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Verification of General Lorentz magnetic force

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【**Abstracts**】Faraday's law is that when the flux in the conductor loop changes, it produces electromotive force in the conductor loop, and obeys to contour integral law $\mathrm{d}U = -\oint \frac{\partial \Phi}{\partial t} \mathrm{d}l$, Maxwell Curl Theory is that when the magnetic intensity of a certain point in ether space changes, there produces electric field at that point in ether space, which is the field mutual production theory of "electric field produces magnetic field and magnetic field produces electric field" in the free space which everybody is familiar with, and it obeys differential law $\nabla \times \boldsymbol{E} = -\frac{\partial \boldsymbol{B}}{\partial t}$; Lorentz magnetic force is that when metal electrons cut magnetic lines, metal electrons forced by $\boldsymbol{F} = q\boldsymbol{v} \times \boldsymbol{B}$ move along the conductor to form inductive current, in fact, it doesn't matter whether coil moves or magnet moves, only if there exists relative motion between magnetic field and conductor, metal electrons must cut magnetic lines, which is, "coil stills while magnet moves to the left" and "magnet stills while coil moves to the right" these two situations are the same, which both belong to metal electrons having cut magnetic lines. According to the difference among the above three theories, this article introduces two experimental methods, the first one is the experimental method to distinguish Lorentz magnetic force and Faraday's Law, the second one is the experimental method to distinguish Lorentz magnetic force and Maxwell field mutual production theory, it can obtain the conclusion that "general Lorentz magnetic force is the physical essence of all electromagnetic inductions" through analysis.

【**Key words**】 Faraday's Law, Maxwell's Curl Theory, Lorentz magnetic force, theoretic disagreement.

1 Introduction

Article [1] points out that there exists dispute in the physical essence of electromagnetic induction, in 1832 Faraday thought that the induction between a magnet and a conductor produces induced electromotive force dU in the conductor, in 1834 Lenz thought that there produces induced current I in the conductor. Although they are both the inductions on conductor, but because dU and I exist on the two sides of Ohms law, which is the cause and which is the result, it is like the philosophy issue of egg and chick at that time. But in 1865 Maxwell though that there produces eddy electric field $\boldsymbol{E}$ in the free space when the magnet moves, the integral of $\boldsymbol{E}$ is the electromotive force, the differential of $\boldsymbol{E}$ is current, which seems to calm down the philosophy dispute of causal relationship between Faraday and Lenz. But when thinking of it carefully, the essence difference between it and the former two theorems is even greater, whether induction is produced on conductor or produced in ether space, its physical essence are quite different, because there exists the essential difference between conductor and ether. In 1892 Lorentz founded electron theory, so metal electrons form induced current when being forced by Lorentz magnetic force, its essence is force $\boldsymbol{F}$ and not field $\boldsymbol{E}$. In 1897 J.J Thomson discovered electrons, and proved that Lorentz's electron theory is correct. In fact, it doesn't matter whether coil moves or magnet moves, only if there exists relative motion between magnet and conductor, the metal electrons must cut magnetic lines, which is that "coil stills while magnet moves to the left" and "magnet stills while coil moves to the right" these two situations are same, they both belong to metal electrons having cut magnetic lines. So the physical essence of electromagnetic induction can be unified to Lorentz magnetic force. Until now, similar essence issues of electromagnetic induction between magnet and coil still have not been unified yet, several theoretic opinions are not the same, but there is just one truth, so the textbooks only have to copy, and separately teach each chapter and verse, nobody teaches the essence difference among them. When we think completely, we will discover that, which is essence, which is phenomenon? Which is cause, which is the result? Even which is truth, which is false? This article introduces the experimental method to distinguish the above theoretic refute, it can predict that general Lorentz magnetic force is the physical essence of all electromagnetic inductions through this experiment.

In 1905, Einstein's relativity theory was published and emphasized[2] that "discussing the absolute space is meaningless; the earth self-rotation causes little mechanic difference. According to Maxwell electric dynamics, the magnet motion causes induced electronic field in the space, and then the current in coils is generated, when the coils move in the space, there generates no induced electric field, but the current in coils is still generated, so a conclusion was made that the space should not have been symmetrical(so called the Principl of Relativity). So this paper's conclusion will negate the Principl of Relativity.

2 Experiment of General Lorentz magnetic force

Charges or metal electrons cut magnetic lines, they are forced by Lorentz magnetic force to move, which is the truth accepted by everybody. This verse proves: when magnetic lines cut metal electrons, it makes metal electrons forced by Lorentz magnetic force to move, so it produces inductive current. According to it, let us see two similar experiments, see Fig 1 and Fig 2.

2.1 Lorentz magnetic force when metal electrons cut magnetic lines

According to what Fog 1 shows, based on absolute space time view, uniform static magnetic field is still, the conductor moves to the right at V_q speed （$\boldsymbol{V}_q = \boldsymbol{V}_x$）, according to the Lorentz magnetic force that everybody knows

$$\boldsymbol{F} = q\boldsymbol{V}_q \times \boldsymbol{B} \quad (1)$$

Because the electric quantity q of electron is negative, according to Lenz's right hand law, the metal electrons on conductor move to the y direction, while the positive charges move to the $-y$ direction (through the paper), so the direction of current is $-z$ shown in the graph. According to this experiment, it is the acknowledged law.

2.2 Lorentz magnetic force when magnetic lines cut metal electrons

According to what Fig2 shows, conductor is still, uniform static magnetic field moves to the left at the speed of V_B, referring to $\boldsymbol{V}_x = \boldsymbol{V}_q$ in graph 1 can get $\boldsymbol{V}_q = -\boldsymbol{V}_B$, substitute it into Lorentz magnetic force $\boldsymbol{F} = q\boldsymbol{V}_q \times \boldsymbol{B}$, it is $\boldsymbol{F} = q(-\boldsymbol{V}_B) \times \boldsymbol{B}$, the negative sign here is not added randomly, it is because the moving direction of magnetic field is opposite to the moving direction of conductor. So there comes

$$\boldsymbol{F} = q(-\boldsymbol{V}_B) \times \boldsymbol{B} \quad (2)$$

According to the right hand rule, so the metal electrons in both two graphs move downward, uniform and constant magnetic lines cut metal electrons, which is also Lorentz magnetic force. Because "conductor moves to the right" and "magnetic lines move to the left" these two things are equivalent, they both belong to magnetic lines cutting magnetic lines. So the metal electrons on conductor move to y direction (or positive charges move to $-y$ direction), so the current direction is $-z$ shown in the graph. Comparing the above two graphs, "conductor moves to the right" and "magnetic lines move to the left" these two things are equivalent, they are both forced by Lorentz magnetic force. So we call

$$\boldsymbol{F} = q\boldsymbol{V}_q \times \boldsymbol{B} \oplus q(-\boldsymbol{V}_B) \times \boldsymbol{B} \quad (3)$$

as General Lorentz magnetic force. Experiment proves that the current directions in the above two graphs are the same. Sign $\oplus$ denotes "or" operation.

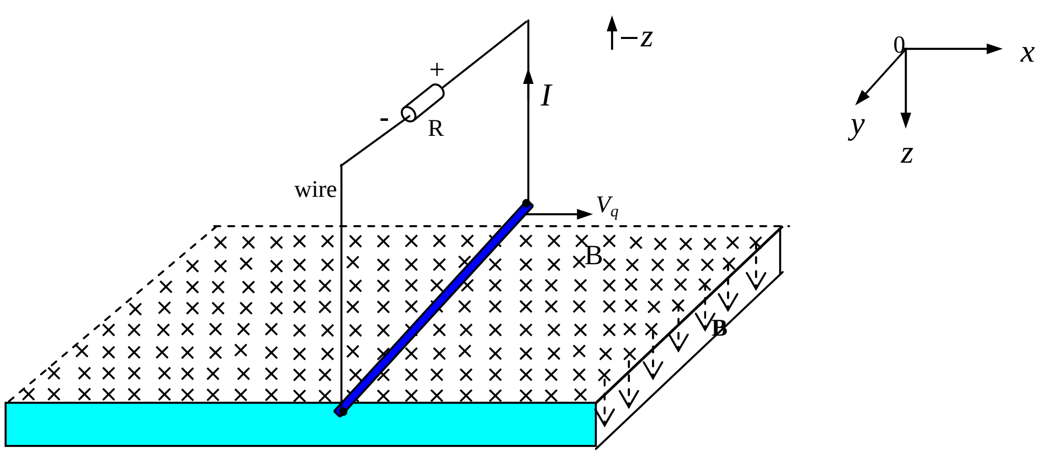

Fig 1 Magnetic lines still while conductor moves to the right

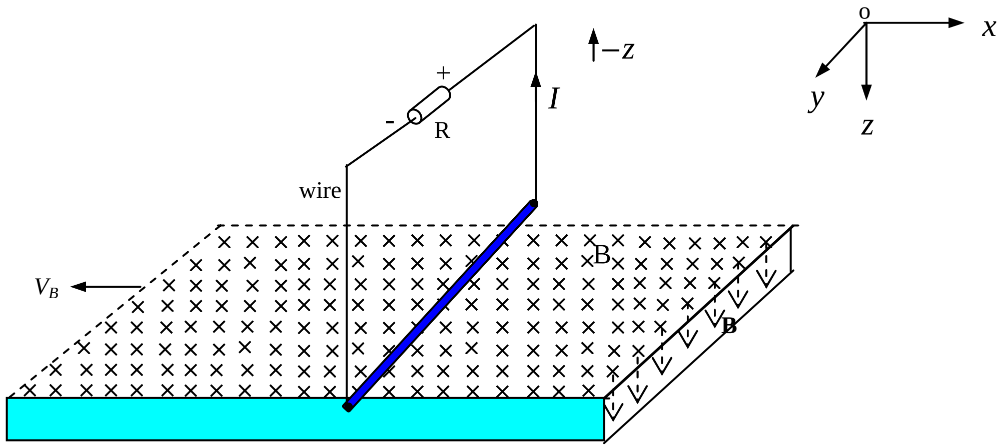

Fig 2　Conductor stills while magnetic lines move to the left

2.3　Fabrication of large uniform magnetic field

During the above discussion, individual readers might say that magnetic lines are bent, how can uniform static magnetic field come? So this verse introduces the fabrication method of uniform magnetic field, according to what Fig 3 shows. Two coils are in serial operation, the produced magnetic lines have the same direction, close though the core. In this way it actually forms an electromagnet. When fabricating, it makes the magnetic field be distributed as even as possible, and the area as big as possible, the fabricated uniform magnetic field does not influence the experimental requirements of Fig 1 and Fig 2.

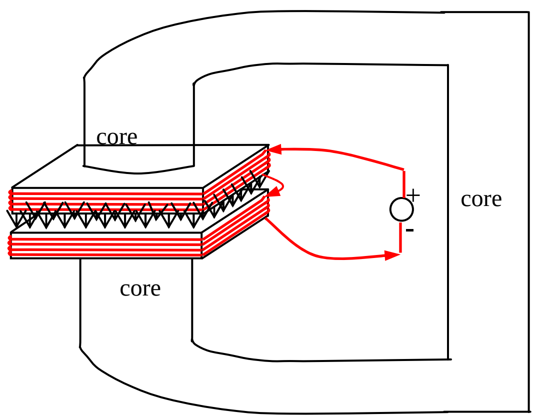

Fig 3　Large uniform magnetic field 的制作

3 The distinguish of General Lorentz magnetic force and Faraday's law

Electromagnetic induction theorem is expressed as: inductive electromotive force is proportional to the change rate of flux that goes through the conductor loop. The formula is: $\varepsilon = -\frac{\partial \Phi}{\partial t}$. It can obtain according to electromagnetic induction theorem: when the flux that goes through the closed conductor loop does not change according to the time, there will not produce inductive electromotive force and inductive current in the closed conductor loop, when the flux that goes through closed conductor loop changes according to the time, there will produce inductive electromotive force in the closed conductor loop, and there will be inductive current according to ohms law.

This experiment analyzes that when the flux that goes through closed-conductor-loop does not change according to the time, but it produces inductive current or electromotive force, while when the flux that goes through closed-conductor-loop changes according to the time, but it does not produce inductive current or electromotive force.

3.1 Experimental procedure

Experiment of Fig 4: In a closed-conductor-loop *abcd* placed in the uniform magnetic field, wire *ab* segment is placed in a half- open shielding-box, and it is insulate between such shielding box and this closed-conductor, wire *cd* segment bears in the magnetic field.The lengths of *ab* segment and *cd* segmentin the shielding box are equal, conductor loop and shielding box move to the right together. It is obvious that the flux of conductor loop in such experiment does not change, if it is according to Faraday's Law, there will be no inductive current in the conductor loop. But in fact, the metal electrons in *cd* segment cut the magnetic lines, and it produces inductive current, sub current times the internal resistance of conductor comes electromotive force

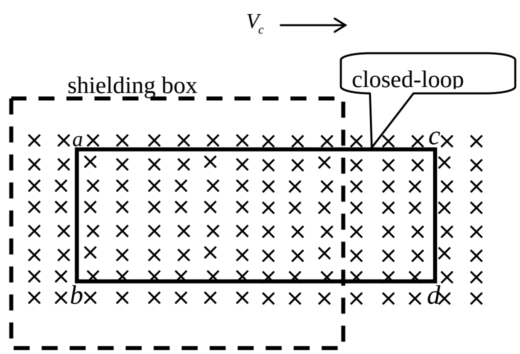

Fig4 shielding box and closed loop move to the right

Experiment of Fig 5: a closed conductor loop *efgh* placed in the uniform magnetic field, the wire of segment *gh* is placed in a half-open shielding box, and it is insulate between this shielding box and this closed conductor. The wire of segment *ef* bears in the magnetic field. Here the loop *efgh* and magnetic field are both still, only the half-open shielding box moves to the right (the left

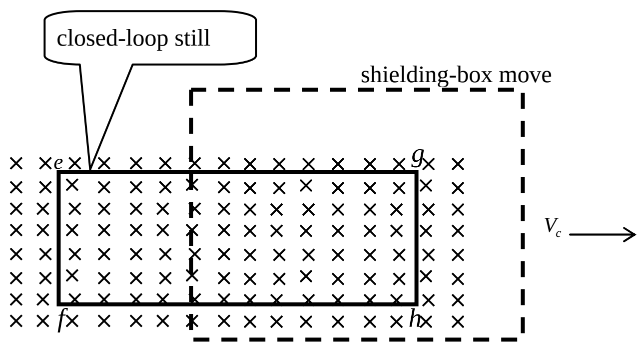

Fig 5 shielding box and closed loop move to the right side of shielding box is open), which makes the flux in loop *efgh* be changed, which is $\varepsilon = -\frac{\partial \Phi}{\partial t} \neq 0$, if it is according to Faraday's Law, there is supposed to have electromotive force and inductive current in the conductor loop, but there is no inductive current in the experimental result.

3.2 Fabrication of half-open shielding box

Shielding box is shown in Fig 6, in order to measure accurately, the requirement is promising that there is no magnetic lines in half-open shielding-box. Or, once the magnetic lines are magnified, the magnetic lines formed on upward and downward iron walls will move together with the iron box, which will cut metal electrons or metal electrons cut magnetic lines, the accuracy measured in this way will be greatly low. So this article requires: the magnetic permeability of the back wall and side wall of iron box should be big, in order to ensure that there is no magnetic line between upward wall and downward wall when the iron box moves in the magnetic field.

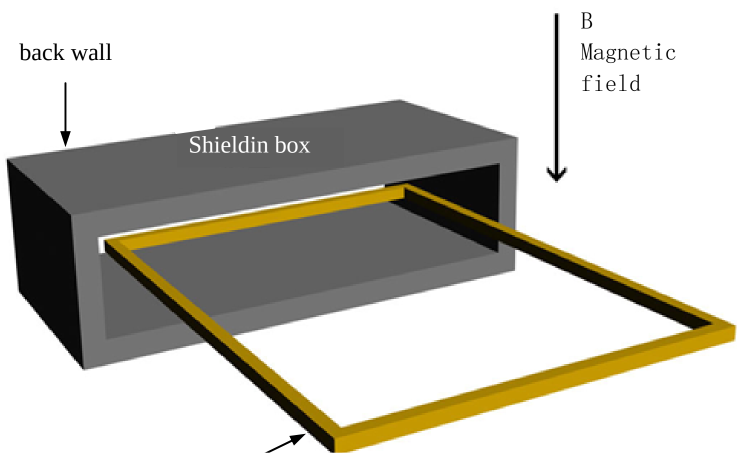

Fig 6 Cenzhi Teng's shielding box

3.3 Conclusion analysis

We analyzed the experimental graph 4 above that when the flux that goes through closed conductor loop does not change, but there produces inductive electromotive force and inductive current in the closed conductor loop, when the flux that goes through closed conductor loop changes in the experimental graph 5, but there produces neither inductive electromotive force nor inductive current in the closed conductor loop. So the conclusion of such experiment can be described as:

According to graph 4 experiment, although the flux in closed loop *abcd* does not change, but there is inductive current, this is because the metal electrons of segment *cd* cut the magnetic lines, and it forms current under Lorentz magnetic force. In other words, inductive current does not depend on the change rate of flux, it only depends on Lorentz magnetic force.

According to the experiment of graph 5, although the flux of closed loop $efgh$ changes, but there is no inductive current, this is because metal electrons have not cut magnetic lines, so there is no inductive current. In other words, inductive current is not linked with the change rate of flux. Lorentz magnetic force is the physical essence of electromagnetic induction.

All in all, the opinion of this article is: General Lorentz magnetic force is the physical essence of electromagnetic induction, while Faraday's law is just the phenomenon of electromagnetic induction.

4 The distinguish of General Lorentz magnetic force and Maxwell field mutual production theory

It does two comparable experiments here, the first is the experiment based on Maxwell's "changeable magnetic field produces electric field", the second is the experiment based on the electromagnetic induction of General Lorentz magnetic force, shown in graph 7 and graph 8, it can distinguish the refute through measuring the magnetic intensity of moving magnet, comparing the measurement results on Gauss meter. The "ring" in graph 7 represents conductor coil, the "ring" in graph 8 represents the electric field enclosing lines in the free space (It was called the electric field enclosing lines in ether space at that time).

4.1 The analytic result of General Lorentz magnetic force

Referred to graph 7, according to General Lorentz magnetic force, when the magnet moves, the moving magnetic lines B cut metal electrons, so metal electrons are forced by General Lorentz magnetic force $\boldsymbol{F} = e(-\boldsymbol{v}_B) \times \boldsymbol{B}$ to produce inductive current, the inductive current on this conductor coil produces new magnetic field $B_L^{'}$, its direction is opposite to the direction of the original magnetic field B of the magnet, the field intensity measured on Gauss meter after cancellation will be weakened a lot. Shown in graph 7, which is the formation principle of inverse magnetic field and back electromotive force.

4.2 The analytic result of Maxwell field mutual production theory

Referred to Fig 8, according to Maxwell field mutual production theory, when the magnet moves, there produces eddy displacement current in the free space (enclosing lines), and such displacement current produces new magnetic field $B_M^{'}$ again, its new magnetic field direction is opposite to the original magnetic field direction of the magnet, the field intensity measured on Gauss meter after cancellation will also be weakened a lot. Shown in Fig 7, which is the result of Maxwell field mutual production.

Comparing these two graphs, i_c in Fig 7 is the conductive current on conductor coil, i_D in graph 8 is Maxwell's spatial displacement current $\varepsilon_0 \frac{\partial E}{\partial t}$. Actually these two graphs distinguish the physical essence issue of back electromotive force. Let us compare the measurement results of these two experiments now. If graph 7 and Fig 8 these two experiments get the same result, it says that it is difficult to distinguish General Lorentz magnetic force and Maxwell field mutual production, but if it measures that the magnetic field in Fig 7 is small (because a part of it is cancelled by inverse magnetic field), while the magnetic field in Fig 8 is bigger, which says that changeable magnetic field does not produce changeable electric field, which proves the universality of General Lorentz magnetic force.

Faraday, Lenz and Lorentz all think that electromagnetic induction happens in the conductor, while Maxwell field mutual production theory thinks that electromagnetic induction happens in the free space (It was called ether space then). According to Maxwell field mutual production theory: changeable magnetic field produces changeable electric field (displacement current), changeable electric field produces changeable magnetic field again, so there should have been new B_M' in graph 8. But this article can foreseeably get the experimental conclusion: there is only Lorentz B_L', not Maxwell B_M'. If it were true, it would indicate: there does not produce magnetic field in the displacement current in free space, and it also indicates that time variable magnetic field does not produce time variable electric field either. This article thinks that General Lorentz magnetic force is true and reliable, while Maxwell field mutual production theory can't completely explain all electromagnetic induction phenomena.

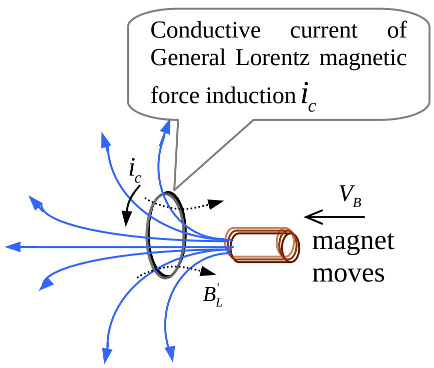

Fig 7 Bent moving magnetic lines cutting metal electrons forms inductive current i_c under General Lorentz magnetic force, i_c produces opposite direction magnetic field B_L'

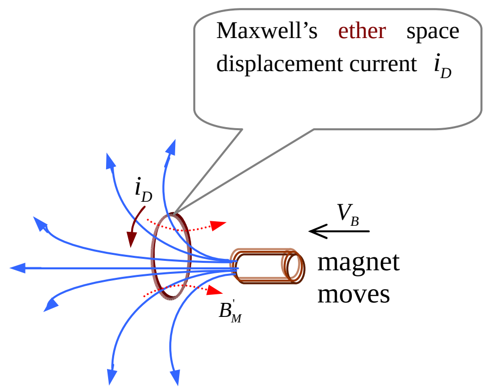

Fig 8 Time variable magnetic field produces time variable electric field, which produces time variable displacement current i_D, i_D produces opposite direction magnetic field B_M'

4. Epilogue

It needs to primarily point out that Faraday's Law can also explain the electromagnetic induction phenomenon when magnet moves, because Faraday's law is the same as Lorentz magnetic force, which belongs to electromagnetic induction happening on conductors, only Maxwell field mutual production theory belongs to electromagnetic induction happening on free space. So the explanation result of Faraday's Law is completely coincident with the explanation result of General Lorentz magnetic force, shown in Fig 9, there also exists opposite direction magnetic field B_L in conductor coil. But Faraday's law can't explain the situation of Fig 5 and Fig 6. Generally speaking, unifying the electromagnetic induction phenomenon of Fig 5, Fig 6, Fig 7, Fig 8 to analyze, this article thinks: Lenz Law determines the current direction, Faraday's Law, Maxwell Curl Theory and Lorentz magnetic force all give out the physical concept description to electromagnetic induction phenomenon, face to the disagreement among these three theoretic opinions, which theory is the physical essence of electromagnetic induction? Through the above analysis in this article, it can think: General Lorentz magnetic force is the physical essence of electromagnetic induction, while Faraday's Law and Maxwell field mutual production theory only describe the individual phenomena of individual electromagnetic inductions, and are not the physical essence of whole electromagnetic induction. Article [1] proves the universality of General Lorentz magnetic force, according to such general character, all electromagnetic induction phenomena can be given out the complete and accurate physical explanation by Lorentz magnetic force (including the reflect mechanism of electromagnetic wave, the receiving mechanism of electromagnetic wave, electronic induction accelerator, direct current generator, Hall effect and all electromagnetic induction products), it doesn't matter whether metal electrons cut magnetic lines or magnetic lines cut metal electrons, the physical essence are both the result of charges being forced by Lorentz magnetic force $\boldsymbol{F} = q\boldsymbol{V} \times \boldsymbol{B}$. Especially when magnet moves while coil stills, the moving magnetic lines cut stationary metal electrons, the forced magnetic force is $\boldsymbol{F} = e(-\boldsymbol{v}_B) \times \boldsymbol{B}$. Sign "-" here is not randomly added by this book, it is because the moving direction of $\boldsymbol{B}$ is opposite to the moving direction of coil. So this chapter calls $\boldsymbol{F} = e\boldsymbol{v}_e \times \boldsymbol{B} \oplus e(-\boldsymbol{V}_B) \times \boldsymbol{B}$ as General Lorentz magnetic force, in other words, it doesn't matter whether coil moves or magnet moves, metal electrons both cut magnetic lines, under General Lorentz magnetic force, metal electrons move along the conductor to form inductive current I, it is just because of the move of electrons so that there constructs inductive electromotive force $\mathrm{d}U = \frac{-I}{\sigma s}\mathrm{d}l$ (ohms law) and inductive electric field $E = \frac{\mathrm{d}U}{\mathrm{d}L}$ (definition of electric field). Which is that, in electromagnetic induction, $\boldsymbol{F}$ is the cause, I, dU and E in the conductor are phenomena, current comes out first and then the voltage.

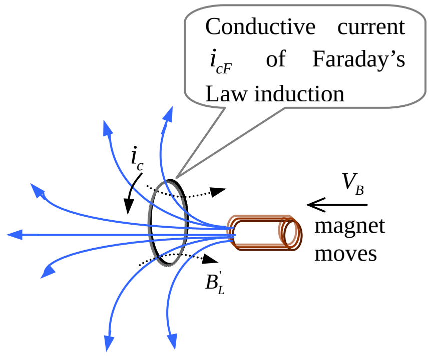

Fig 9 i_{cF} in Faraday's Law, i_{cF} produces opposite direction magnetic field $B_L^{'}$

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