A New Understanding of Macroscopic Electromagnetic Phenomena at the Micro Level

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Abstract:

As we all know, contemporary electromagnetic theory is based on the macroscopic electromagnetic theory established by the 19th century. Because of the lack of microscopic cognition in that era, various electromagnetic phenomena could only be explained and described at the macro level, and their origins could not be explained at the micro level. And because of the microscopic understanding of atomic physics in the 20th century, new progress has been made. Considering that it is now the 21st century, this paper attempts to establish a new theory of microscopic interpretation of classical electromagnetic theory based on the new cognition of atomic physics in the 20th century. Starting from the general assumption, the current will be interpreted as the momentum flow produced by the directed collision between electrons; the charge will be interpreted as a form of expression of electron motion; the voltage is interpreted as the potential difference (energy level difference) of the electron orbit. In the end, this paper successfully developed a new microscopic electromagnetic theory by introducing microscopic atomic physics and rigid body mechanics models to Maxwell's macroscopic electromagnetic theory.

Keywords: charge; current; electric field; magnetic field

1：Introduction

What is the origin of the charge? What is the origin of the current? What is the origin of the electric field? What is the origin of the magnetic field? What is the origin of electromagnetic force? What is the origin of electromagnetic waves? What is the origin of magnetic monopoles? This has always been the mystery of physics. At the same time, referring to the relevant literature [1,2,3,4,5,6,7,8,9,10,11,12,13,14], I have seen many people trying to solve similar problems, but I will adopt Another new way to solve these problems. Based on the new understanding of atomic physics in the 20th century, this paper attempts to explain their origins microscopically.

2: The origin of microscopic charge and current.

According to the classical electromagnetic theory [15], the conduction current is the quantity of charges that flow across a section of a conductor per unit time, which can be expressed mathematically as follows:

$$I = \frac{dq}{dt} \qquad (1)$$

Since the hypothesis of conducting current is based on the cognition of the 19th century, the nuclear model was not known at that time, and the existence of electrons was not known, and the movement of electrons around the nucleus was unknown. Therefore, the current can only be explained by the hypothesis of directed transfer of charge. Since the conduction current is only a hypothesis, we need a more visual explanation, considering that we are unaware of what the nature of the charges is. Therefore, the interpretation of the current with the direction of the electrical charges appears too abstract, and we need a more vivid explanation. Here, based on the new cognition of atomic physics[15], we know the atomic model, the movement of electrons around the nucleus, we can regard the current as a momentum flow. That is to say, the current is the transfer of momentum P transfer between electrons. Because electrons movement around the nucleus, so here the electronic momentum P is the electronic angular momentum impulse（increment）u, namely $P \Rightarrow u$. The current I can be expressed as the quantity of electronic angular momentum impulses u that flow across a section of a conductor per unit time. Thus the nature of an electric charge is the electronic angular momentum u, while the nature of charge quantity q is the quantity n of electronic angular momentum impulse u. That is to say, $q \Rightarrow n$. Then the conduction current can become a conduction force flow:

$$I_n = \frac{dn}{dt} \qquad (2)$$

It can be seen from equations (1) and (2) that the interpretation of current by charge transfer is based on the macroscopic understanding of the 19th century; the use of momentum transfer to explain current is based on the microscopic cognition of atomic physics in the 20th and 21st centuries. So, I redefine the current.

Then, the new current density can be expressed as:

$$J = \frac{dn}{dt \bullet ds_{\perp}} \qquad (3)$$

If the number of carriers per unit volume in the conductor is N, then $\rho = Nn$ (n is the electric momentum of a single carrier). Then the current density in the conductor is:

$$J = Nnv \qquad (4)$$

The relationship between the current density and the current on surface s is:

$$I = \iint_s j \cdot ds \qquad (5)$$

On closed surfaces, it is:

$$I = \oiint_s j \bullet ds \qquad (6)$$

The continuity equation of the current is:

$$I = \oiint_s j \bullet ds = -\frac{dn_{\text{int}}}{dt} \qquad (7)$$

Because the current is the momentum flow, so, the electromotive force is the impulse force of the electron, expressed as:

$$\varepsilon = \int \frac{dp}{dt} dt \qquad (8)$$

Since the current is the momentum flow generated by the impulse of the electron angular momentum, the voltage is the potential difference (energy level difference) of the electron angular momentum or the orbital potential:

$$U_{ab} = \varphi_a - \varphi_b = L_a - L_b = E_a - E_b = \varepsilon \qquad (9)$$

Then, the intensity of the voltage represents the number of potential differences of the electrons:

$$U = n(\varphi_a - \varphi_b) = n(L_a - L_b) = n(E_a - E_b) = n\varepsilon \qquad (10)$$

Therefore, in the closed circuit, the voltage intensity is the inventory quantity of the impulse of the electronic angular momentum; the current represents the flux of the impulse of the electronic angular momentum, so the resistance can be expressed as:

$$R = U - I \qquad (11)$$

It can be seen from the above equation that the resistance is the amount of impulse of the electron angular momentum lost during the conduction process. Ohm's definition of resistance is wrong $R \neq \frac{U}{I}$, we have made a correction here.

Thus, the resistivity is expressed as:

$$\rho = \frac{U - I}{U} = \frac{R}{U} \qquad (12)$$

Conductivity is:

$$\sigma = \frac{I}{U} \qquad (13)$$

Conclusion

From the above derivation, it can be seen that based on the new cognition of atomic physics at the microscopic level, we can know that the current is the momentum flow, the charge is the impulse (or increment) of the electron angular momentum, the quantity of charge is the amount of the impulse of the electron angular momentum, and the voltage is the potential difference of the electrons (the energy level difference), the resistance is the amount of impulse of the electron angular momentum that is lost during conduction. Considering that charge is a manifestation of electron motion, it is expressed in the form of impulse of electron momentum or electron angular momentum.

3: The origin of microscopic electric and magnetic fields

Based on the new cognition of atomic physics, we know the atomic model, know the existence of electrons, know the electron spin, know the movement of electrons around the nucleus, and know the existence of electron magnetic moments. According to the classical electromagnetic theory, the electric field intensity is expressed as:

$$E = \frac{F}{q} \quad (14)$$

As is shown above, the nature of the charge is the impulse u of the electronic angular momentum. According to classical electromagnetic theory and quantum optics theory[16], the electric field is generated by the charge, and the photon is the medium particle of the electric field. It follows that the electric field force is the force produced by the collision of electronic angular momentum impulses with photons. This force is an impulse moment, expressed as $M = r \times u$. The impulse of the electronic angular momentum is generated by electron spin and orbital motion, so, the field source of the electric field is the electron magnetic moment, and the field source particles are electrons e, namely $q \Rightarrow e$. Given that the magnetic field is generated by the molecular magnetic moment $\sum m \neq 0$, while the magnetic moment is generated by the electron spin angular momentum and orbital angular momentum, and also given that t the photon is the medium particles of the magnetic field, then the magnetic field force can also be seen as the force produced by the collision of electronic angular momentum impulses with photons. This force is also an impulse moment, expressed as $M = r \times u$. Accordingly, the field source of the magnetic field is also the electron magnetic moment, and the field source particles are also electrons e. Therefore, we can deduce that the electric field E and the magnetic field H have the same field source, which is the electron e. So we can get a powerful equation that explains that a magnetic field and an electric field have the same field source:

$$H = E = \frac{F}{e} \quad (15)$$

According to the above derivation, since the electric field and the magnetic field have the same field source, the electric field and the magnetic field belong to the same object. This signifies that the nature of the electric field is the magnetic field, so the nature of the electric field force is the magnetic force and the acting force of the positive and negative charges is the acting force of the two magnetic poles. Therefore, we explain the electric field from the aspect of the magnetic field, and explain the acting force of positive and negative charges from the aspect of the magnetic force. Electromagnetic waves can be interpreted as media fluctuations generated by electronic collision media. The amount of charge measured by Millikan's 'oil-drop' experiment can be interpreted as the force generated by the electron magnetic moment. The positive and negative charges can be interpreted as the behavior of the two magnetic poles of the magnetic field.

Since we have explained the electric field from the aspect of the magnetic field, we need to explain the nature of magnetic and magnetic forces. For the nature of the magnetic force, we can assume from the kinetic point of view that the impulse of the angular momentum impinging on the photon of the medium causes the photon vortex to move, which in turn produces a medium impulse moment (similar to fan blowing). The medium impulse moment is the magnetic force, and the essence of the magnetic force line can be regarded as the cyclotron motion path of the medium photon. Thus, the magnetic force represents the cross product of the impulse u applied by the electron to the photon of the medium with the vector of the photon displacement vector r, which can be expressed mathematically as:

$$M = r \times u \quad (16)$$

Magnetic field can be defined as "a vortex force system generated by photon cyclotron motion of electrons colliding with multiple spins", that is the superposition state of the magnetic moment. Its mathematical expression is:

$$M = \sum m \quad (17)$$

If the magnetic field line is used to express the magnetic field, then the magnetic field can also be expressed with the geometric changes of field strength and magnetic flux:

$$\Phi_H = \iint_s H \bullet ds \tag{18}$$

In this way, we defined the nature of magnetic field and magnetic force, and thus unraveled the mystery about the intrinsic nature of electromagnetic field and electromagnetic force.

According to the law of Ampere Circle $\oint_L B \cdot dl = \mu_0 \sum_{i=1}^{n} I_i$, the relationship between the magnetic field strength and the current in the current-carrying conductor can be expressed as:

$$\oint_L H \cdot dl = \mu_0 \sum_{i=1}^{n} I_i \tag{19}$$

Taking into account that the field source of the magnetic field is the electron e, the force applied on static electrons in the magnetic field is:

$$F = eH \tag{20}$$

The force applied on moving electrons in the magnetic field is :

$$F = ev \times H \tag{21}$$

The total force acting on the current-carrying conductor in the magnetic field is:

$$F = \int_L dF = \int_L de \times H \tag{22}$$

Taking into account that the field source of the magnetic field is the electron e, and the impulse momentum produced by per unit electron is M_e.

With reference to Biot-Savart law, it indicates that the physical meaning of current element is the electronic impulse moment $Idl \Rightarrow M_e$. Then the magnetic field strength generated by the electron at any point in the space can be expressed as:

$$dH = \frac{dM_e \times e_r}{r^2} = \frac{Idl \times e_r}{r^2} \tag{23}$$

The vector integral form is:

$$H = \int_L dH = \int_L \frac{dM_e \times e_r}{r^2} \tag{24}$$

The magnetic interaction between two electrons can be expressed as:

$$dF_{1\to 2} = \frac{dM_{e2} \times (dM_{e1} \times e_r)}{r^2} \tag{25}$$

When the vector is not considered, the acting forces between two electrons can be idealized as $F_{1\to 2} = \frac{e_2 e_1}{r^2}$. The equivalent Coulomb's law thus can be derived:

$$F_{1\to 2} = \frac{e_2 e_1}{r^2} \Leftrightarrow \frac{q_2 q_1}{r^2} \tag{26}$$

It can be seen from the above that we can deduce the equivalent Coulomb's law from the angle of the magnetic field, and prove that the Coulomb electrostatic field is a current element magnetic field. (Of course, this is an interesting discovery, you can think of a lot of things)

Thus we can come up with a prediction:

"The frictional electrification phenomenon is the friction generating current (momentum flow) and the magnetic field".

The mechanism is:

Friction causes the electron to direct the collision motion to generate a momentum flow (current), and the electron momentum flow (current) polarizes the electron magnetic moment to generate a magnetic field (this is an electromagnet).

The rubbed object has the property of attracting light and small objects. The essence is that the current element magnetic field (strong magnetic field) generated by friction polarizes the electron magnetic moment of light and small objects, so that light and small objects display magnetic properties externally, and the attraction phenomenon is the interaction between the two magnetic fields. So the frictional electrification phenomenon is the friction generating current and magnetic field.

Therefore, we can predict that both electromagnets and powerful magnets can attract shredded paper.

Experimental verifications:

We can verify this conclusion by observing whether a strong magnetic field is capable of attracting light objects (paper scraps).

Discussion: If we see the phenomenon that a strong magnetic field can attract light and small paper scraps, the theory is correct. If we do not see such a phenomenon, the theory is wrong. (Although we have carried out experiments to verify our conjecture, we still invite you to verify our theory through repeated experiments).

Experimental equipment: power supply（AC）, voltage regulator, after the power to generate magnetic field copper coil, paper, field strength measuring instrument

Experimental steps:

1: Series the power supply（AC）, voltage regulator and copper coil

2: Sprinkle paper scraps around the copper coil

3: Turn on the power supply, through the voltage regulator to control the current, observe the copper coil around the magnetic field can attract paper scraps.

4：In the experiment, we can see that the greater the current, the greater the intensity of the magnetic field, attracting the more intense. the intensity of electromagnetic radiation (value range is 0-8181 w/cm^2).

This experiment proves that electromagnets (strong magnetic fields) can also attract shredded paper (or electrostatic attraction).

Discuss:

According to the conclusions herein, the magnetic field can attract shredded paper. However, ordinary magnets do not attract shredded paper and other light and small objects, which will prompt many people to question my conclusion.

So I need a clarification. The reason why ordinary magnets can't attract shredded paper is because the magnetic force is small and the magnetization ability is weak. The frictional ruler can attract the shredded paper because the friction generates the magnetic field excited by the current, and the current is excited. The magnetic field strength is much larger than that of an ordinary magnet, so the magnetization ability is strong and the paper scraps can be magnetized. This is equivalent to friction making the plastic ruler an electromagnet, so the magnetic field generated by the electromagnet can attract shredded paper. Thus, this means that as long as the magnetic field strength is large enough, it can attract shredded paper. In fact, it is true. In my subsequent experiments, I used a powerful magnet to get close to the shredded paper. Finally, there was a phenomenon of attraction. Interested friends would like to repeat my experiment or ask me to ask for an experimental video.

Note: In fact, powerful magnets can attract almost all small and light objects, such as hanging apples, tomatoes, burning matches, etc. (I can provide experimental videos)

The force exerted by the current carry conductor L_1

on the electron e_2 is:

$$dF_{1\to 2} = M_{e2} \times \int_{L_1} \frac{dM_{e1} \times e_r}{r^2} \qquad (27)$$

The force exerted by the current carrying conductor L_1 on the current carrying conductor L_2 is:

$$F_{1\to 2} = \int_{L_2} dF_{1\to 2} = \int_{L_2}\int_{L_1} \frac{dM_{e2} \times (dM_{e1} \times e_r)}{r^2} \qquad (28)$$

On the contrary:

$$F_{L_2\to L_1} = -F_{L_1\to L_2} \qquad (29)$$

From the above, we can extrapolate that the magnetic field excited by the impulse of the electronic angular momentum follows the inverse square of the distance.

The moment of forces in the magnetic field can be expressed as:

$$M = m\times H \qquad (30)$$

According to Faraday's law of electromagnetic induction, we can work out the relationship equation between EMF and magnetic field strength:

$$\varepsilon_i = -\frac{d\Phi}{dt} = -\iint_s \frac{\partial H}{\partial t}\cdot ds \qquad (31)$$

It can be inferred from the above deduction that we can theoretically explain all the electric field phenomena from the aspect of the magnetic field, and predict that triboelectrification is a result of friction generating a magnetic field, which is another major breakthrough point in this paper.

Discussion: If triboelectrification is essentially a phenomenon where friction produces a magnetic field, then the unipolar electrostatic field is actually a dipole magnetic field. We can verify this by seeing if the charged scraps in the triboelectrification phenomenon have the magnetic properties of the two poles.

4: A new expression of Maxwell's equations at the microscopic level

According to the above inference, the essence of the electric field at the microscopic is the current element magnetic field. So the same objects cannot be transformed into each other, and we need to improve Maxwell's equations.

According to the above-mentioned derivation of Faraday's law of electromagnetic induction, the electromotive force in the magnetic field is:

$$\varepsilon_i = -\frac{d\Phi}{dt} = -\iint_s \frac{\partial H}{\partial t} \cdot ds \qquad (32)$$

The electromotive force ε_i here represents the impulse force of the electron.

The fourth equation of Maxwell's equations is:

$$\oint_L H \cdot dl = I_{oint} + \iint_s \frac{\partial D}{\partial t} \cdot ds \qquad (33)$$

Considering that the current density of electric displacement is $J_d = \frac{\partial D}{\partial t}$, and the current density of the conduction momentum flow is $J = \frac{dn}{dt \cdot ds_\perp}$, then the relationship between the electric displacement D and the quantity of electronic angular momentum impulses n can be expressed as $\partial D = \frac{\partial n}{\partial s}$, so the above equation can be improved as follows:

$$\oint_L H \cdot dl = I_{oint} + \iint_s \frac{\partial n}{\partial t} \qquad (34)$$

Which signifies the varied quantify of electronic angular momentum impulses can generate a magnetic field.

Considering that the electric field and the magnetic field have the same field source, namely the electron e, the equations of the Maxwell's equations of the electric field and the magnetic field can be overlooked. The latest improved Maxwell's electromagnetic transformation equation is as follows,

$$\begin{cases} \varepsilon_i = -\iint_s \frac{\partial H}{\partial t} \cdot ds \\ \oint_L H \cdot dl = I_{oint} + \iint_s \frac{\partial n}{\partial t} \end{cases} \qquad (35)$$

According the above derivation, a varied magnetic field can produce an electromotive force and the varied quantity of electron momentum can produce a magnetic field which means.

5: Conclusion

Because Maxwell's theory of electromagnetics was established in the 19th century, there was no atomic physics in that era. Therefore, Maxwell can only describe various electromagnetic phenomena from a macroscopic perspective, and cannot explain their origins microscopically.

Since we have gained new understanding in atomic physics in the past 100 years, this paper attempts to introduce microscopic atomic physics and rigid body mechanics models for Maxwell's macroscopic electromagnetic theory. Thus, a new theory of the microscopic expression of Maxwell's classical electromagnetic theory is established, and finally a new understanding of macroscopic electromagnetic phenomena at the micro level is sought.

We know that in Maxwell's macroscopic electromagnetic theory, all electromagnetic phenomena are manifestations of electric charge, electric field and magnetic field. In this paper, I introduced atomic physics and rigid body mechanics models from the microscopic, which weakened the concepts of macroscopic charge, electric field and magnetic field.

To understand all macroscopic electromagnetic phenomena into microscopic magnetic moments, moments, momentum, angular momentum, and momentum flows. Finally, a feasible explanation of the origin of charge, current, voltage, electric field, magnetic field and electromagnetic force is proposed from the micro level.

Therefore, this paper inherits and develops Maxwell's classical electromagnetic theory, brings macroscopic electromagnetics into the field of microscopic electromagnetics, and obtains a deeper and more thorough understanding, which makes up for the deficiency of Maxwell's macroscopic electromagnetic theory at the micro level, open a new research area.

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