

# The logic of physical law verification and the methodology of revolutionary technology development

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**Abstract:** The logic of physical law verification as well as the methodology of revolutionary technology development were examined. It is discovered that physical law can only be proved true through the combination of physical experiment verification and logical experiment verification, physical experiment verification is the necessary condition for proving a physical law true, but not the sufficient condition for proving a physical law true, physical experiment falsification is the sufficient condition for disproving a physical law, but not the necessary condition for disproving a physical law. That is, a physical law must be proved true in both physical experiment verification and logical experiment verification before becoming a real physical law for the present time, conversely, if a physical law is disproved by either one physical experiment or one logical experiment, it does not hold true anymore. Therefore, the double-half verification law which states that a physical law is verified only if both physical experiments and logical experiments confirm its validity is proposed for verifying physical law. In the verification process, the physical experiment verification is a half, the logical experiment verification is the other half of the verification process. The physical experiment verification is a necessary condition, the logical experiment verification is another necessary condition, and the combination of them is the sufficient and necessary conditions for physical law verification. Additionally, the methodology of eight approaches to efficiently develop revolutionary technologies is also proposed.

**Keywords:** Logical experiment verification; physical experiment verification; physical law verification; the double-half verification law; eight approaches surrounding the revolutionary technology development.

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## 1. Introduction

After four fundamental laws of electromagnetism were falsified<sup>[1]</sup>, it becomes a big question that why the physical laws, which have been proven to be correct by massive physical experiments and processes, and which have made great contributions to human civilization, can still be falsified and still be false. Karl Popper<sup>[2]</sup> has discussed this, but it was wondered if there are more convincing arguments proving that physical laws, which have been proven to be correct by massive physical experiments and processes, and which have made great contributions to human civilization, can still be falsified and they are still false. Therefore, the logic of physical law verification and the methodology of revolutionary technology development were examined. Physical laws (which encompass all scientific laws) constitute the core and most fundamental knowledge in natural science. The verification of physical laws is the fundamental way to achieve revolutionary development and

progress in fundamental science, and the fundamental way to create revolutionary technologies. Although scientific development and technological innovation do not always need to prove or falsify a physical law, however, the revealing of the logic of physical law verification as well as the methodology of the revolutionary technology development will fundamentally enhance the creativity of scientists, fundamentally enhance human ability to understand the natural world, and will play a decisive role in promoting the systematic improvement of the level and efficiency of scientific development and technological innovation.

In the field of science and technology, whether a physical experiment can be repeated or not is often used as the only criterion for whether a physical law holds true or not, that is, physical experiments are used as the only evidence to test the validity of physical laws. However, this is completely wrong and an illogical thinking. Whether a physical experiment can be repeated or not is only a criterion for whether the physical experiment itself is true or not, and it is definitely not a criterion for whether the physical law extracted from this physical experiment is true or not. The great philosopher of science and technology, Karl Popper, in his book “The Logic of Scientific Discovery” [2], had already demonstrated that physical experiments alone could not prove physical law true, and that any physical laws were nothing more than conjectures and hypotheses. The fact that there are counterexamples to any and all physical laws is not a problem at all, there is only one question that when and who discovers these counterexamples. Therefore, there is nothing inconceivable about discovering that there is a counterexample to a certain physical law, and then this physical law is falsified, that is only a necessity of logical determination.

Logically, physical laws cannot be directly proved true, whereas physical laws can only be proved true by the processes in which they cannot be falsified at the present time. That is, the essence of physical law verification is the opposite of the process of physical law falsification. Therefore, in this research, the logic of physical law verification was examined through the falsification process of physical law. Finally, a new methodology for physical law verification as well as a new methodology for revolutionary technology development are proposed in this paper.

## 2. Physical laws cannot be verified solely through physical experiments

The nature of physical laws lies in interpreting certain necessities of the natural world, rather than interpreting specific physical experiments. Physical experiments (encompassing all scientific experiments) merely serve as tools for humans to discover these necessities of the natural world. Physical laws explain how phenomena occur, but not why they occur. In contrast, theorems explain both how and why phenomena occur. For a physical law, to be true or not to be true is a critical question. Physical law must be extracted upwards and over the relevant specific physical experiments which the physical law is extracted from to describe necessities of the natural world, which is behind the relevant specific physical experiments. Therefore, the inductive method is suitable for constructing physical laws, but the deductive method is appropriate for formulating theorems. In fact, physical laws can only be constructed using the inductive method, not the deductive method. The statement of a necessity formulated through deductive methods must be theorems, not physical laws, because the deductive method is downward reasoning rather than upward extraction, even though it is true that the deductive method itself is flawless, as long as the premise of the process using the deductive method is irrefutable. In fact, physical laws can only be constructed using the inductive method. When a physical law is extracted using the inductive method, the scope governed by the physical law will be much inflated to include areas where the physical law has not been and cannot be verified by physical experiments. This is because there are infinitely many cases in these areas that

would need to be verified by physical experiments, yet both the amount and methods of physical experiments that can be conducted are limited. Therefore, physical laws cannot be verified solely through physical experiments. However, since physical laws must be true in accordance with the objective reality, they must be proved true through physical experiments. In addition, physical laws must also be proved true in all possible situations. However, physical experiments cannot deal with the problem of verifying a physical law in all possible situations, whereas logical experiments can address this issue. This is because that the working methodology for logical experiments is to intentionally seek counterexamples only, rather than verifying a physical law one experiment by one experiment. Therefore, physical laws must be verified through the combination of physical experiment and logical experiment. That is, a physical law must be verified by both physical experiments and logical experiments before it can be considered a genuine physical law. However, almost all of the physical laws established so far have only been verified through physical experiments, but not verified through logical experiments. Therefore, it is not surprising that some physical laws and even some fundamental physical laws are disproved, even these physical laws having been proved by numerous physical experiments over a long period. Additionally, logically, no matter how many physical experiments prove a physical law true, as long as there is one physical experiment counterexample or one logical experiment counterexample found, this physical law does not hold true definitely. These are the reasons why a physical law that has been proved true by numerous physical experiments over a long period can still be disproved. In other words, there are two reasons why a physical law that has been proved true by numerous physical experiments over a long period can still be disproved. The first reason is that almost all of the physical laws established so far have only been verified through physical experiments, but not have been verified through logical experiments. The second reason is that there is an inevitability determined by the logical flaws of the inductive method [2]. In other words, when extracting physical law by the inductive method from the specific physical experiments conducted, the scope governed by the physical law will be much inflated and will cover an area where the physical law has not been verified and cannot be verified by physical experiments, and this area is here termed as the augmented area. That is, there will be a territory that is governed by the relevant physical law, but has not been physical-experimentally verified and cannot be physical-experimentally verified.

That is, when a physical law is established by inductive method based on the results of physical experiments, such as observations, measurements, and other material processes, then as illustrated in the cone of physical laws in Figure 1, what the physical law states produces an additional area, that is the augmented area, in which there are places where the relevant physical law has not been and cannot be verified by physical experiments. This is because that in this area there are infinite cases including some unknown kinds of cases need to be verified by physical experiments, but the amount and method of physical experiments which can be conducted are both limited. Therefore, physical law cannot be verified solely through physical experiments.

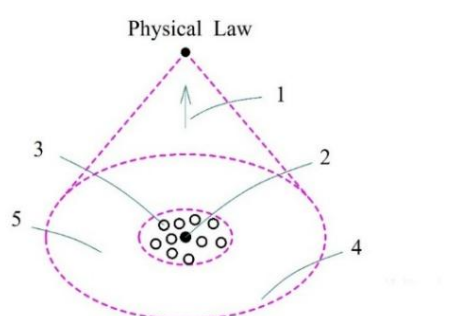


Figure 1: Schematic diagram of the cone of physical law illustrating the process of extracting the physical laws. 1. The extracting direction of physical laws, 2. The first experiment which implies a new physical law exists, 3. The physical law verification experiments, 4. The area where the physical laws fail mostly (the existence possibility of new physical laws is high), 5. The augmented area formed in the process of extracting the physical laws.

Actually, the fact that physical law cannot be verified solely through physical experiments leads to the following conclusions:

- A physical law cannot be proved true by physical experiments which this physical law is extracted from.
- A physical law cannot be proved true by physical experiments designed right in the scope governed by this physical law, even if the results of these physical experiments comply with what this physical law states.
- A physical law cannot be proved true by any physical experiments, even if the results of these physical experiments comply with what this physical law states.
- A false physical law can also be seemingly proved true by physical experiments.
- Physical experiment is only the necessary condition required to prove physical law true, but not the sufficient condition required to prove physical law true, even if a physical law is proved true by each and every physical experiments conducted, the physical law can still be false.
- A case proving a physical law true cannot invalidate a case that disproves this physical law. However, a case disproving a physical law definitely invalidates a case that proves this physical law true, and then this physical law does not hold true anymore.
- Once a physical law is found to have counterexamples, none of the past and future truth cases of experiments can invalidate the falsification by the counterexamples.
- If Person A asserts that he has disproved physical law Y using process X, while Person B asserts that the physical law Y is true, because various processes have all proved the physical law Y true. Then actually, Person B is completely and logically mistaken and in illogical thinking. Since the only way to refute Person A is to demonstrate that the process X used by Person A is flawed, and any other attempts to prove Person A wrong are logically incoherent.
- A physical law must be proved true in both physical experiment verification and logical experiment verification before becoming a real physical law.
- It is a logical mistake that if the results of physical experiments comply with what a physical law states, the physical law is consequently concluded to be true.
- A physical law that has been proved true by numerous physical experiments over a long period can still be disproved.
- A physical law that drives great strides in human civilization can still be found to have counterexamples, and it can still be false.

These conclusions should help humans to get better understanding of the logic of physical law verification and to get better understanding of the relations between physical law and physical experiments.

### 3. The double-half verification law for physical law verification

Since physical laws must be true in contrast with objective reality, physical law must be proved true in physical experiments. In addition, physical law must be proved true in all possible situations before becoming a real physical law. The requirement that physical laws must be proved true in all possible situations before becoming a real physical law implies that it needs an infinite number of different physical experiments including all possible sorts of physical experiments to verify a physical law. Since it is impossible to conduct an infinite number of different physical experiments, not only that, but it is also impossible to complete even a finite number of different physical experiments due to the limited conditions and other reasons, for example, due to the time and cost reasons. Therefore, physical experiments cannot deal with the problem of verifying a physical law in all possible situations, or deal with the problem of verifying a physical law in the situations of vast array of different physical experiments. Therefore, it is impossible to truly prove physical laws solely through physical experiments, but logical process can deal with the problem of verifying the physical laws in all possible situations, as the logical experiments do not require examining each case individually within the scope governed by the physical law. Therefore, the verification of physical law can only be achieved through the combination of physical experiment verification process and logical experiment verification process.

Physical laws do not interpretate the entirety of related physical experiments, instead, they are the upward conclusion, abstract conclusion, and inductive conclusion derived from those experiments. Because upward-raised, abstracted, and inductively-concluded, physical laws extend far beyond the scope where the original physical experiments can go through with and verify, physical law cannot be proved true by the physical experiments which these physical laws extracted from. Specifically, this is because that physical law states more general things than the physical experiments which it is extracted from can do, and governs more universal processes than the physical experiments which it is extracted from can do, and reveals more profound logical relations than the physical experiments which it is extracted from can do, and finally contains the cases that do not exist in the scope of the physical experiments which it is extracted from. That is, physical law goes far beyond the scope where the physical experiments which it is extracted from can reach.

Again, because upward-raised, abstracted, and inductively-concluded, physical law also cannot be proved true by the physical experiments which are designed right in the scope governed by the same physical law, even if the results of these physical experiments match what the physical law states. This is because that these physical experiments are only one or several different physical experiments in the scope governed by the relevant physical law, where there are infinite different physical experiments exist. This means that it is entirely possible that there are physical experiments in the scope governed by the relevant physical laws that fully meet the requirements of the relevant physical law, but whose results are contrary to the results of all existing physical experiments which prove the physical law true.

Physical law still cannot be verified by any other physical experiments, even if the results of these physical experiments are consistent with those this physical law states, because any other physical experiments which can be conducted are still only one or several different physical experiments in the scope governed by the relevant physical law, where there are infinite different physical experiments exist. And the same, this means that it is entirely possible that there are physical experiments in the scope governed by the relevant physical law, that fully comply with the requirements of the relevant physical law, but

whose results are contrary to the results of all existing physical experiments. These statements mean that it is entirely possible that there are physical experiments in the scope governed by the relevant physical law that fully meet the requirements of the relevant physical law, but whose results are contrary to the results of all existing physical experiments which prove the physical law true.

Physical law is not an interpretation of a certain physical experiment, nor an interpretation of a certain type of physical experiments, but only an interpretation of a certain natural necessity. In essence, once a physical law is established, it is no longer directly related to any specific physical experiment, including the physical experiments which the physical law is extracted from and the physical experiments which are designed right in the scope governed by the physical law.

All in all, physical law is general, universal and absolute, that is, physical law manifests itself wherever, whenever and whatever, so it is beyond the reach of any physical experiment, therefore, physical law cannot be proved true solely through physical experiments. And the issue that physical law cannot be proved true solely through physical experiments logically implies that a false physical law can also be proved true by physical experiments. So, if it is wanted to verify a physical law in all possible physical experiments within the physical law's scope, the only way is to use the process verification of logical experiments, because logical experiment verification is the only process that can deal with verification in all possible situations, as logical experiment verification only searches for counterexamples and does not examine the validity case by case over the scope governed by the physical law. However, most people believe that physical experiments are the way to verify physical law, but in fact this is a logical mistake. In other words, it is a logical mistake that if as long as the results of physical experiments are consistent with what a physical law states, then it is concluded that the physical law is proved true. Why many physical laws are falsified after a long period of domination of mankind? The fundamental reason for this is here. The fundamental reason for this is that the relevant physical laws are only verified by physical experiment verification but not by logical experiment verification which is also an indispensable process.

In other words, since physical experiment cannot deal with the problem of verifying a physical law in all possible situations, but logical experiment can deal with this issue. Therefore, physical law must be verified by the combination of physical experiment and logical experiment, that is, physical law must be verified by physical experiment and must be verified by logical experiment before it becomes a real physical law. Therefore, no matter how large number of physical experiments prove a physical law true, as long as there is one physical experiment counterexample or one logical experiment counterexample found, this physical law does not hold true definitely. Similarly, no matter how large number of logical experiments prove a physical law true, as long as there is one physical experiment counterexample or one logical experiment counterexample found, this physical law does not hold true definitely.

What stated above indicate that the logical flaw of the inductive method makes the combination of physical experiment verification and logical experiment verification to become to be the sufficient and necessary conditions for the verification of physical law, and the physical experiment verification is only a necessary condition, but not a sufficient condition for the verification of physical law. In other words, physical experiments only possess the necessity in verifying physical law, but do not possess the sufficiency in verifying it, physical experiments only possess the sufficiency in falsifying physical law, but do not possess the necessity in falsifying physical law, because the physical experiments are only the half way of verifying physical law. Because there are two half ways of verifying

physical law, if a physical law is false in any half way, it must be false, and if a physical law is true in this half way, it is not certainly true. That is, no matter how large the amount of physical experiment verifications is, which prove a physical law true, it still cannot verify the physical law solely through physical experiments, but as long as there is one physical experiment verification that falsifies a certain physical law, then this physical law must be false and disappear. In the same way, no matter how big the number of logical experiment verifications is, which prove a physical law true, it still cannot verify the validity of physical law solely through physical experiments, but as long as there is one logical experiment verification that falsifies a certain physical law, then this physical law must be false and disappear. As illustrated in Figure 2, in the process of verifying physical law, the physical experiment verification is only the half way of the process, and the logical experiment verification is only the other half way of the process, a physical law must be verified in both of physical experiment verification process and logical experiment verification process, any of these half verification process are indispensable, and if a physical law is falsified in any of these two verification processes, then this physical law does not hold true. This statement is here termed as the double-half verification law for verifying physical law, and shorted as the double-half verification law.



Figure 2: Schematic diagram of the double-half verification law for verifying the validity of physical law.

What illustrated in Figure 3 is the flowchart for verifying the validity of a physical law with the double-half verification law. If phenomena obtained in physical experiments or in observations are extracted with inductive method, then, a tentative physical law can be obtained. If there is one physical experiment or one logical experiment does not confirm the validity of the tentative physical law, then, the tentative physical law is a false physical law. However, if both of physical experiments and logical experiments confirm the validity of the tentative physical law, then, the tentative physical law is a true physical law.

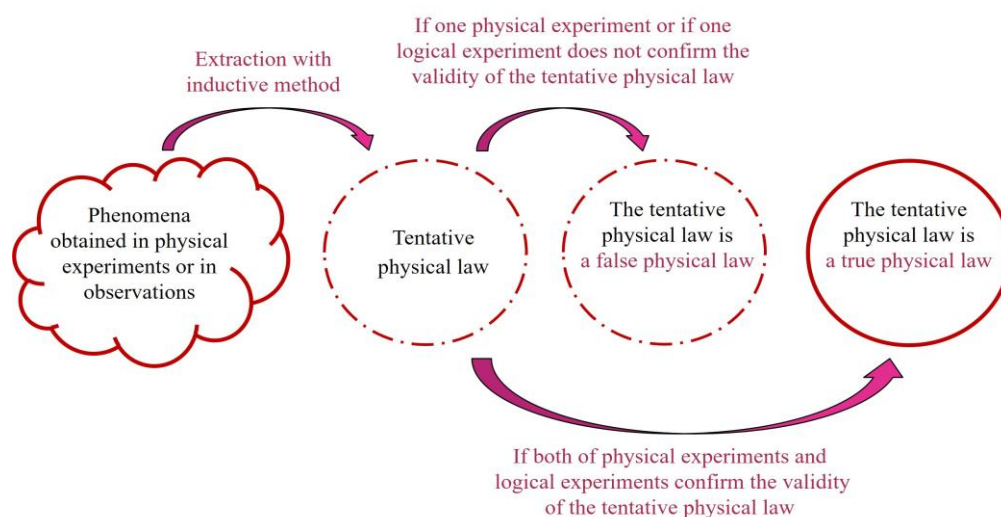


Figure 3: Schematic diagram of the flowchart for verifying the validity of physical law with the double-half



verification law.

Of course, even if a physical law is verified by both of physical experiment verification and logical experiment verification, then this physical law will become to be a current-effective physical law, but not a physical law forever. As stated above, physical law manifests itself wherever, whenever and whatever, however, it is only effective wherever, whenever and whatever, before it is disproved. With the time going, there is still a risk for the physical law verified by the double-half verification law to be disproved. However, this does not imply that physical law can be verified only through physical experiments, or only through logical experiments, because the physical law that is verified by the double-half verification law is far more profound and far more stable than the physical law that is verified solely through physical experiments, or solely through logical experiments. Therefore, the physical law that is verified by the double-half verification law is far more essential and stable than the physical law that is verified solely through physical experiments. Additionally, the physical law that is verified by the double-half verification law will greatly deepen human kind's understanding of the nature world.

Based on a large number of experiments and observations, Aristotle extracted the Aristotle's law of free fall motion that heavy object has a higher free fall motion speed than the light objects. After this law was proposed, it was proven correct by countless physical experiments and physical processes, and for this reason this law has ruled mankind for thousands of years. It was not until 1600 years later that Galileo falsified Aristotle's law of free fall motion through logical experiment verification, and proposed the law of free fall motion of objects that the free fall motion speed of all objects is the same. In Galileo's logical experiments, Galileo assumed that there are heavy object A, light object B, and a heaviest object AB of the combination of the heavy object A and the light object B. According to Aristotle's law of free fall motion of objects, the free fall motion velocity of these three objects should be: heaviest object AB > heavy object A > light object B. However, on the other hand, since the heaviest object AB includes the heavy object A and the light object B, therefore, the slow free fall motion speed of the light object B will inevitably reduce the free fall motion speed of the heavy object A, so the free fall motion speed of the heaviest object AB should be slower than the free fall motion speed of the heavier object A. In this way, there is a contradiction between the two logical experiments, and this contradiction can only be solved if the free fall motion speed of the heavy object A, the light object B, and the heaviest object AB are all the same. Thus, Galileo came to the conclusion that the velocity of free fall motion of all objects is the same. From that time, many physical experiments have proven that the velocity of free fall motion of all objects is the same. This event represents disruptive advancements in natural science, however, at its core, the advancements demonstrate that the double-half verification law is the key tool for physical law verification.

#### 4. The application of the double-half verification law

In order to make the double-half verification law easy to understand, an example of the application of it is listed below:

In a physical experiment as illustrated in the lower part of Figure 4, it was observed that a closed loop's current-carrying conductor experiences a force and moves when it is placed in a magnetic field. Based on this observation, electromagnetic scientists extracted the Ampère force law which states that a current-carrying conductor experiences a force in a magnetic field, as illustrated in the upper part of Figure 4. This force is termed as the Ampère force and this Ampère force is considered to be  $F = BIL\sin\beta$ , where  $I$  is the current strength,  $L$  is the length of the current-carrying conductor,  $B$  is the magnetic induction



intensity,  $\sin$  is the sine function, and  $\beta$  is the angle between the current direction and the magnetic field direction. However, in the physical experiment as illustrated in the lower part of Figure 4, the movement of the current-carrying conductor will inevitably cause a change in magnetic flux within the closed loop consisting of the current-carrying conductor. This implies that in the process of making a current-carrying conductor to experience a force in a magnetic field, the magnetic flux within the closed loop consisting of the current-carrying conductor must be changed. However, the issue that the magnetic flux within the closed loop consisting of the current-carrying conductor must be changed indicates that in order to make the current-carrying conductor to experience a force in a magnetic field, there must be a closed loop consisting of the current-carrying conductor involved and there must be a change in magnetic flux within the closed loop. This implies that the so-called Ampère force apparently generated by a current-carrying conductor in a magnetic field is actually not generated by the current-carrying conductor itself, but it is generated by a closed loop consisting of the current-carrying conductor with a change in magnetic flux within the closed loop. This is because that it is a common logic that if the whole must be involved in the process of achieving an event X, then the event X is achieved by the whole, but not by part of the whole, and any part of the whole does not possess any possibility to achieve the event X. In this case, the closed loop consisting of the current-carrying conductor is the whole, while the current-carrying conductor is part of the whole.

In fact, the Ampère force law, as illustrated in the upper part of Figure 4, includes at least three scenarios. They are: the scenario where the movement of the current-carrying conductor driven by the so-called Ampère force leads to a change in magnetic flux within the closed loop consisting of the current-carrying conductor, and the scenario where the movement of the current-carrying conductor driven by the so-called Ampère force does not lead to a change in magnetic flux within the closed loop consisting of the current-carrying conductor, even if the current-carrying conductor moves, as well as the scenario where there is no closed loop exists at all. As illustrate in the upper part of Figure 5, the scenario where the movement of the current-carrying conductor driven by the so-called Ampère force does lead to a change in magnetic flux within the closed loop consisting of the current-carrying conductor is an example of the so-called Ampère force law, and the scenario where the movement of the current-carrying conductor driven by the so-called Ampère force does not lead to a change in magnetic flux within the closed loop consisting of the current-carrying conductor, even if the current-carrying conductor moves, is absolutely the counterexample to the Ampère force law which states that a current-carrying conductor experiences a force in a magnetic field, since if there is no change in magnetic flux within the closed loop consisting of the current-carrying conductor, there must be no the so-called Ampère force. This is because that the change in magnetic flux within the closed loop consisting of the current-carrying conductor is the concomitant of the so-called Ampère force, as illustrated in the lower part of Figure 4 and the lower part of Figure 5. It is a logical truth that if X is the concomitant of Y, both achieved in the same process, then if there is no X, there must be no Y, and vice versa. Within this scenario, there must be no the so-called Ampère force, and there must be no the movement of the current-carrying conductor. Again, as illustrated in the upper part of Figure 5, the scenario where there is no closed loop exists is also absolutely the counterexample to the Ampère force law which states that a current-carrying conductor experiences a force in a magnetic field, since if there is no closed loop exists, how there can be a change in magnetic flux within the closed loop consisting of the current-carrying conductor, which is the indispensable prerequisite to generate the so-called Ampère force.

In other words, the Ampère force law which states that a current-carrying conductor experiences a force in a magnetic field, as illustrated in the upper part of Figure 4, includes

the counterexamples to itself. However, this does not imply that this Ampère force law does not hold true in some cases, but holds true in some other cases. In fact, this indicates that this Ampère force law does not hold true in any cases, that is, the Ampère force law which states that a current-carrying conductor experiences a force in a magnetic field does not hold true under any circumstance. These are the logic issues that make the Ampère force law which states that a current-carrying conductor experiences a force in a magnetic field to be false. It can be concluded that the so-called Ampère force is actually not generated by the current-carrying conductor itself, but is generated by a closed loop consisting of the current-carrying conductor with a change in magnetic flux within the closed loop. This indicates that the whole of a closed loop is the minimum physical unit required to generate the so-called Ampère force. That is, the closed loop consisting of the current-carrying conductor is the minimum physical unit required to make a current-carrying conductor to experience a force in a magnetic field, but the current-carrying conductor cannot make itself to experience a force in a magnetic field. As the conclusion of all above, the Ampère force law which states that a current-carrying conductor experiences a force in a magnetic field has logic flaw in its construction process, it does not have logic foundations and is logically untenable, therefore, it cannot hold true.

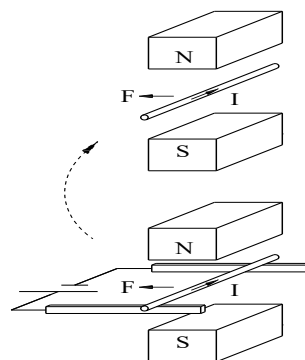


Figure 4: A schematic illustration of logical examinations on the law construction process to test the validity of the Ampère force law which states that a current-carrying conductor experiences a force in a magnetic field.

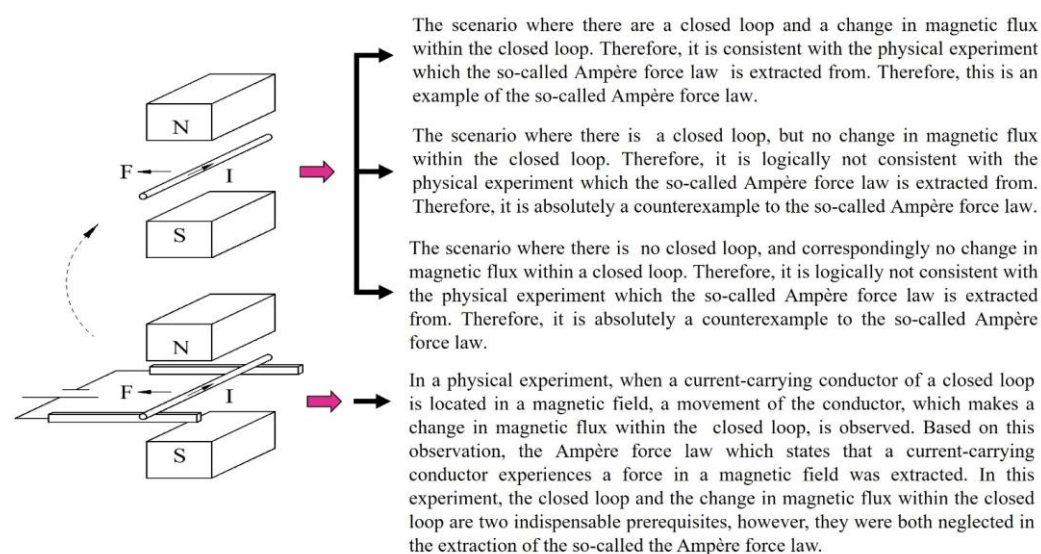


Figure 5: A schematic illustration of logical experiments on the law construction process to test the validity of the Ampère force law which states that a current-carrying conductor experiences a force in a magnetic field, which clarifies that the so-called Ampère force law actually contains at least two counterexamples of itself.

That is, as illustrated in Figure 5, in a physical experiment, when a current-carrying conductor of a closed loop is located in a magnetic field, a movement of the conductor, which makes a change in magnetic flux within the closed loop, is observed. Based on this observation, the Ampère force law which states that a current-carrying conductor experiences a force in a magnetic field was extracted. In this experiment, the closed loop and the change in magnetic flux within the closed loop are two indispensable prerequisites, however, they were both neglected in the extraction of the so-called the Ampère force law. Just because this, the so-called Ampère force law which states that a current-carrying conductor experiences a force in a magnetic field contains three scenarios:

The scenario 1 where there are a closed loop and a change in magnetic flux within the closed loop. Therefore, it is consistent with the physical experiment which the so-called Ampère force law is extracted from. Therefore, this is an example of the so-called Ampère force law.

The scenario 2 where there is a closed loop, but no change in magnetic flux within the closed loop. Therefore, it is logically not consistent with the physical experiment which the so-called Ampère force law is extracted from. Therefore, it is absolutely a counterexample to the so-called Ampère force law.

The scenario 3 where there is no closed loop, and correspondingly no change in magnetic flux within a closed loop. Therefore, it is logically not consistent with the physical experiment which the so-called Ampère force law is extracted from. Therefore, it is absolutely a counterexample to the so-called Ampère force law.

Therefore, the Ampère force law which states that a current-carrying conductor experiences a force in a magnetic field has logic flaw in its construction process, includes the counterexamples to itself, it does not have logic foundations and is logically untenable, therefore, it cannot hold true.

This example shows that if there is no logical experiment, it is difficult to find out that the so-called Ampère force law which states that a current-carrying conductor experiences a force in a magnetic field has counterexamples to itself and has no way to hold true, thus the so-called Ampère force law will be mistakenly recognized as a valid physical law, if it is verified solely through physical experiments. That is, this example shows how important the double-half verification law is.

## 5. The general content of logical experiments

The above stated logical experiment verification is to use people's philosophical ability and logical ability to challenge and judge the validity of physical law. The falsification by logical processes is to challenge and judge the validity of a physical law, and if a physical law cannot be falsified, then it is determined that the physical law is verified in the logical experiment verification process. That is, the falsification by logical processes is applied to replace the verification by logical processes. The falsification by logical processes usually includes: the falsification by counterexample of physical experiment, the falsification by logical combining, the falsification by thought experiment, the falsification by existing laws (e.g., the falsification process by the law of causality and the falsification by the law of conservation of energy, etc.), the falsification by the law of inheritance of symmetry, the falsification by the indispensability of necessary conditions, the falsification by the must-manifesting law of physical law, and the falsification by the existence of the interaction relations.

The so-called falsification by counterexample of physical experiment: Use logical processes to design as many as possible physical experiments which fully match the requirements of the relevant physical law, but they are logically different from the physical experiments which have proved the relevant physical law true, and then conduct all the physical experiments. If the result of any of these physical experiments is inconsistent with the result stated by the relevant physical law, then that physical experiment is the counterexample of physical experiment to the relevant physical law, then the relevant physical law is falsified by the counterexample of physical experiment, that is, the physical law is disproved.

The so-called falsification by logical combing: Make rigorous logical examinations of the extracting process (law construction process) of the relevant physical law to determine whether there are logical flaws in this process, and if any logical flaw is found in this process, then the physical law is falsified by logical combing, and that is, the physical law is disproved.

The so-called falsification by thought experiment: Use imaginations to design as many as possible physical experiments that are difficult or impossible to be implemented in reality, but fully conformed to the requirements of the relevant physical law. Then use logical examinations to determine the results of the physical experiments. If the result of any of the thought experiment does not match the result stated by the relevant physical law, then the relevant physical law is falsified by thought experiment, that is, the relevant physical law is disproved.

The so-called falsification by existing laws: Use existing physical laws to examine the validity of relevant physical law. For example, to falsify a physical law by the law of causality and by the law of conservation of energy, etc. If the relevant physical law is contrary to the existing physical law, then at least one of these two physical laws is false, and if the existing physical law is found to be true, then the relevant physical law is falsified by the existing law, that is, the physical law is disproved. Because the physical laws of nature are interrelated systems, no physical law can contradict any other physical law. When using existing physical laws to examine the validity of relevant physical law, existing fundamental physical laws such as the law of causality, the law of conservation of energy and the law of conservation of matter are usually used, because these fundamental physical laws are simple and stable.

The so-called falsification by the law of inheritance of symmetry: Examine whether the symmetry of cause and the symmetry of result, which the relevant physical law states, are consistent with each other or not. If the symmetry of cause and the symmetry of result, which the relevant physical law states, are not consistent with each other, then the relevant physical law is falsified by the law of inheritance of symmetry, that is, the relevant physical law is disproved. This is because the symmetry of cause and the symmetry of result must be consistent with each other, otherwise, it will violate logics. This is because that symmetrical causes can only lead to symmetrical results, but not asymmetrical results, asymmetrical causes can only lead to asymmetrical results, but not symmetrical results, symmetrical results can only arise from symmetrical causes, but not from asymmetrical causes, and asymmetrical results can only arise from asymmetrical causes, but not from symmetrical causes. This is defined as the law of inheritance of symmetry. The law of inheritance of symmetry is an irresistible law that explains the universal rules that nature has.

The so-called falsification by the indispensability of necessary conditions: Examine whether the relevant physical law states the necessary conditions for the physical

experiment which the relevant physical law is extracted from, and if the relevant physical law does not state the necessary conditions for the physical experiment which the relevant physical law is extracted from, then the relevant physical law is indispensably falsified by the indispensability of necessary conditions, that is, the relevant physical law is disproved. The physical law must state the sufficient and necessary conditions for it to manifest itself, and this sufficient and necessary conditions is the minimum requirement for the relevant physical law to manifest itself, and the necessary conditions are indispensable therein. If a physical law does not state the necessary conditions for it to manifest itself, then the physical law must be upward raised too much, which in turn will lead to the scope governed by this physical law is inflated too much, and eventually lead to the invalidity of the physical law.

The so-called falsification by the must-manifesting law of physical law: Examine whether a physical law does manifest itself or not under the condition that the sufficient and necessary conditions for the manifestation of the physical law are fulfilled, and if the physical law does not manifest itself, then the physical law is falsified by the must-manifesting law of physical law, that is, this physical law is disproved. For example, if a process belongs to the process which the physical law X states, then the physical law X must manifest itself in this process, which is a necessity determined by the nature of physical law. Because if this physical law does not manifest itself in this process, it means that the physical law is resistible, and the resistible physical law means that it is not true physical law. This is defined here as the must-manifesting law of physical law. For example, in any form of energy conversion process, the law of conservation of energy cannot be unmanifested, and in the measurement of the quantity of any form of matter, the law of conservation of matter cannot be unmanifested. If a physical law should manifest itself, but it does not manifest itself, then this physical law does certainly not hold true. And if in a physical experiment, a physical law should manifest itself, but it does not manifest itself, then, this physical experiment is in essence the counterexample of physical experiment of the physical law. And the claimed manifestation processes of this physical laws are nothing more than the illusion of the fact that is achieved by other physical law which does hold true.

The so-called falsification by the existence of the interaction relations: Examine whether the interaction relation for the results stated by a physical law exists or not, and if the interaction relation for the results stated by a physical law does not exist, then the physical law is falsified by the falsification by the existence of the interaction relations, that is, the physical law is disproved. For example, if a physical law claims that Y moving in the direction perpendicular to the physical field X produces Z by the interaction of the physical field X, this physical law is obviously untenable. This is because that it is as absurd as saying that an object moving in the direction of the contour of the Earth's gravitational field does work on the gravitational field or gains energy from the gravitational field. This is also because that it is impossible for a physical field to act in its vertical direction (i.e., in the vertical direction of the field line of physical field), which is here defined as the law of no interaction on vertical direction of physical field.

There should be more logical experiments which can be applied to examine the validity of physical laws, however, the logical experiments stated above are simple and easy to use.

## 6. The methodology of revolutionary technology development

The development of technologies that you don't have, but that others have developed, is follow-up innovation. The development of new technologies on top of existing technologies is breakthrough innovation. The development of unprecedented technology based on

the existing physical laws (which encompass all scientific laws) is disruptive innovation. The development of unprecedented technology based on newly established physical laws is a revolutionary innovation.

If we want to develop technologies that can trigger a scientific and technological revolution, we must establish new physical laws, and if we want to achieve a scientific and technological revolution, we must establish new physical laws. In a word, the establishment of new physical laws is the fundamental way to develop revolutionary technologies and the fundamental way to realize scientific and technological revolution.

However, due to the lack of scientific and technological innovation methodology, especially the lack of methodology for the development of scientific and technological revolutionary technologies, human beings have always believed that the falsification of existing physical laws is a matter of luck, not something you can force, or even the gravest sin against heaven and earth. And for the same reason, human beings have always believed that the establishment of new physical laws is a matter of luck, not something you can force, or even the gravest sin against heaven and earth.

In fact, this is totally wrong, this is a kind of illogical thinking, and the falsification of existing physical laws is a logical necessity and a matter of course, and the establishment of new physical laws is also a logical necessity and a matter of course.

The falsification of existing physical laws and the establishment of new physical laws are one of the monumental engineering feats in the history of human civilization and one of the greatest missions of mankind.

The falsification of existing physical laws and the establishment of new physical laws are not a problem at all, there is only one problem, that is, how to accelerate the falsification of existing physical laws and the establishment of new physical laws, so as to realize a new scientific and technological revolution at an early date, so that human society can sail towards a better tomorrow at an early date. In fact, the fundamental way to achieve this goal is to popularize the logic of physical law verification and the methodology of revolutionary technology development. The logic of physical law verification has been explained in much of the above, and the methodology of revolutionary technology development includes:

- (1) Recognize that all physical laws are only hypotheses and conjectures, and they are only periodic truths, not absolute truths.
- (2) Recognize that the falsification of existing physical laws is a logical necessity and a matter of course, and the establishment of new physical laws is also a logical necessity and a matter of course.
- (3) Conduct physical experiments that totally consistent with the existing physical laws, but are totally different from the existing physical experiments in terms of physical quantities. If the physical experiments succeeded, then disruptive technologies are formed, if the physical experiments failed then, the existing physical law is falsified, and then new physical laws can be established, and finally revolutionary technologies can be developed.
- (4) Conduct physical experiments that totally consistent with the existing physical laws, but are totally different from the existing physical experiments in terms of way of conduction. If the physical experiments succeeded, then disruptive technologies are formed, if the physical experiments failed then, the existing physical law is falsified, and then new

physical laws can be established, and finally revolutionary technologies can be developed.

(5) Conduct physical experiments that totally consistent with the existing physical laws, but are totally different from the existing physical experiments in terms of logic. If the physical experiments succeeded, then disruptive technologies are formed, if the physical experiments failed then, the existing physical law is falsified, and then new physical laws can be established, and finally revolutionary technologies can be developed.

(6) Examine the validity of existing physical law with logical experiments, if the existing physical law violates the logic, then the existing physical law is falsified, then, new physical law can be established, and finally, revolutionary technologies can be developed.

(7) Make rigorous logical examinations of the extracting process (law construction process) of the relevant physical law to determine whether there are logical flaws in this process, and if any logical flaw is found in this process, then the physical law is falsified by logical combing, and that is, the physical law is disproved, and then new physical laws can be established, and finally revolutionary technologies can be developed.

(8) Deeply investigate the cause of the failed physical experiments which should not be failed according to the relevant physical law. If the cause is clarified, then, the failed physical experiments may be the counterexamples. If it is the case, then the physical law is falsified, and that is, the physical law is disproved, and then new physical laws can be established, and finally revolutionary technologies can be developed.

## 7. Refutations towards rectifying the biased understanding of how physical laws are falsified

Most people have a biased understanding of how physical laws are verified and falsified. Therefore, an appeal letter for a manuscript of the author for publication in a Journal is presented below to further clarify the logic of physical law verification.

### The Comments of the Reviewer to the Author and the Point-By-Point Appeal:

(the Page number and Figure number are not related to this paper)

#### (1) Comment 1 of the Reviewer

The Author has made a great effort to improve the manuscript. However, to make a statement as important as 'four fundamental laws of electromagnetics do not hold true', evidence, explanations and discussions must be clearer and provided with greater rigor.

**Response:** I owe the Reviewer a debt of gratitude for his time and effort spent on this comment and I am very grateful to response to the Reviewer's concerns. However, the Reviewer's Comment 1 reflects a biased understanding of how physical laws are falsified. The Reviewer mistakenly requires clearer and more rigorous evidence, explanations and discussions, even after counterexamples to the relevant fundamental laws of electromagnetism are undeniably observed. In fact, in the process of falsifying a physical law, the evidence is sufficient and the rigor is enough, and explanations and discussions are not necessarily required, as long as a counterexample to the physical law is observed. This is because that logically, especially according to Karl Popper's logic for falsification of a physical law, that is, **If from a law L we logically deduce Q, but what is observed is  $\neg Q$ , we infer that the law L is false**, the observation of one counterexample is everything for falsifying a physical law, and nothing more is really



**needed. Therefore, logically, the Reviewer should not require clearer and more rigorous evidence, explanations and discussions, after counterexamples to the relevant fundamental laws of electromagnetism are undeniably observed.**

Karl Popper constructed his falsification theory in his works “Conjectures and Refutations” and “The Logic of Scientific Discovery”, mostly by the concepts of **“Scientific laws are nothing but conjectures and hypotheses.”**, **“All Scientific theories are conjectures, even those that have successfully passed severe and varied tests.”**, and **“A theory which is not refutable by any conceivable event is non-scientific.”** This falsification theory indicates that in natural science, each and every physical law have counterexample and will eventually cease to hold true.

In his book “The Logic of Scientific Discovery”, Karl Popper illustrated the logic for falsification of physical law, that is: **If from a law L we logically deduce Q, but what is observed is  $\neg Q$ , we infer that the law L is false.** In other words, it takes each and every physical experiments to possibly prove a physical law true for the present time, but if one physical experiment proves that a physical law has a counterexample, then this is totally sufficient to conclude that this physical law does not hold true anymore. This indicates that a physical law that has even been proven true by numerous physical experiments over a long period can still be found to have counterexamples and be disproved. Thus, it is not a special problem to discover a counterexample to a physical and falsify it. The problem is just about when the counterexample is discovered and the law is falsified. Therefore, it is a logical thing to discover that four fundamental laws of electromagnetism have counterexamples and do not hold true, but it is not a thing needs special explanations and special discussions, as long as relevant counterexamples are observed.

In this research, all the physical experiments are those fully conforming with the requirements of the relevant laws of electromagnetism, all the counterexamples are those being undeniably observed in the relevant physical experiments, and all the conclusions are those being logically drawn fully according to the observed counterexamples and the falsification logic by Karl Popper. Therefore, the evidence of counterexample is sufficient and the rigor is enough. Logically, especially according to Karl Popper’s logic for falsification of a physical law, in the process of falsifying a physical law, special explanations and discussions are not necessarily required, as long as a counterexample is observed.

Most people may have doubts about why a physical law that has been proven true by numerous physical experiments over a long period can still be found to have counterexamples and be disproved. This is because that physical law is extracted using inductive method. However, when a physical law is extracted using inductive method, the scope governed by the physical law will be much inflated to include areas where the physical law has not been and cannot be verified by physical experiments. This is because there are infinitely many cases in these areas that would need to be verified by physical experiments, yet both the amount and methods of physical experiments which can be conducted are limited. Therefore, physical laws cannot be verified solely through physical experiments. Most people may also have doubts about why four fundamental laws of electromagnetism which have counterexamples and do not hold true can still be utilized in the development of electromagnetic equipment and devices. This is because that the fact that physical laws cannot be verified solely through physical experiments is logically equivalent to the fact that a physical law that made great contribution in human civilization can still be found to have counterexamples and do not hold true, and is logically equivalent to the fact that a false physical law can still be useful. For example, even the geocentric theory does not hold true, but it can still be applied to predict that the Sun will be in the east of X city every 9:00 a.m. at X time zone in the Northern Hemisphere.

Therefore, I would greatly appreciate it if the comment 1 of the Reviewer could be ignored.

## *(2) Comment 2 of the Reviewer*

The Author demonstrates a misinterpretation of well-established concepts. A very clear case is given in the response to point 9 of the Reviewer where the Author erroneously demonstrates that the Lorentz force violates the law of conservation of energy. Please note that the demonstration would be valid for  $B=0$  as well, so it would claim that the system composed of the particle and the bent energy-dissipating charge pipe 2 (a system free of external forces) violates the conservation of energy, which is totally wrong.

Therefore, the manuscript is recommended for rejection.

**Response: Attention 1:** The logical experiment the Reviewer concerned in his Comment 2 which demonstrates that the Lorentz force violates the law of conservation of energy is not part of the manuscript, it is just a discussion in the Response to the Reviewer. Therefore, logically, the results of this logical experiment should not be used as a criterion for the publication of the manuscript, regardless of whether the results are correct or not. **Attention 2:** The Author's interpretation of well-established concepts (of the electromagnetism) does not affect the physical experiments and the discovery of the counterexamples in the manuscript in any way. Therefore, logically, the Author's interpretation of well-established concepts should not be used as a criterion for the publication of the manuscript, regardless of whether the Author demonstrates a misinterpretation of well-established concepts or not.

Even so, I deeply admire and respect the Reviewer for his time and effort spent on this comment and I am very grateful to response to the Reviewer's concerns. However, the Reviewer's Comment 2 also reflects a biased understanding of how physical laws are falsified. The Reviewer mistakenly requires more counterexamples, even after one counterexample is undeniably observed. In fact, in the process of falsifying a physical law, one counterexample is totally sufficient. This is because that according to Karl Popper's word on falsification of physical law: **"The belief that 'all swans are white' can be falsified by observing a single black swan."**, for the falsification of a physical law, one counterexample is totally sufficient.

This is Karl Popper's word: **"The only way to verify a claim such as 'All swans are white' would be if one could theoretically observe all swans, which is not possible. On the other hand, the falsifiability requirement for an anomalous instance, such as the observation of a single black swan, is theoretically reasonable and sufficient to logically falsify the claim."** That is, his other word: **"The belief that 'all swans are white' can be falsified by observing a single black swan."**

Therefore, for a physical law to be true, it must be true in all experiments, however, as long as a physical law does not hold true in one experiment, this physical law is false definitely, even if it holds true in each and every other experiments. This indicates that as long as a physical law is falsified in one experiment, the previous and subsequent truth cases which are observed in experiments are incapable of proving that this physical law holds true.

The Reviewer recognized the result obtained in Author's logical experiment, that is, when the magnetic induction intensity  $B \neq 0$ , the Lorentz force law violates the law of conservation of energy. This is totally sufficient to draw the conclusion that the Lorentz force law

violates the law of conservation of energy.

This is because that as stated above, Karl Popper's logic for falsification of a physical law indicates that as long as a physical law is falsified in one experiment, the previous and subsequent truth cases which are observed in experiments are incapable of proving that this physical law holds true. That is, the logical experiment the Reviewer recognized (in the response to point 9 of the Reviewer) has fully proven that the Lorentz force law violates the law of conservation of energy, even if when the magnetic induction intensity  $B=0$ , the Lorentz force law ostensibly does not violate the law of conservation of energy.

In fact, in physical experiments, regardless of whether the magnetic induction intensity  $B=0$  or the magnetic induction intensity  $B \neq 0$ , the curved trajectory of moving charged particle can be observed, as long as there is a change occurs in magnetic flux within the closed loop consisting of the trajectory of moving charged particle, if the trajectory of moving charged particle curves. However, it reveals a fundamentally different electromagnetic nature of the world, depending on whether the force which curves the trajectory of moving charged particle is generated by the moving charged particle itself as stated in the Lorentz force law, or generated by the whole of a closed loop which consists of the trajectory of moving charged particle and the displacement currents with a change in magnetic flux within the closed loop. This is an extremely important scientific question and is one of the key problems resolved in the manuscript.

What the logical experiment the Reviewer recognized in the comment 2 confirms is that the force which curves the trajectory of moving charged particle is not generated by the moving charged particle itself as stated in the Lorentz force law, but it is generated by the whole of a closed loop which consists of the trajectory of moving charged particle and the displacement currents with a change in magnetic flux within the closed loop. In other words, what the logical experiment confirms is that if the force curves the trajectory of moving charged particle is generated by the moving charged particle itself, then the law of conservation of energy is violated. However, if the force curves the trajectory of moving charged particle is generated by the whole of a closed loop which consists of the trajectory of moving charged particle and the displacement currents with a change in magnetic flux within the closed loop, then the law of conservation of energy is adhered to, since the change in magnetic flux within the closed loop is the source of energy.

In fact, even with the situation in which the magnetic induction intensity  $B=0$ , that is, the system is free of external forces, as the Reviewer states, the Lorentz force law still does not hold true. This is because that in this situation, the force curves the trajectory of moving charged particle can only be generated by the whole of a closed loop which consists of the trajectory of moving charged particle and the displacement currents, but cannot be generated by the moving charged particle itself as stated in the Lorentz force law, since there are no external forces existed. If there are no external forces existed, the moving charged particle itself has no way to be interacted with external forces. Therefore, the force curves the moving charged particle can only be generated by the whole of a closed loop which consists of the trajectory of moving charged particle and the displacement currents. And this indicates that the Lorentz force law does not hold true.

**Therefore, I would greatly appreciate it if the comment 2 of the Reviewer could also be ignored.**

**Therefore, I would greatly appreciate it if the statement of "the manuscript is recommended for rejection" of the Reviewer could be ignored, and the manuscript is published in the Journal.**

If the works of **“The Logic of Scientific Discovery”** of Karl Popper is expressed in one sentence, that sentence is: Physical laws cannot be verified solely through physical experiments. However, the fact that physical laws cannot be verified solely through physical experiments leads to the following conclusions:

A physical law that has been proven to be correct by numerous physical experiments can still be found to have counterexamples, and it can still be false.

A physical law that drives great strides in human civilization can still be found to have counterexamples, and it can still be false.

Therefore, the conclusions in the manuscript that four fundamental laws of electromagnetism have counterexamples and do not hold true are not something impossible, or something ridiculous, but they are something logical, understandable, and at best, they are disruptive achievements which are achievable.

**Therefore, I think the statement of “the manuscript is recommended for rejection” of the Reviewer should be ignored, and the manuscript should be published in Journal. Additionally, the results in manuscript are very important discovery, therefore, if the manuscript is published in the Journal, it will greatly enhance the readership of the Journal. Therefore, I think the manuscript should be published in Journal.**

Most people have a biased understanding of how physical laws are verified and falsified. For example, based on countless experiments and observations, the conclusion (law) is inductively deduced: inertial force and gravitational force are two very different forces. This is a conclusion (law) that has been verified by countless observations and physical experiments, and people have long believed in it. And no one has question on it, so there is a biased understanding of how physical laws are verified and falsified.

However, in the year of 1907, Einstein did an elevator thought experiment (logical experiment). Suppose there is an observer X in a closed elevator X, and if the elevator X is placed on a planet such as Earth, then this observer X will feel gravity, and if it is on Earth, then this observer X will feel his weight, for example, 80 kilograms of gravity on Earth. However, if this elevator X is placed in space without directional gravity, the observer X will feel weightless and will be floating in space with the elevator X. However, assuming that the ignition of the rocket installed outside the elevator X to accelerate the elevator X with acceleration A, since the elevator X is closed, the observer X does not know that the elevator X is accelerating, but he will feel that he is affected by gravity, and if the acceleration A of the elevator X is equal to the acceleration of gravity on the earth, then the observer X's perception is no different from that of being on earth. It is then proved that the inertial force and the gravitational force are the same effect, and the essence of the two is the same. And therefore, Einstein's equivalent principle is established. As demonstrate by this event, logical experiments are increasingly recognized as one of the key tools for verifying physical laws.

Human beings should be aware that falsifying a physical law does not mean falsifying the physical phenomena, physical experiments, or related technologies and products associated with the physical laws, but that there are better ways emerged to achieve them. Human beings should be aware that the belief that the results of physical experiments complied with what a physical law states, then the physical law must be true is a kind of illogical thinking. Human beings should be aware that it is impossible for a new physical law to explain the old physical law, but only to explain the old physical experiments that ostensibly prove the old physical law true.

## 7. Discussion

There are many physical laws in the fields of whole nature science, however, as shown in Figure 6, a big portion of the physical laws established so far are only verified by physical experiments, but not verified by logical experiments. In the process of establishing the physical laws so far, humans have basically only emphasized the half verification that is physical experiment verification, and have ignored the other half verification that is the logical experiment verification. As a result, a big portion of the physical laws have been recognized as the real physical laws up to now without the undergoing of logical experiment verification process, so it is important to re-verify the existing physical laws which have not been verified by logical experiment verification process, and then some new physical laws may be discovered. Therefore, it is not strange things that some physical laws and even some fundamental physical laws are disproved. These are the answers why a physical law that has been proved true by massive cases of physical experiments for a long time can still be disproved. And in essence, this is because that there is an inevitability determined by the logical flaws of the inductive method. This implies that if re-verify the physical laws established so far with the logical experiment verification, that is, with the double-half verification law proposed above, some new laws may be discovered.



Figure 6: Schematic diagram of the verification process of physical laws so far.

In other words, there are two reasons why physical laws cannot be proved by physical experiments alone:

First: In the augmented area, there are physical experiments that conform to the physical law but whose paradigm or logic is different from the physical experiments which the physical law extracted from.

Second: It is because that changes in physical quantities, such as mass, temperature, and velocity, will lead to changes in space-time, and changes in space-time will lead to changes in the functional relationship of physical laws.

## 9. Conclusions

Based on the results obtained in this article, it is concluded that a physical law cannot be proved true solely through physical experiments even by the physical experiments which this physical law extracted from, or by the physical experiments which are designed right in the scope governed by the physical law, and a false physical law can also be proved true by physical experiments. Physical law can only be proved true by the combination of physical experiment verification and logical experiment verification, that is, a physical law must be proved true in both of physical experiment verification and logical

experiment verification before becoming a real physical law, and this is defined as the double-half verification law for verifying physical laws. Since a big portion of the physical laws established so far are only verified by physical experiments, but not verified by logical experiments, therefore, if the double-half verification law proposed above is applied to reverify physical laws established so far, some new understanding of natural world may be achieved. Additionally, eight approaches for revolutionary technology development are proposed.

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**Author Declarations**

**Ethics approval and consent to participate** The author declares that this study was conducted in accordance with ethical standards and guidelines.

**Consent for publication** The author declares that this manuscript does not contain any personal data or sensitive information that requires consent for publication.

**Competing interests** The author declares that he has no competing interest.

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