurisdiction of the physical experiments that this physical law is extracted from. In the jurisdiction of any physical law, no matter whether the jurisdiction itself is large or small, there must be an infinite number and type of physical experiments. For example, Newton's law of gravity has an infinite number and an infinite type of physical experiments in its jurisdiction, such as changes in mass size, changes in distance, changes in relative velocity between two particles, etc., which inevitably lead to the infinite number and the infinity types of physical experiments in the jurisdiction of the law of gravity.

In fact, within the jurisdiction of any physical law, there are two zones: the human activity zone and the no man's zone. The so-called human activity zone refers to the area involved in the physical experiments carried out by human beings in response the relevant physical law. The so-called no-man's zone refers to the area that is not covered by physical experiments conducted by human beings in response to relevant physical law. For example, Newton's laws of motion, in the early days, the areas involved in physical experiments conducted by human beings were concentrated in the lows-peed zone, and all physical experiments conducted by human beings in the low-speed zone were consistent with Newton's laws of motion, therefore, Newton's laws of motion are regarded as eternal truths. But as everyone knows, in addition to the low-speed zone, there is also the high-speed zone, called no-man's zone. Because in the early days, humans never entered the high-speed zone to verify the validity of Newton's laws of motion, so the high-speed zone is called no-man's zone. When humans entered the no-man's zone of Newton's laws of motion, they found that Newton's laws of motion did not match the results of physical experiments. In other words, Newton's laws of motion, a longtime-tested physical law that has made immeasurable contributions to human civilization, being regarded as the physical laws of eternal truth, are falsified in no man's zone within its jurisdiction. It is precisely because of this that the theory of relativity was born.

This shows that Newton's laws of motion, such a tried-and-tested physical law, can still

be falsified.

In fact, the physical laws are bound to be falsified in their no-man's zone. This is because:

(The same is true for natural science theories, and there is no need to go into detail here.)

(1) The indelicacy of the possibility of falsification of the physical laws determined by Karl Popper's scientific falsification theory[8] [9]. Specifically, there are infinite number and infinite types of physical experiments in the jurisdiction of any physical law, and the relevant physical laws must be consistent with the results of each physical experiment of the infinite number and infinite types of physical experiments in their jurisdiction if they are not to be falsified, which is obviously impossible. This shows that no physical experiment that verifies a physical law can eliminate the possibility of falsification of the physical law.

(2) The falsification inevitability of the physical laws determined by the law of information distortion. The so-called the law of information distortion refers to the fact that the information (observation result) obtained by the observer is determined by the observer and the observed, so the information observed by the observer is not the true nature of the observed, so the essence of the observed can only be approached, not reached. Therefore, the results of any physical experiment are deviated, and it is precisely because human beings do not notice this deviation or do not detect this deviation due to the limitation of the accuracy of the detection method, that the physical laws are consistent with the results of physical experiments. This means that, from an extremely precise point of view, as long as two different physical experiments are conducted, the results of at least one of the physical experiments do not correspond to the relevant physical laws.

(3) The falsification inevitability of the physical laws determined by the law of change in the function relationship of the physical laws. The so-called the law of change in the function relationship of the physical laws means that the change of physical quantities will inevitably lead to the change of the form of time and space, and the change of the form of time and space will inevitably lead to the change of the natural law, which in turn will inevitably lead to the change of the function relationship of the physical laws. This means that no matter whether it is in the human activity zone of the relevant physical laws or in the no-man's zone, as long as it is a different physical experiment, its physical quantities will inevitably change, so the function relationship of the physical law will inevitably change. The reason why the results of all physical experiments in the human activity zone of the relevant physical laws are consistent with the physical laws is because the function relationship of the physical laws has a small amount of change, that is, the amount of change in the physical law is small, and it is not observed. This also means that, from an extremely precise point of view, as long as two different physics experiments are conducted, the results of at least one of the physical experiments do not correspond to the relevant physical laws.

This means an important thing that greatly improving the observation accuracy of physical experiments, greatly improving the measurement accuracy of physical experiments, greatly changing the physical magnitude of physical experiments or challenging physical laws and natural science theories with logical experiments will reveal counterexamples of physical laws and natural science theories, and will discover new physical laws and new natural science theories.

In a word, all theories or laws that need to be verified by physical experiments to be considered true will inevitably be falsified one day, in other words, the authenticity of the physical experiments of theories and physical laws is equivalent to their falsifiability.

The falsified physical laws and theories and their founders are not losers, but the great founders and great contributors of the existing scientific and technological civilization, but the solid shoulders of the great giants for those who will create new physical laws or new theories. The recurring cycle that the existing physical laws and natural science theories are falsified and the new physical laws and new natural science theories are formulated is a kind of natural law, the fundamental form of scientific development and technological progress, and is the foundation of the continuous development of human scientific and technological civilization.

Because Maxwell's equations are the cornerstone of classical physics and modern physics, the new system of equations proposed in this paper to explain the electromagnetic nature of the world may improve the process of making breakthroughs in basic science and creating disruptive technologies in the fields of electromagnetism, electrodynamics, relativity and quantum mechanics, by all researchers.

This paper focuses on a rigorous re-examination of longtime-tested physical laws and natural science theories, so it may create a new paradigm of scientific research, which may change the way we understand the natural world, improve the level and efficiency of basic scientific breakthroughs, and improve the level and efficiency of scientific and technological innovation. That is, this paper could make more paradigm challenger.

This paper proves that physical laws and natural science theories need to be proven not only in physical experiments, but also in logical experiments, in other words, the verification of the physical laws and natural science theories must be conducted with the double-half verification law[10]. This paper also illustrates the double-half verification law is of great significance to promote the development of basic science.

7. Conclusions

In this study， it is discovered that: Oersted's law of electromagnetism does not hold true; Ampère's circuital law does not hold true; Ampère-Maxwell's law that covers displacement currents does not hold true; Faraday's conclusion that an open coil with the change of magnetic flux in it produces an electromotive force does not hold true; The component of the closed loop generating an electric current due to the change of internal magnetic flux does not generate an electromotive force; A changing magnetic field (/a time-varying magnetic field) cannot form a changing electric field (/a time-varying electric field) or a vortex electric field in an empty space (vacuum).

Inspired by these findings, two new system of equations explaining the nature and interaction relations of electric field, magnetic field and electromagnetic force field are proposed to replace Maxwell's equation to better explain the electromagnetic nature of the world. These equation systems include These equation system includes the electric field property equation, the magnetic field property equation, the electromagnetic force field property equation, the equation explaining how electric fields and electromotive force are induced by magnetic fields, the equation explaining how magnetic fields are induced by electric fields and electric currents, the equation explaining what are the interaction relations among electric fields, magnetic fields and the electromagnetic force fields, the equation explaining how electromagnetic force field is induced by electric current, and the equation explaining how electromagnetic force field is induced by magnetic fields.

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Author Declarations

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Reference

1. Maxwell, James Clerk. 1873. A Treatise on Electricity and Magnetism. 1st ed. 2 vols. Oxford: Clarendon Press.

2. Purcell, Edward M. & Morin David J., Electricity and Magnetism, 2013.

3. Jin B. Counterexamples to Four Fundamental Laws of Electromagnetism Are Found with Physical Experiments. Journal of STEM, 2025, 2(2), 00012. https://doi.org/10.63460/VUOY3743

4. Cheng, David K., Field and Wave Electromagnetics, CIP (2019) 284478.

5. Faraday, Michael, Experimental Researches in Electricity. – First Series. Philosophical Transactions of the Royal Society, Series 2, Volume 122 (1832), pp. 125-162.

6. Collin, Robert E., Field Theory of Guided Waves, 1960.

7. Jin B. Nine New Fundamental Laws Are Proposed for Electromagnetism. Journal of STEM, 2025, 2(2), 00011. https://doi.org/10.63460/XHMR2132.

8. Popper, Karl R., The Logic of Scientific Discovery, Published by Hutchinson, 1959.

9. Popper, Karl R., Conjectures and Refutations: the growth of scientific knowledge, Published by New York, Basic Book, 1962.

10. Jin B. The logic of physical law verification and the methodology of revolutionary technology development. Journal of STEM, 2025, 2(2), 000010. https://doi.org/10.63460/XHMR2132