《量子物理与材料化学杂志(ISSN 2958-4027)》
Journal of Quantum Physics and Materials Chemistry (ISSN 2958-4027)

ChengZhu Science™

Serial in November, 2022

ChengZhu Science Research Center Limited

(Hong Kong Registration NO. 80561228)

Journal article DOI is registered via JiangXi Province ChengZhu Environmental Engineering Company Ltd, with Crossref membership (DOI prefix 10.58473)

出版人：　刘焕　香江出版社有限公司

Publisher: Liu Huan,　Xiangjiang Publishing Company Ltd.



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Article 4. Electromagnetism and Materials

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DOI: https://doi.org/10.58473/JQPMC0004

Formally published on 15/11/2022; Latest revised on 26/10/2026.

Abstract:

This paper first discusses the basic concepts and interrelations of the independent dimensions among field, energy and mass. The basic concepts of magnetic field, electric field and electromagnetic wave are also summarized with common application technologies. Finally, unlike the theory of relativity which introduces time variable into multi-dimensional coordinates, this paper introduces the four-dimensional variables based on the theory in space topology, which discusses the field of the fourth-dimensional parallel space based on the symmetry of the magnetic field and the electric field, and incorporates the original bio-electromagnetic wave theory into the study of electromagnetic theory, filling in the research gap which has not been covered in the previous textbooks.

译文：本文首先论述场量、能量、质量三者量纲独立存在的基本概念与相互联系。磁场、电场、电磁波相关基本概念以及常见应用技术也随后进行概述。最后，不同于相对论将时间变量引入多维坐标，本文将引入空间拓扑学的高维度空间的四维度变量，以磁场、电场的对称性为基础论述第四维度平行空间的场量，并且将生物电磁波理论纳入电磁理论的学习，弥补之前教材的研究空白。

Key words: Magnetism, Electric Field, Electromagnetism, Electromagnetic Wave, Electromagnetic Materials.

1.Introduction

Electromagnetic study mainly contains three parts: magnetism, electric field, electromagnetic waves. This journal has previously pointed out that magnetism is the original/first attribute of substances, and the other two parts of both electric field and electromagnetic waves become the secondary/derived attributes of substances [25], so that this article discusses the original attribute of magnetism with emphasis on the magnetic materials application firstly, and then subsequently outlines the electric field and electromagnetic waves. Finally the original viewpoints have been discussed with regards to the above themes.

Before discussing the three parts of electromagnetic study, this article need to classify

the physical attributes of field, energy and mass firstly. The physical attribute of field is revealed as the potential of work, and when field is conducting work, it releases energy. In this article, electromagnetic waves is defined as a kind of work conducted by both magnetic and electric field, and this form of work is in absence of mass. However, this work expressed as electromagnetic wave can be converted into other forms of work involving in mass attribute by thermal process, which has been substantially discussed in my previous journal article [26]. Consequently, the three physical attributes of field, energy and mass exists in the universe independently.

2.Magnetic Field and Magnetic Materials

2.1.Magnetic Field

Magnetic field is a kind of vector field existing with directional and numerical value at any position in the space. In the conceptions of electromagnetism, magnets, electric currents and time-varying electric fields all produce magnetic fields, which imposes magnetic force on the magnetic substance or current in the magnetic field, thus showing the existence of the magnetic field. For example, magnets and other magnets exert force and torque on each other through their respective magnetic fields; and electric charges in motion also produce magnetic fields. It is specified that the direction of the magnetic field force received by the north pole of the small magnetic needle at a point under the magnetic field is the direction of the electromagnetic field at that point. Outside the magnet, the magnetic induction line starts from the north pole to the south pole, while inside the magnet it starts from the south pole to the north pole [12].

2.2.The Interactions Between Moving Charges and Magnetic Field

The first part is the force of the moving charges induced by the magnetic field. The force received by the moving charge in the magnetic field is called Lorentz force. The Lorentz force formula is $F = QVB\sin\theta$. F is the Lorentz magnetic force, Q is the amount of charges at a point, V is the speed of motion, and B is the strength of the magnetic field at this point, θ is the angle between V and B [1].

The second part is the magnetic field generated by the moving charges. Fig 1 below is the typical experiment: For two parallel wires, when the current direction is the same between both, the two wires attract each other (shown as case A); When the current flows in the opposite direction, the two wires repel each other (shown as case B). When the movement direction of a positive point charge is the same as the current direction of a wire, it is attracted by the wire (shown as case C); If the movement direction is opposite to the current direction of the wire, it is exclusive against the wire (shown as case D) [1].

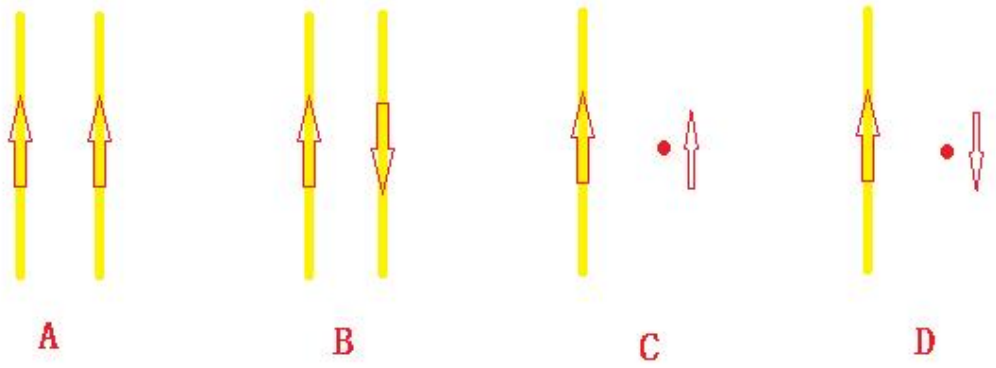


Figure1. Typical cases on the magnetic field generated by the moving charges [1].

2.3.Magnetic Moment

Magnetic moment is a physical property of magnet that is imposed by the torque when it is located in the external magnetic field. This causes magnetic moment to be arranged along the direction of magnetic field line under the external magnetic field, which can be expressed as a vector. The general direction of the magnetic moment of the magnet is from the South pole of the magnet to the North pole. The strength of the magnetic moment depends on both the polarity of magnetism and intensity of the magnet [2].

According to the multi-magnetic poles' expansion of its Taylor formula, the magnetic poles are classified into odd mono-poles and even poles, with constant value of zero for odd mono-poles. Then the even magnetic poles contain the magnetic dipoles, the magnetic quadrupoles, ... and so on. However, the magnetic dipoles usually become the major component, forming magnetic dipole moment [2].

The magnetic dipole moment of a rectangular coil current carrying cycle is the carrying current multiplied by the loop area,

$$\mu = I\,\mathrm{A},$$

where μ is the magnetic dipole moment, I is the current, A and is the area vector. The direction of magnetic dipole moment and area vector is determined by the right-hand rule [2].

For the current carrying cycle in the external magnetic field, the relationship among the torque which it receives, its potential energy and the magnetic dipole moment is:

$$\tau = \mu\,\mathrm{B}$$
$$\mathrm{U} = -\mu\,\mathrm{B}$$

where, τ is the torque, B is the magnetic field, and U is the potential energy [2]. When

the direction of magnetic moment is positively parallel to the external magnetic field, the potential energy is the Minimum; when the direction of magnetic moment is oppositely parallel to the external magnetism, the potential energy turns to be the Maximum [1].

2.4.Electron Intrinsic Magnetic Moments

Many elementary particles, such as electrons, possess intrinsic magnetic moments that is different from the magnetic moment of classical physics, but related to the spin of particles explained by quantum mechanics. These intrinsic magnetic moments are quantized, and the smallest basic unit is often called ‘magneton’[2].

$$\mu_s = - g \mu_b S/h$$

In this equation, μ_s is the magnetic moment of the electron spin, (g) factor is a proportional constant of the electron spin, S is the Bohr magneton, μ_b is the electron spin, and h is the reduced Planck constant [2].

$$\mu_b = eh/2m_e$$

Where e is the negative charges of electron, and m_e is the mass of electron. This equation is also applicable on the protons, which choose positive charges and mass of protons to fill in parameter e and m_e respectively [2].

2.5.Magnetic Moment of Electrons Inside Atom

Inside an atom, there may be many electrons. To calculate the total angular momentum of an atom containing multi electrons, it is to sum the spin of each electron to get the total spin, expressed as summing the orbital angular momentum of each electron to get the total orbital angular momentum of an atom by using the angular momentum coupling method. The component of magnetic moment to magnetic field direction is [2]

$$\mu_z = - g \mu_b J_z/h$$

Among them, g is the unique Lande g factor of the atom; μ_z is the component of the total angular momentum to the direction of the magnetic field; J_z is the magnetic quantum number, which is 2J+1 integer value in total from - J, - J+1,..., J-1, and J. Because electrons have a negative charge, μ_z is negative [2].

2.6.Magnetic Moment of Nucleus

Spin is one of the quantum properties of nucleons[2]. Nuclear magnetic moment is a physical quantity that represents the magnetic intensity of atomic nucleus. Both the

protons and neutrons in an atomic nucleus possesses certain magnetic moments and the movement of charged protons inside the nucleus also produce magnetic moments, both of which contribute to the magnetic moments of atomic nuclear [3].

2.7.Magnetic Moment of Molecules

The magnetic moment of molecules are attributed to multiple sources including election spin, nucleus spin, etc. According to the strength of each source, the first contribution to magnetic moment of molecule is the unpaired electrons. If there are unpaired electrons, the magnetic moment generated by their spin (paramagnetic contribution) is the strongest sources of magnetic moment for molecules; Secondly, when the electrons are under the ground state, the orbital motion produces a magnetic moment (diamagnetic contribution) that is often proportional to the external magnetic field, which becomes the secondary sources of magnetic moment for molecules; Thirdly, the total magnetic moment produced by the nuclear spin would be another minor source contributing to the molecular magnetic moment [2].

2.8.Maxwell Equations Composed of Four Sub-equations:

Gauss law: this law describes the relationship between electric field and spacial distributions in electric charges, expressed as the electric field line commencing from the positive charge and terminating at the negative charge. By calculating the quantity of electric field lines penetrating through a closed spacial surface, defined and named as electric flux, it is to know the total charges contained in the closed surface. More specifically, this law interprets the relationship between the electric flux penetrating via an arbitrary closed surface and the electric charges in the closed surface [3].

Gauss magnetic law: This law shows that magnetic monopoles do not actually exist. Therefore, there is no isolated magnetic poles, so that the magnetic field line passes without both initial point and termination point. Magnetic field lines can form loops or extend to infinity. In other words, the magnetic field lines that enter any region must leave that region, which means that the magnetic flux through any closed surface is equal to zero, or the magnetic field is a passive field [3].

Faraday's Law of Induction: This law describes how a time-varying magnetic field induces an electric field, which becomes the theoretical basis for many generators. For example, a rotating bar magnet is capable of generating a time-varying magnetic field, which in turn generates an electric field, causing adjacent closed circuits to induce current [3].

Maxwell Ampere's Law: This law clarifies that magnetic field can be generated in two ways: one is by conducting current (the original Ampere's Law), while the other is by time-varying electric field or displacement current (Maxwell's correction term) which means that time-varying electric field can generate magnetic field, while time-varying magnetic field can generate electric field due to Faraday's law of induction. In this way, the two equations theoretically explain the electromagnetic waves propagate in

space by self-maintaining[3].

$$\Delta \times H = J + \frac{\partial D}{\partial T}$$

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

$$\Delta \times B = 0$$

$$\Delta \times D = \rho$$

The first equation is the differential form of the full current law, which shows that the curl degree of the magnetic field strength (H) is equal to the full current density at the point calculated as the sum of the conducted current density (J) and the displacement current density $\frac{\partial D}{\partial T}$. The vortex source of the magnetic field is determined by the full current density, and both the displacement current and the conducted current can produce magnetic fields [3].

The second formula is the differential form of Faraday's law of electromagnetic induction, indicating that the curl of electric field strength (E) is equal to the negative value of the rate of magnetic flux density (B) with time change (t) at this point, which means that the vortex source of electric field is the time change rate of magnetic flux density [3].

The third equation is the differential form of the principle of magnetic flux continuity, which shows that the divergence of magnetic flux density (B) is constant as zero, which means that line (B) has neither commencement nor terminal. That is, there is no magnetic charge corresponding to the electric charge [3].

The fourth equation is an extension of Gauss's law of electrostatic field, revealing that under time-varying conditions the divergence of electric potential shift (D) is still equal to the volume density of free charges at the point [3].

In addition to the above four equations, the constitutive equation of the medium is also required as blow:

$$D = \varepsilon E \qquad B = \mu H \qquad J = \sigma E$$

To finally solve the field calculation, parameters of medium is determined in above three equations, where ε represents the dielectric constant of the medium, μ indicates the permeability of the medium, and σ means the conductivity of the medium respectively [3].

2.9.Formation of Magnetic Materials

Why do not all materials become magnetic? Such as potatoes that do not show magnetism, but it also has electrons in its atoms. Why are the orbits of these electrons not aligned to excite the magnetic field? If the orbits of these electrons were arranged, which direction would their north-south polar axis display? There are some explanations below [1]:

First of all, some materials may not be able to become magnets, possibly because the contribution of each electron orbit to the atomic magnetic moment is zero. For example, there are two electrons in an atom, which move in opposite directions, so that its magnetic moment of an atom turns to be zero as a whole. In this way, there is no doubt that it has no magnetism [1].

Even if atoms show magnetic moments that are not offset, however, the directions of different atomic magnetic moments may also be random, leading them to be zero when they are added together. This disorganized orientation is a reflection of thermal movement. When the temperature reaches a critical value, the magnetism will disappear due to the enhancement of irregular thermal movement and this critical temperature is called Curie temperature [7]. When it is heated, atoms move randomly. If the magnet is taken off the refrigerator and heated on the baking tray for a while, its magnetism becomes weaker. If it is heated above the Curie temperature, this thermal movement becomes very violent, which can even completely destroy the magnetism of the magnet as a whole. However, inversely, if it is cooled below the Curie temperature, the magnetism is restored. Consequently, this is an reversable process [1].

Further more, which direction does the magnetization point to? (Here, it is assumed that the crystal formed by atoms has no direction). How do these small atomic magnetic moments display towards a common direction, forming a state of magnetic order? The answer is that they need the help of an external magnetic field. When these dipoles are under an external magnetic field, the external magnetic field forces these magnetic moments to be aligned in the direction of the field. If the external magnetic field is removed, what will happen? In some cases, the irregular thermal motion is dominant, resulting in the disappearance of magnetism. For paramagnetic materials, below the Curie temperature, even if the external field is removed, the dipoles will remain aligned in that direction, because these dipoles will themselves excite a magnetic field strong enough to maintain the alignment even if the external field disappears. Therefore, magnetism is the result of joint action among atomic magnetic moments [1].

2.10.Paramagnetism

Paramagnetism refers to the magnetism of materials in response to external magnetic field, although the generated magnetic moment is usually weak with value range from 10^{-6} to 10^{-3}. It is to define the magnetic susceptibility K = M/H, where M and H are magnetization and magnetic field strength respectively, and the magnetic

susceptibility K is positive, because the direction of the magnetic susceptibility is the same as the magnetic field strength [5].

Although some atomic nuclei (such as 1H, 7Li, 11B, 13C, 17O, etc., and neutrons) also possess magnetic moments, which generate paramagnetism under the induction of external magnetic field, their magnetic susceptibility (K) is much smaller than the contribution of electrons to paramagnetism, only in the order of 10^{-6} - 10^{-10} [5].

From the perspective of atomic structure to explain the causes of paramagnetism, atoms, ions or molecules that make up paramagnetic materials have inner shell orbits that are not completely filled by electrons, which means that there are unpaired electrons. Consequently there are inherent and free magnetic moments in atoms, ions or molecules of such materials, and the orientation of these free magnetic moments is irregular, so that the materials is incapable of forming spontaneous magnetization. Once external magnetic field is imposed, the direction of these free magnetic moments can be regulated into the same direction under the magnetic field, leading to paramagnetism formed [5].

2.11.Diamagnetism

Diamagnetism is a magnetic phenomenon that some kinds of substances generate repulsive force to the external magnetic field when they are transferred into an external magnetic field, although the generated repulsive magnetic force is usually weak [6].

The cause of diamagnetism is that when the material is under external magnetic field, the external magnetic field leads the movement in the electron orbit region of the material to change. When the external magnetic field B is applied, the magnetic force F will be generated on the moving electrons (charge q) expressed as formula: $F = QV \times B$. This force changes the centripetal force on the electron, altering both the electron orbit and accelerated speed of electrons. As a result, the electron in turn changes its orbital magnetic moment in the direction opposite to the external magnetic field [6].

It is to further demonstrate two electron orbit domains between a clockwise motion and a counterclockwise motion. The external magnetic field entering the plane at the direction of clockwise rotating electrons increases the centripetal force, and consequently increases the magnetic moment in the direction of leaving the plane. Inversely, the same external magnetic field reduces the centripetal force of the counter-clockwise rotating electron and the magnetic moment at the direction of entering the plane. In theory, both changes are in balance with the external magnetic field in the direction of entering both clockwise and counter clockwise planes. However, the magnetic moment induced by the external magnetic field for most substances is very small, so the net effect may be a repulsive force [6].

From above discussion, the effects of external magnetic field on electrons may result in both attractive and repulsive forces concurrently in an atom. However, this article gives different demonstration to the formation causes of diamagnetism in the last part of this article.

2.12.Ferromagnetism

Ferromagnetism refers to the magnetic state of a material with spontaneous magnetization, mainly including transition metals (such as iron), their alloys and compounds. The reasons for the formation of ferromagnetism is that the magnetic moments of adjacent atoms or ions in the material are arranged roughly in the same direction in some areas due to their interaction. When the applied magnetic field strength increases, the directional arrangement of the magnetic moments in these magnetic particles would reach its maximum value [7].

In ferromagnetism materials, there are many unpaired electrons like paramagnetic materials. Due to exchange interaction among unpaired electrons of different atoms, the rotation of these electrons tends to be in the same direction as the rotation of adjacent unpaired electrons. As the strength of external magnetic field increases, the magnetization of ferromagnetism materials also increase correspondingly due to its paramagnetic characters until the magnetic materials reaches ‘saturation point’, and the net magnetic moment is constant at the saturation magnetic moment. After reaching the saturation point, increasing the external magnetic field will not change the magnetization again. However, the magnetization will also decrease when the external magnetic field is weakened, but this descending rate will not be the symmetrically identical to the previous ascending rate of magnetization under the constant external magnetic field, so that the curve of magnetization ratio to external magnetic field is expressed as a hysteresis loop. After meeting or exceeding the saturation point, and subsequently removing the external magnetic field, the ferromagnetic material can still retain some magnetized state, which means that the net magnetic moment and magnetization vector are not decreased to zero, further indicating that ferromagnetic materials after magnetization have ‘spontaneous magnetic moment’[7].

There is another kind of ferromagnetic materials in physics. Ferromagnetic materials contain different sub-lattices with opposite atomic magnetic moments, such as anti-ferromagnetism, but the strength of the contrary magnetic moment is not equal, so there is still temporary magnetism in anti-ferromagnetic materials. This phenomenon occurs when the sub-lattice is composed of different materials or iron with different valence states (such as $Fe^{2+}$and Fe3+). This kind of ferromagnetic materials maintains transient magnetism below Curie point like ferromagnetism, and have no magnetic sequence above this temperature. However, sometimes at a temperature lower than the Curie point, the two contrary sub-lattices would have the same magnetic moment, resulting in zero net magnetic moment. This phenomenon is named as the magnetic cancellation point. Similarly, there may be an offset point of

angular momentum in the ferromagnetism, under which the net angular momentum in the magnetic sub-lattice is offset to be zero. For example, usually ferrous salts and magnetic garnets exhibit this kind of ferromagnetism [8].

2.13.Antiferromagnetism

In antiferromagnetic materials, the magnetic moments of atomic spins are arranged in order due to the exchange action. If the spins of adjacent atoms are subject to negative exchange action and the rotations are arranged in an anti-parallel manner, the magnetic moments become an ordered state, called ordered magnetism, but the total net magnetic moments become zero when they are not under an external field. This magnetic order is called antiferromagnetism. Antiferromagnetism is caused by the reversely parallel arrangement due to the negative exchange of electron rotations between adjacent different sub-lattices. There is spontaneous magnetization within the same sub-lattice, with electronic magnetic moments aligned in the same direction, but between different sub-lattices, the electron magnetic moments are arranged in reverse order. Consequently, the spontaneous magnetization strength in the two adjacent sub-lattices is equal but the direction is opposite, so no spontaneous magnetization of antiferromagnetic materials can be observed at any temperature [9].

However, when the external magnetic field is added to this material, its magnetic moment tends to be arranged along the direction of the magnetic field, showing a small positive susceptibility. This susceptibility of antiferromagnetic materials is depended on temperature and reaches a maximum at the Neel Temperature. When the antiferromagnetic substance is placed in the external magnetic field below Neel Temperature, the magnetic moments between its neighboring sub-lattices are equal and the arrangement direction is just opposite, so its net magnetic susceptibility remains zero; When the temperature approaches a certain temperature - Neel Temperature, the susceptibility of the antiferromagnetic material will increase slightly; When the temperature exceeds the Neel Temperature, the magnetism of the antiferromagnetic material is close to paramagnetism under external magnetic field. Many transition element compounds have this antiferromagnetism character, and antiferromagnetic materials are mostly non-metallic compounds, such as MnO [9].

2.14.Velocity Filter

There is a three-dimension axis (X,Y,Z). Two parallel electric plates are placed in the plane (X,Y) on this paper, and the two electric plates are positively and negatively charged in the up and down plate respectively after being energized. The direction of the magnetic field (B) is consistent with the positive Z axis that is perpendicular to the plane (X,Y) towards us when we look at this paper. The relation among the velocity (V) of positive charged particles passing through the middle of two parallel electric plates, particle charges (q+), the electric field strength and magnetic field strength is calculated as [1]:

$$qE = qV_0B$$

Consequently, $V_0 = E/B$

When the velocity V is higher than V_0, the magnetic force is stronger than the electric force so that the positive charged particles move towards the up plate; if V is lower than V_0, the magnetic force is weaker than the electric forces so that the positive charged particles goes towards the down plate; only when V is equal to V_0, charged particles pass through the filter [1].

2.15.Cyclotron Mechanism

The direction of the magnetic field (B) is consistent with the Z axis that is perpendicular to the plane (X,Y).When the charged particles enter the plane with velocity (V), it is imposed by the magnetic force whose direction is always vertical to the velocity so that the motion of charged particles turns to be the circular motion under the magnetic field. The centripetal force is equal to the magnetic force, which is [1]:

$$mv^2/r = qVB$$

The parameter (m) is the mass of particles and (v) is the tangent velocity. Parameter r and q is radius of spin and electric charges, respectively. The relationship between angular velocity (ω) and tangent velocity (V) is:

$$V = \omega r$$

The above two equations is incorporated as:

$$\omega = qB/m$$

The angular velocity (ω) is also called as cyclotron frequency in this case, which is determined by the ratio of charges to mass, regardless of tangent velocity [1].

3.Electric Field

3.1.Electric Field

Electric field is a special substance existing in the space around electric charge or varying magnetic field, which is different from ordinary objects, because it is not composed of molecular atoms, but it exists objectively with attributes of both force and energy that ordinary substances possess [11].

The nature of the force generated by electric field is that the electric field exerts the force on the electric charge under the electric field, which is called electric field force. The energy attribute of the electric field is shown when the charges move in the electric field, and the electric field force does work on the charges as the indicator of

electric field energy [11].

The electric field strength (E) is defined as the ratio of the electric field force (F) imposed on the charges placed at a point in the electric field to its electric charges (q), indicating the strength of the electric field at that point. However, once E at a certain point in the electric field is determined, both magnitude and direction of the electric field strength at that point are the constant values, independent of the charges that are put in that point. Even if the charges is moved out, the magnitude and direction of the electric field strength at that point remain unchanged [11].

Electric field strength (E) between the two homogeneous charges with both the same q and the same nature shows the characters below:
(1) On the connecting line between two charges, regardless of positive charge or negative charge, the field strength at the midpoint O is always zero;
(2) On the vertical line at the middle of the connection line of two charges, from the midpoint O along the mid vertical plane (mid vertical line) to infinity, the field strength increases firstly and then decreases;
(3) Two symmetrical points around point O possesses equal electric field strength and equal electric potential but the direction of electric field is opposite to each other [11].

Electric field formed by the two heterogeneous charges with the same q but different natures:
(1) along the connecting line of two charges, the electric field direction points from positive charge to negative charge, and the electric field strength along the electric field direction decreases firstly and then increases, while the electric potential decreases from positive charge to negative charge gradually;
(2) The direction of the electric field on the vertical line at the middle of connection lines between the two charges is the same and constantly perpendicular to the vertical line. From the midpoint O to infinity, the field strength keeps decreasing but the electric potential at each point is equal;
(3) The field strength between two symmetrical points around the midpoint O is constantly in the same direction [11].

This article further deduce that the above characters of electric field strength E would be determined by the magnetic field between two symmetrical charges. When the two electric charges are homogeneous or heterogeneous, the magnetic polarity becomes homogeneous or heterogeneous correspondingly and respectively.

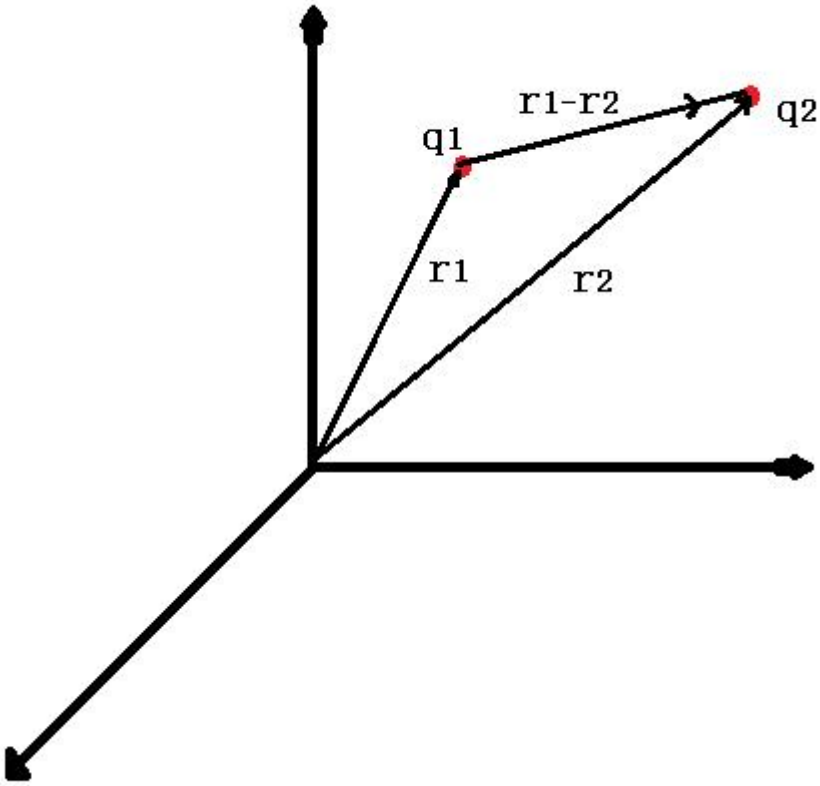


Fig2. Coulomb's law between charges at point q1 and q2， with position vector r_1 and r_2 respectively [1].

3.2.Coulomb's law

Coulomb's law is the law of the interaction of point charges at static state, which reveals that the interaction force between two static point charges in vacuum expressed as formula that is proportional to their charge amount, but is inversely proportional to the square of their distance, with the direction of the Coulomb's force on their connecting lines. Charges with the same nature repel each other while charges with the opposite nature attract each other [10].

Mathematical expression of Coulomb's law:.

$$F = K \frac{q1q2}{r2} e_{12}$$

Where r is the distance between charges at points q1 and q2 in Fig 2; e_{12} is the vector diameter from q1 to q2, equal to $(r_2-r_1)/r$; K is the coulomb constant (electrostatic force constant), defined as 9.0×10^9 Nm^2/C^2 when all physical quantities are in SI units [10].

In fact, Coulomb's law applies not only to vacuum, but also to homogeneous medium.

However, Coulomb's law is only applicable between point charges, and on the case where the charge field source is static while the point charges that is imposed by Coulomb's force is moving, but it is not applicable on the moving charge field sources influencing the static charge [10].

4.Electromagnetic Wave

4.1.Electromagnetic Wave

Electromagnetic wave is a kind of oscillating particle wave derived from the mutually perpendicular electric and magnetic fields, which emits as waves in space. It is a kind of energy state as electromagnetic field propagating in the form of waves that display wave particle duality. The propagation direction of electromagnetic waves is perpendicular to the electric field, so that the electric field direction, magnetic field direction and propagation direction of electromagnetic wave are perpendicular to each other, forming shear wave. When its energy phase transitions exceeds the radiation critical point, it radiates outward in the form of light, in which the wave body is a photon, so the sunlight is a visible radiation form of electromagnetic wave. Electromagnetic wave does not depend on the medium to propagate [13].

4.2.Physical Properties of Electromagnetic Wave

Frequency is an important physical property of electromagnetic wave. Arranging these electromagnetic waves in the order of wave frequency is the electromagnetic spectrum. According to the frequency of electromagnetic wave from low frequency to high frequency, electromagnetic radiation is divided into radio wave, microwave, infrared ray, visible light, ultraviolet ray, X-ray and gamma ray. The electromagnetic wave that can be perceived by the human eye is called visible light with wavelength range of 380~780nm. The amount of electromagnetic radiation is related to temperature and generally the substances or particles under temperature higher than absolute zero generate electromagnetic radiation. The higher the temperature, the greater the radiation [13].

Electromagnetic wave is a kind of motion form of electromagnetic field. The changing electric field or current produces the magnetic field, while the changing magnetic field generates the electric field correspondingly. Both the changing electric field and the changing magnetic field are integrated into an inseparable unified field, which is electromagnetic field. The varying electromagnetic field leads to electromagnetic wave when it propagates in space [13].

When the frequency of electromagnetic wave is low, it can be transmitted only by tangible conductors. The reason is that when the electromagnetic waves is generated by the low-frequency electrical oscillation, the mutual change between magnetoelectricity is relatively slow, so that almost all of its energy stays within the original circuit without energy radiation; When the electromagnetic wave frequency is high, it can be transmitted in the free space other than bounding in the tangible

conductive body [13].

The propagation of electromagnetic waves does not require a medium, but electromagnetic waves of the same frequency show different velocities in different media, which means that the electromagnetic wave can travel along a straight line only in the same homogeneous medium. When electromagnetic waves with different frequencies propagate in the same medium, the greater the frequency, the greater the refractive index, and the smaller the speed. If the same medium is uneven, the refractive index of the electromagnetic wave in it is different, so that it transmits along a curve in such a medium. When passing through different media, the physical properties of waves such as refraction, reflection, diffraction, scattering and absorption can be observed [13].

The energy of electromagnetic wave is determined by Poynting vector: $S = E \times H$, where S is Poynting vector (W/m^2), E is electric field strength, and H is magnetic field strength. Physical parameters E, H and S are perpendicular to each other, forming a right-hand spiral relationship. In this formula, S represents the electromagnetic energy in the unit duration flowing through the unit area that is perpendicular to it [13].

4.3.The wave-particle duality of electromagnetic waves

In addition to the above knowledge, there are some original knowledges published in my previous articles with regards to the wave-particle duality of electromagnetic waves and bio-electromagnetism, as pointed out to display the full conceptions on this theme in below section 4.3. and 4.4. [14][15]:

“Magnetic mass lines in micro-particle structure: the concept of magnetic mass line is proposed in this paper. The magnetic mass line in three-dimensional space of micro particles is a function of the spatial distribution of both mass and magnetic field (magnetic fields can be measured by electric charges). Therefore, the geometric center of the spatial distribution of the magnetic mass line within the micro particle (such as a molecule) is not only different from the geometric center point of mass spatial distribution, but also different from the geometric center point of the spatial distribution of electric charges; it is the interaction point of the doubles. The geometric center point of the magnetic mass line is exactly the center point of the rotation motion of the materials aggregated as a whole (such as the rotation motion of electrons in atom, molecule revolution motion discussed above, or celestial rotation motion). It can be inferred that the geometric center of the magnetic mass line in a atom is not the center of the nucleus, which can only be interpreted to be closer to the nuclear center point, because the electron mass is much smaller than the nuclear mass, and the nuclear center point is closer to the geometric center point of the whole atomic mass. Therefore, it is too simple to simplify that the internal motion of the electron in an atom is defined as the rotation of the electrons around the nucleus. In fact, both the nucleus and the electron rotate around the geometric center of its

magnetic mass line of an atom. This provides a basis for the theoretical calculation of rotational motion in astrophysics and the optimization of synthetic structure of polymers by 3D simulation of molecule movement. In addition, since the nucleus of positive charge and the electron of negative charge rotate around the geometric center of the magnetic mass field line in atom respectively, the characteristics of electromagnetic waves generated by each rotation should be significantly different from each other, which needs to be further discussed. This is of great significance to the application on the electromagnetic spectrum analysis in the next.

For example, the characteristics of the γ rays should be revealed as the electromagnetic waves generated by the positively charged protons rotating around the spin center inside the atomic nucleus, which is different from the rotation center of the whole atom. The rotation center of an whole atom is the common rotation center of both the nucleus and the electron, whereas the inner spin center of the nucleus is the spin center of the elementary particles in the nucleus. Compared to the electromagnetic spectrum produced by electrons, the electromagnetic waves produced by γ ray does not only have shorter wavelengths and higher frequencies because of their smaller rotation radius, but also leads to higher penetration capacity due to its energy of higher intensity in nucleus, and the energy of electromagnetic waves produced by nucleus is much higher than the electron consequently. In this paper, it is to further propose that the electromagnetic wave produced by the rotation of positively charged protons around the spin center inside nucleus transmits at faster speed than the electromagnetic wave produced by an electron rotating around the spin center of an whole atom. Further because of the electric charge difference between the positively charged protons and the electrons, the wave crest peak and the wave trough bottom point have opposite polarity between these two electromagnetic waves respectively. This is the main reason why the γ ray penetration capacity is high. For example, if the wave peaks of the electromagnetic waves produced by the nucleus are defined as the anode and the bottom points of waves are defined as the cathode respectively, then the peaks of the electromagnetic waves produced by the electrons are defined as the cathode and the trough bottoms are the anode correspondingly. γ radiation of high energy flow density can easily neutralize and penetrate the electromagnetic waves generated by electrons when they transmit to meet each other in the opposite direction. Therefore, for the wave-particle duality analysis of electromagnetic waves, the polarity of the peaks and bottoms of waves should be analyzed as a basic element in this paper, which is different from that of mechanical waves.

For another example, according to the experimental data, the electron resonance frequency is measured to be 8.41GHz under the main magnetic field environment of 0.3T, while the proton resonance frequency measured by common nuclear magnetic resonance (NMR) is only 12.77MHz [4]. In further comparison, the frequency of the γ ray is above 10^{20}Hz [13]. γ rays is the electromagnetic waves generated by the proton rotating around the spin center inside the atomic nucleus, while the NMR frequency

of proton reflects the electromagnetic wave generated by the protons rotating around the whole atomic spin center, and electron resonance frequency represents the electrons rotating around the whole atomic spin center. Therefore, it is easy to deduce that the angular frequency of proton rotation around the spin center inside the atomic nucleus is much greater than the angular frequency of proton rotation around the whole atomic spin center, and is also much greater than the angular frequency of electrons rotation around the whole atomic spin center. The angular frequency of electrons rotation around the whole atomic spin center is significantly higher than the angular frequency of protons rotation around the whole atomic spin center due to much less mass of electron.

Comparing and contrasting between light wave and α Ray, β Ray, γ ray: light wave is a kind of electromagnetic wave with shearing and transverse wave nature, and itself does not produce electric current effect, but it is capable of producing photoelectric effect through propagation medium such as specific electrical conductors; Ray is a type of electromagnetic wave with longitudinal wave nature. When the emission frequency of ray changes (not constant), it is to generate the pulse electromagnetic wave, which further results in current effect. Therefore, the electric current can be detected without medium in the propagation direction of electromagnetic wave for rays. Rays travel faster than light waves with stronger penetration. My another paper has discussed in detail that the current effect propagates in the form of electromagnetic wave energy flow [20].”

My another article has originally created the electromagnetic mechanism of light refraction, diffraction and reflection [18]:

“Further discussion: compared with the electron, the radius between the proton and the rotation center in the nucleus is shorter, and the proton rotation speed is higher, so the energy flow intensity of electromagnetic wave is higher, and the transmission speed of electromagnetic wave is faster. The refraction or diffraction of light is caused by the interference influences between the magnetic field on the obstacle surface and the polarity of light wave, which is different from mechanical wave. Therefore, different characteristics of materials with different magnetic field on the surface generates different light refraction or diffraction angles. This is also applicable on the other frequencies of electromagnetic wave. These findings provide basic characters for the synthesis of new materials. As discussed in Figure 3, the vertical red line represents the boundary between medium A (left) and medium B (right); magnetic field B in the medium A is vertical to the magnetic intensity curve (on the plane by axis y and z) of electromagnetic wave; electric field E in the medium A is vertical to the electric intensity curve (on the plane by axis x and z) of electromagnetic wave; in medium A, the transmission direction of electromagnetic wave V is parallel to axis z. Once the electromagnetic waves passes from medium A (left) into medium B (right), the direction of magnetic field B in medium B is different from it in medium A, so that the magnetic field B in medium B alters the transmission direction of

electromagnetic wave V, making the magnetic field B in the medium B vertically to the magnetic intensity curve of electromagnetic wave in medium B. This is the mechanism of light refraction, which is also applicable on the light diffraction.

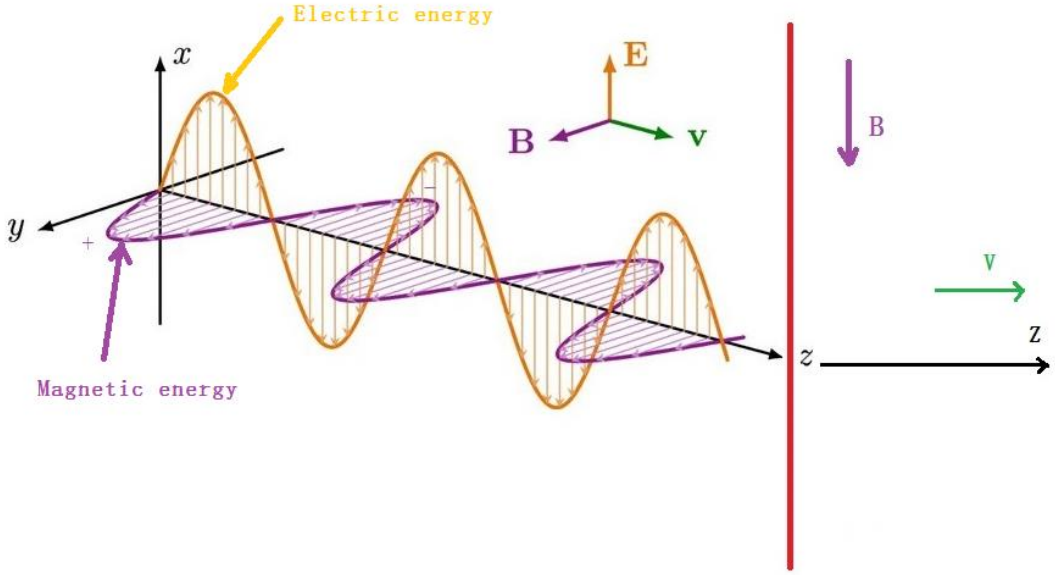


Figure 3. The mechanism of light refraction from medium A (left) to medium B (right) with the boundary of vertical red line between them.

This paper further discusses the electromagnetic wave principle of light reflection phenomenon: as proposed in my another article [21], the overall structure of an atom yields the effects of neutral shielding on the elementary particles inside the atoms. This neutral shielding effect is completely understandable: if the neutral shielding effect does not exist, when two atoms collide, the electrons of one atom are attracted by the nucleus of the other atom because of the Coulomb force, thus merging and neutralization. This is obviously not the facts, so the existence of this neutral shielding effect can be proven inversely according to the fact. The shielding effect of both molecular structure [22] and the electronic orbitals [23] have also been discussed in my other papers. Therefore, this paper further deduces that the neutral shielding effect of the whole atomic structure is the electromagnetic wave principle of the light reflection phenomenon. The stronger the reflection effect of light on the surface of the object, the higher the neutral shielding capacity of the object atoms. In my quantum chemistry paper [23], it is to point out that the shielding effect of electronic orbits relative to adjacent orbitals is generated during rotation motion due to their repelling force. Consequently, this paper further deduces that for the atoms of the same element in different molecular structures, because the electron orbitals forming chemistry bonds, molecular bond angle, bond energy and bond length vary among different molecular structures, even for the atoms of the same elements, the neutral shielding effect will be different in different molecular structures.

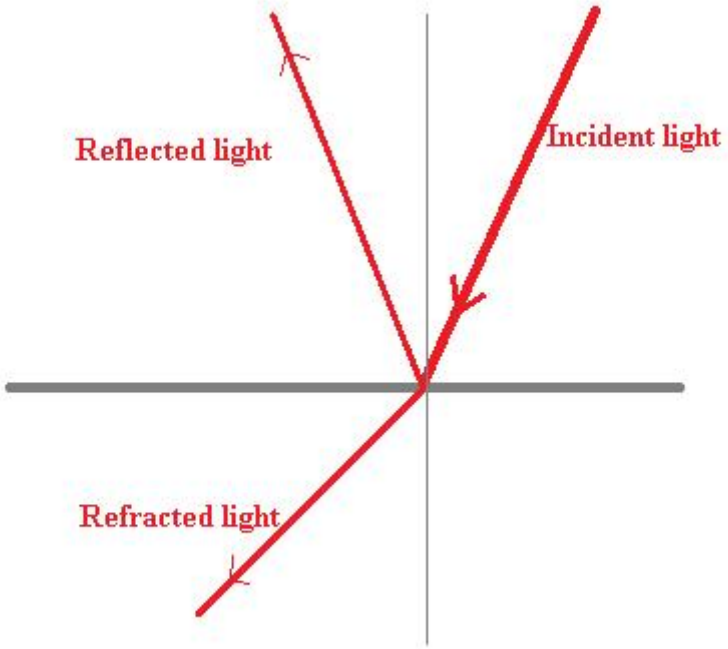


Figure 4. This figure illustrates the relations among incident light, reflected light, refracted light.

As shown in Fig 4, the incident light is divided into reflected light and refracted light after the incident light penetrates the surface of medium substance. If the neutral shielding effects generated by the atoms of medium substance is stronger, then the intensity of reflected light is stronger and the refracted light intensity is weaker correspondingly.

More over, because our three-dimension space is curved sphere, all the remote objects observed by us are the enlarged images due to the magnifier effects, so the astro-observation data have to be corrected. The electromagnetic wave transmission speed (such as light speed) varies between different magnetism fields (NOT constant), which leads to significant effects on the astro-observation data. These two effects require corrections of data received by astronomy observations. Otherwise it is too different significantly from the real data. ”

4.4.Biological magnetic field and Bio-electromagnetism

“In this paper, biophysics academy focus on the biological magnetic field. Biological magnetic field is defined as the indicator of life nature, rather than the material body of creatures. Biological magnetic field utilizes biological energy to express as biological magnetic pole which gives Yin pole and Yang pole, and the polarity of biological magnetic pole is the indicator of biological activity. When biological organs utilize materials to carry out a series of life activities (such as synthesizing DNA molecules), the biological magnetic poles make cutting motion against the

material's own magnetic poles, thus generating biological electromagnetic waves (biological signal waves). Therefore, whether or not they release life signals is the principal indicator to judge if they are alive. For example, for a multi-cellular intelligent individual organ, after the death of the individual, the body cell still has the characteristics of life and still releases the life signal wave. Creatures releases bio-electromagnetic waves in the bio-energy utilization process. Life signal waves are the biological electromagnetic waves released by organisms, which possess the characteristics of wave particle duality. However, this paper supplements the following viewpoints: the biological electromagnetic wave released by soft organism is longitudinal wave, which is that the vibration direction is the same as the wave transmission direction; the light wave (including ultraviolet light wave) is shear wave, which is that the vibration direction is perpendicular to the wave propagation direction. The key characters of biological wave (mainly including acoustic wave and bioelectromagnetic wave / life signal wave) is different from abiotic mechanical wave or electromagnetic wave: for biological wave, the conversion between different frequencies must be continuous in its wave frequency range; for abiotic mechanical wave or electromagnetic wave, the conversion between different wave frequencies can be the ‘jumping points’ and in-continuous type. For biological waves, in their own frequency range, if the probability of occurrence at each frequency is closer to the normal distribution rate, it is expected to give the purer and higher quality (for example, the singer's tone is superior; or the Qigong life signal wave is better, or the bloodlines is purer). For different species, there are distinct differences in the frequency of life signal waves, which can be used to classify different species. In the metabolic process of soft organism, bioenergy is converted between different frequencies, thus creating new energy, which does not obey the energy conservation law (the previous energy conservation theorem is based on the conclusion of the conversion of abiotic energy). In the theory of ‘biological clock’, double cell magnetic poles will be inverted from positive to negative (or from Yang to Yin) once in a life cycle. Therefore, the coordinate of biological waves equation should be defined as three coordinate axes, X axis as frequency, Y axis as amplitude and Z axis as life cycle. Positive value of Z axis is defined as "Yang Qi" time, while negative value of Z axis is defined as "Yin Qi" time [15].”

5.Discussion of Original Viewpoints:

In addition to 4.3. and 4.4. sections which have been published in my other articles, there are more original discussion below. Before discussion, it is worthwhile clarifying that my another article has classified that “there are three types of electron motions discussed: electron spinning motion is the spinning motion around the center of electron itself, rather than around the nucleus of an atom, whereas electron rotation motion is the rotation motion around the nucleus of an atom and electron revolution motion is the revolution motion around the center of a molecule.[28]”

According to Pauli exclusion principle, for each pair of two paired electrons, the magnetic dipole moment generated by two paired electron orbits must be in the opposite directions, so the net magnetic dipole moment is zero [4]. This paper believes that this viewpoint is inaccurate. For each pair of paired electrons, the orbits of the two electrons must be crossed and symmetrically arranged, and the rotation direction of one is clockwise and the other is counterclockwise, which is described in detail by the Figure 4 of my another article [14]. However, the vectors of the spin orbits of the two electrons are not completely opposite (this is only an ideal state, and the electron cloud theory has shown that the electron orbits are not completely regular), so the generated magnetic dipole moment will not be completely offset. Thus, the net magnetic dipole moment generated by two paired electrons may not be zero. However for the magnetic dipole moment of the whole atom, the contribution of the magnetic dipole moment of the paired electrons is indeed weaker than that of the unpaired electrons. Even so, when calculating the contribution of sources, the net contribution of the paired electrons is also a factor that cannot be ignored.

Shankar et al. (2018) discussed the magnetization principle of both ferromagnetic materials and antiferromagnetic materials at the micro particle level, and demonstrated the influence of the thermal movement of micro particles on the magnetization of materials [1]. According to their discussion, it can be clearly inferred that the vector of the magnetic dipole moment generated by microscopic particles in the process of spin and thermal motion is random, so it is unreliable to attribute the causes of van der Waals force to the magnetic dipole moment generated by microscopic particles, which means that the magnetic dipole moment generated by randomly moving micro-particles only possesses a very small probability to make particles pull and connect each other to keep the materials stable at macro-scale. When the temperature reaches a critical value, the magnetism will disappear due to the enhancement of irregular thermal movement, and this critical temperature is called Curie temperature, which means that the vector sum of magnetic dipole moment among molecules or atoms tends to be zero under this thermal motion condition. Under this situation, the directions of magnetic induction lines among molecules or atoms tend to be opposite, to generate repelling force against each other, which destroys the van der Waals force rather than generating van der Waals force. My another article has further modeled the formation of magnetic materials by binary arithmetic for better understanding of this process [19]. My another journal article has also discussed the dark matter theory and the cause of van der Waals force [22].

Shi Tuo et al., (2012) discussed the symmetry properties of electric field and magnetic field from the perspective of vector transformation [16]. My article has previously discussed the antimatter in the fourth dimensional space [17], so the symmetry principle of electric field and magnetic field must be analyzed on the four dimensional coordinate axis so that it can be full and integrated. Under this four dimensional symmetry, the electric field inside the atom can be displayed as a series and closed loop, so as to achieve the stability of charged particles. If the electric field is not a

series and closed loop, the electric charges of micro-particles may be generated instantaneously and disappear at transient time. This phenomenon is similar to the difference between filament lamp and fluorescent lamp. The reason why the fourth dimensional space is called parallel space is that both magnetic field and electric field display as parallel field lines on the fourth dimensional axis, but the transmission direction is opposite to each other. In my article this closed electric field inside an atom can be defined as: the propagation directions of the electric field and the magnetic field are parallel and opposite in the fourth dimension axis, but in the corresponding three-dimensional space, they turn to be the mutually vertical propagation directions. Only in this way the electric field inside an atom can achieve the closed loop, so that the elementary particles inside an atom carry the stable electric charges. I have discussed in my previous articles [14][24] that the three-dimensional space where we are living is the curved sphere, so after both electric field and magnetic field penetrate into the three-dimension space from the fourth dimension axis, there must be refraction effect resulting in the change of the propagation directions of both. This theory has been further demonstrated by the Figure 3 of my next journal article [27]. The principle of magnetic field symmetry should become a criterion applied to testify the performance of new magnetic materials, because the symmetry of magnetic dipole moment of magnetic materials is closely related to the magnetic stability and persistence of magnetic materials under the changing environmental conditions.

My another article has previously discussed the mechanical balance of each mass particle inside an atom on the basis of simplified physical model at four dimensional axis[17]. Next, it is further to discuss the mechanical balance of each particle inside an atom: according to the experimental measurement, the magnetic dipole moment produced by the electron spin motion is significantly larger than that produced by the proton spin motion (For example, the magnetic moment strength of the electron is 659.59 times higher than the proton in the hydrogen nucleus), and the resonance frequency of the electron must be higher than that of the proton [4]. Therefore, the force balance of both electrons and protons is analyzed separately below: The electrons are mainly imposed by three torques: the centrifugal force generated by the rotation motion of negatively charged electrons in an atom, the centripetal force generated by the decomposition of Coulomb force and magnetic force of positive charge proton in atomic nuclei, and the magnetic moment torque generated by positively charged electrons in the antimatter of symmetric three-dimensional space (Figure 5); The protons in the atomic nucleus are also mainly subjected to the force of three moments: the centrifugal force generated by the rotation motion of the atomic nucleus in an atom, the centripetal force generated by the decomposition of the Coulomb force and magnetic force of negatively charged electrons in an atom, and the magnetic moment torque generated by negatively charged protons in the antimatter of symmetric three-dimensional space. It is easy to understand that the centripetal force generated by the decomposition of both the Coulomb force and magnetic force between positive and negative charged particles in the atom should be the opposite in

the vector direction with the same force strength, which belongs to the interaction force to achieve mechanical balance. Therefore, the reason that the magnetic dipole moment generated by the electron spin motion is significantly larger than the proton must be explained by the magnetic line in the fourth dimension axis. Since the magnetic dipole moment produced by the spin motion of negatively charged electrons is significantly greater than that of protons, the magnetic moment torque produced by positively charged electrons in the symmetric three-dimensional space of antimatter must be greater than the antimatter of negatively charged protons correspondingly, so that the centrifugal force generated by the rotation motion of negatively charged electrons in an atom is higher than that of positively charged proton, the angular frequency of the spin motion of negatively charged electrons is greater, and the electron resonance frequency must be higher. This is consistent with the experimental measurement results. Here what needs to be distinguished is that the rotation motion of positively charged protons in this section refers to the atomic nucleus that brings the protons together to rotate around the whole atomic spin center, which is different from the rotation center inside the atomic nucleus.

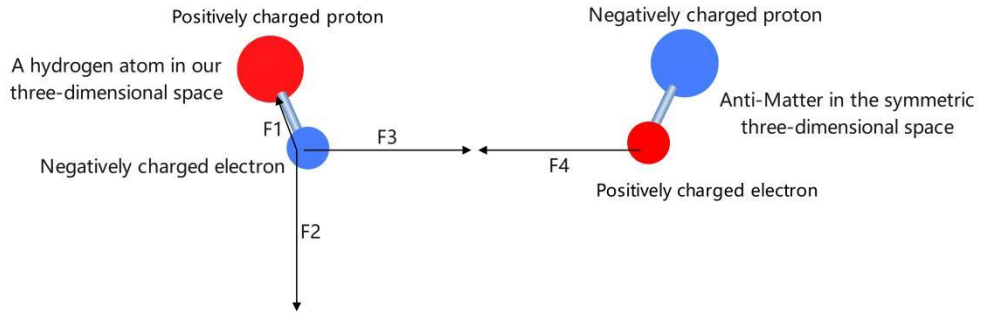


Figure 5. Inside a hydrogen atom, the electron imposed by three torques: F1 is the centripetal force generated by the decomposition of Coulomb force and magnetic force of positive charge proton in atomic nuclei; F2 is the centrifugal force generated by the rotation motion of negatively charged electrons in an atom; F3 is the magnetic moment torque generated by positively charged electron in the antimatter of symmetric three-dimensional space; F4 is the interaction force against F3.

This diamagnetism section of this article explains the causes of diamagnetism from the perspective of electron orbits, resulting in the theory that both clockwise and counter clockwise electron orbits' change in balance with the external magnetic field in the direction of entering both clockwise and counter clockwise planes. However, this theory is inconsistent with the fact that the net effect may be a repulsive force in diamagnetism materials, which is attributed to the magnetic moment that induced by the external magnetic field for most substances is very small. This article does not agree with this deduction and the evidence used. Firstly, if the the diamagnetism

phenomenon is caused by the variation in electron orbits, then the direction of the external magnetic field would significantly change the diamagnetism of materials, which means that when the external magnetic field passes through the materials at different direction to the materials, the expressed diamagnetism phenomenon would vary significantly by the change of external magnetism directions if it is caused by the variation in electron orbits. However, this is not reported to date. This article believes that the causes of diamagnetism phenomenon is attributed to the alteration of the vector sum of both the fourth dimensional magnetic moment and the electron orbit magnetic moment in the three dimensional spaces. Once the induced electron orbit magnetic moment by the vector sum is opposite to the external magnetic field, it becomes diamagnetism. In this theory, the variation in the direction of external magnetic field in three dimension spaces does not significantly influence the vector sum with the fourth dimensional magnetism, because the three dimension spaces would be considered as a point along the fourth dimensional axis in theory.

In section 2.7, the contribution sources of magnetic moment of molecules are the main source of unpaired electron, then the paired electrons and the electrons under ground state, and the minor source of nucleus motion. My article further explains that the paired electrons and the electrons under ground state result in less contribution to the magnetic moment of a molecule, because of the neutral shielding effect among different electron's orbitals, and this neutral shielding effect has been substantially discussed in my articles [18][23][27]. In addition to the outermost unpaired electron, the paired electrons at second outermost orbital may also significantly contribute to the magnetic moment of an atom, and it is deduced that the stronger neutral shielding effects will lead to less contribution of paired electrons.

In section 2.11, the diamagnetism is explained as: "it is to further demonstrate two electron orbit domains between a clockwise motion and a counterclockwise motion. The external magnetic field entering the plane at the direction of clockwise rotating electrons increases the centripetal force, and consequently increases the magnetic moment in the direction of leaving the plane. Inversely, the same external magnetic field reduces the centripetal force of the counterclockwise rotating electron and the magnetic moment at the direction of entering the plane. In theory, both changes are in balance with the external magnetic field in the direction of entering both clockwise and counterclockwise planes. However, the magnetic moment induced by the external magnetic field for most substances is very small, so the net effect may be a repulsive force [6]." In my other two articles [29][23], the electron orbitals at both clockwise and counterclockwise orientations are discussed as: "Because the electron's cutting motion along the magnetic line on the fourth dimensional axis is the mechanism of generating negative electric charges in electron clouds, the quantity of electric charges must be different between clockwise spinning electrons and anticlockwise spinning electrons in electron clouds according to the theory about the generating reasons of both positive and negative β decay process: for the positive β decay process, the free electrons of clockwise spinning in electron clouds, which is the negative pole

relatively to the nuclear of an atom, carry more negative electric charges; for the negative β decay process, the free electrons of anticlockwise spinning in electron clouds, which is the positive pole relatively to the nuclear of an atom, carry less negative electric charges (Please note: the β particles' mass is considered to be equal to the electrons in electron clouds, but both positive and negative β particles from the decaying nucleus are not the electrons spinning in electron clouds. Do not be confused!). Therefore, it is further to deduce that the free electrons of clockwise spinning are more active in chemistry reaction than the anticlockwise ones [29].”; and “the electron's orbital sub-layers or energy levels defined by the angular quantum number 'l' above are mainly determined by the clockwise or anticlockwise rotations around the nucleus of an atom. If the free electrons clockwise rotate at a specific electron layer, which is the negative pole relatively to the nuclear of an atom, carry more negative electric charges/energy, then the electron's orbital sub-layer or energy level is higher; In comparison, if the free electrons anticlockwise rotate at a specific electron layer, which is the positive pole relatively to the nuclear of an atom, carry less negative electric charges/energy, then its corresponding orbital sub-layer or energy level is lower [23].” Consequently, my above theories are further supported by the phenomenon of diamagnetism: both clockwise and counterclockwise electron orbits' change caused by the external magnetic field leads to a repulsive force in diamagnetism materials, which proves that the energy levels of clockwise and counterclockwise electron orbitals are not equal.

In section 4.2, “When the frequency of electromagnetic wave is low, it can be transmitted only by tangible conductors; When the electromagnetic wave frequency is high, it can be transmitted in the free space other than bounding in the tangible conductive body.” My article here attributes this phenomenon to the energy absorption effects of 'black body': if the frequency of electromagnetic wave is low, the energy of electromagnetic wave may be easily absorbed by the effects of 'black body' or dark matter; only if the electromagnetic wave frequency is high, its energy can be escaped from the energy absorption of 'black body'. The effects of energy absorption by 'black body' has been discussed by my another article [27].

本文关键观点译文：

根据泡利不相容原理，对于每一对配对的电子对，两个配对的电子轨道产生的磁偶极矩一定是方向相反，从而净磁偶极矩为零[4]。本文认为此观点不准确。对于每一对配对的电子对，两个电子的轨道一定是交叉、对称排列的双轨道，并且其旋转方向一个是顺时针、另一个为逆时针，但是两个电子的自旋轨道的向量不会完全相反 (这仅仅是一种理想状态，电子云理论已经说明电子轨道并非完全有规则的) ，因此产生的磁偶极矩不会因此相抵消，从而两个配对电子产生的净磁偶极矩不一定为零，但是在整个原子的磁矩中，配对电子的净磁偶极矩贡献量与非配对电子相比确实更微弱。即使如此，在计算磁化率的时候，配对电子的净贡献率也是不可忽视的因子。

Shankar 等人对铁磁性物质和反铁磁性物质的磁化原理在微观粒子层面上进行

了论述，以及探讨了微观粒子热运动对物质磁化的影响[1]。根据他们的论述就可以清晰的推测出，微观粒子在自旋运动和热运动过程中产生的磁偶极矩的向量是随机型的，因此依靠微观粒子产生的磁偶极矩来揭示范德华力的起因是不可靠的，即：随机性运动的微观粒子产生的磁偶极矩仅仅有很小的概率使得粒子之间相互牵引、连接从而能够使得物质形态从宏观上保持稳定形态。当温度达到一个临界值时，磁性将消失，由于不规则热运动的增强，这个临界温度被称为居里温度，这意味着分子或原子之间的磁偶极矩的矢量和在这个热运动条件下趋向于零。在这种情况下，分子或原子间的磁感线（磁力线）方向趋于相反，产生相互排斥力，这则对范德华力造成破坏，而不是产生范德华力。我的另一篇文章进一步用二进制算法模拟了磁性材料的形成，以更好地理解这一过程[19]。本期刊之前已经论述了暗物质与范德华力的起因[22]。

史拓等人从向量变换的角度论述了电场和磁场的对称性质[16]。本人文章之前论述了第四维度空间上的反物质原理[17]，因此电场、磁场的对称性原理必须建立在四维度坐标轴上分析，才能完整，并且原子内部的电场才能呈现为一个串联、闭合的回路，从而实现带电粒子的电荷稳定性。如果电场是非串联闭合型，带电粒子的电荷量可能是瞬间产生并且消失。这种现象与白炽灯和荧光灯的区别相类似。第四维度轴之所以称之为平行空间，是因为磁场和电场在第四维度轴上都呈现为平行场线的特性，但是传播方向相反。本文中原子内部的闭合型电场可以这样定义：电场与磁场的传播方向在第四维度轴上平行且相反，但是在对应的三维物质空间，则呈现出了相互垂直的传播方向。只有这样，原子内部的电场才能实现闭合型的回路，使得原子内基本粒子带有稳定电荷。本人在之前文章中已经论述[14][24]，我们所在的三维空间是一个曲面球体，所以电场与磁场从第四维度轴射入第三维度空间之后，必定会有折射效应，发生传播方向的改变。磁场对称性原理应当应用于磁性新材料的性能指标的测试指标，因为磁性材料的磁偶极矩对称性与材料在变化环境下的磁性稳定性和持久性密切正相关。

本人文章之前在四维度坐标轴上的简化物理模型基础上论述了原子内各质点的受力平衡分析[17]。接下来我们进一步论述原子内各质点的力学平衡：根据实验测试结果，电子自旋运动产生的磁偶极矩比起质子自旋运动产生的磁偶极矩显著更大(比如电子磁矩强度是氢原子核中质子的 659.59 倍) ，而且电子的共振频率一定比质子更高[4]。因此对于电子、质子分别做受力平衡分析，电子主要受到三个力矩的作用，原子中负电荷电子自转运动产生的离心力、原子核正电荷质子库仑力和磁力分解产生的向心力、反物质三维空间中正电荷电子产生的磁矩力矩；原子核中的质子也主要受到三个力矩的作用力，原子中原子核自转运动产生的离心力、原子中负电荷电子库仑力和磁力分解产生的向心力、反物质三维空间中负电荷质子产生的磁矩力矩。其中不难理解，原子内正、负电荷带电粒子之间库仑力和磁力分解产生的向心力在向量方向上应当方向相反，受力大小相等，属于相互作用力，实现力学平衡。因此揭示电子自旋运动产生的磁偶极矩比起质子显著更大的原因一定从第四维度轴上的磁力线才能解答。由于负电荷电子自旋运动产生的磁偶极矩比质子显著更大，因此反物质三维空间中正电荷电子产生的磁矩力矩一定比反物质负电荷质子相应更大，从而负电荷电子自转运动产生的离心力比正电荷质子更大，负电荷电子自旋运动的角频率更大，从而才能使得电子共振频率一定更高。这与实验测试的结果是一致的。需要区别的是这里所指的正电荷质

子自转运动是指质子跟随原子核围绕整个原子自转中心的自转运动，不同于原子核内的自转中心。

本文抗磁性原理内容从电子轨道在外磁场下发生改变的角度解释了抗磁性的成因，得出了顺时针和逆时针电子轨道在顺时针和逆时针两个方向随外部磁场平衡变化的理论。然而， 由于大多数物质的由外磁场引起的磁矩非常小的事实存在，因此净效应可能是一种排斥力。本文并不同意这个论述过程和实证论据。首先，如果抗磁现象是由电子轨道的变化引起的，那么外部磁场的方向就会显著地改变材料的抗磁现象，这意味着当外部磁场以不同的方向通过材料时，如果抗磁性是由于电子轨道的变化引起的，那么所表示的抗磁现象就会随着外部磁场的透射方位变化而发生显著变化。然而，这一点迄今为止还没有报告。本文因此认为抗磁现象的原因是由于四维空间中的磁偶极矩和电子轨道磁矩的矢量和的改变所致。一旦外部磁场感应产生的磁矩矢量和与外磁场相反，材料就表现为抗磁性。在这个理论中，三维空间中外部磁场方向的变化并不显著影响电子轨道磁矩与第四维度轴上磁偶极矩的向量和，因为三维空间在理论上可以被认为是沿第四维轴的一个点而已。

场量、能量与质量为三个独立存在的物理量纲。场量为功的势能，在场量做功时候，释放能量。电磁波为磁场和电场一种做功的形式，一种没有质量属性的功。电磁波这种功的形式可以通过热效应转换为其它形式并且具有质量属性的功。

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