New Theory of Quantum Mechamics

——The Rebuilding of Quantum Mechanics

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Abstract Based on the behavior of field in the potential well, this paper draws the conclusion that the field exists in the form of standing wave with energy in the potential well, thus finding out the reason of fluctuation in quantum mechanics. Only one physical model is used in this paper: **the field forms a wave function**, by using Compton wavelength, the relationships among electromagnetic wave energy and mechanical wave energy and frequency are deduced, and it is concluded that wave function has the significance of generalized field. It is pointed out that Sommerfeld's general principle of quantization is the basic equation of quantum mechanics, and thus a new theory of quantum mechanics is established. The superposition, orthogonal normalization and equivalent principle of wave function are analyzed, and it is pointed out that the superposition state of wave function does not exist. Every given conclusion has clear and obvious physical significance, which makes the problem of quantum mechanics simple and clear. A new atomic model is established, and the problems of electron transition, electron spin, electron emission and electron absorption are discussed. Matter is divided into solid matter and field matter. In particular, the essence of light is analyzed, and it is clearly pointed out that light is electromagnetic wave, not material particle. The electronic pattern of Davisson-Gemma experiment, the principle electron microscope, photoelectric effect, Compton effect, double-slit interference and other experiments are reinterpreted. A new uncertain relationship is put forward. It is clearly pointed out that there is no matter wave, no wave-particle duality, no quantum entanglement, Schrodinger equation is not a wave equation, and so on question.

Keywords: Quantum mechanics, Wave function, Generalized field, Generalized quantity, Standing wave condition, Matter wave, New atomic model, Nature of light, Matter, Field, Force, Energy, Davisson-Germo experiment

1. Introduction

Quantum mechanics is an important achievement of theoretical physics research in the past century and the crystallization of collective wisdom. Since the foundation of quantum mechanics, the existence of truth has been controversial. What is generally accepted by scientific community so far is the quantum mechanics theory of Copenhagen School.

However, the theory of quantum mechanics of Copenhagen School has been opposed by some people, especially the physicists who founded quantum mechanics,

such as Einstein, De Broglie and Schrodinger, and even Planck, who pioneered the concept of quantum, strongly opposed it. Einstein always believed that "quantum mechanics is incomplete". Dirac also said, "I can't accept the statement that the basis of quantum mechanics is correct." Although the quantum mechanics theory of Copenhagen School has become one of two pillar theories of modern theoretical physics, and it has developed quantum field theory, standard model of particle physics and string theory, the debate on the quantum mechanics theory of Copenhagen School is not over yet, but it is becoming more and more intense.

In this paper, the author finds out the reason and essence of fluctuation in quantum mechanics, **Generalized field forms fluctuation, and generalized field is wave function**, and makes a clear explanation of physical meaning of wave function with strict mathematical deduction, thus solving the fundamental problems of quantum mechanics and establishing a new theory of quantum mechanics.

Comparing light with matter wave, the problem of light has been clearly studied in Maxwell's equation of electrodynamics, so the quantum mechanics of studying matter wave should be like this:

Light → Electrodynamics → Maxwell equation → Electromagnetic wave → Electric field and magnetic field → Field fluctuation.

Matter → Quantum mechanics → Schrodinger equation → Matter wave (Mechanical wave) → Field (generalized field) → Field fluctuation.

2. The Reasons for the Fluctuation of Micro-matter

Comparing the energy density of electromagnetic waves, we find that the energy densities of electromagnetic waves and mechanical waves have the same form:

Energy density of electromagnetic wave:

$$w = \frac{1}{2}(\varepsilon \vec{E}^2 + \frac{1}{\mu}\vec{B}^2) = \varepsilon \vec{E}^2 = \frac{1}{\mu}\vec{B}^2 \quad (1)$$

Energy density of mechanical waves:

$$w = \frac{1}{2}(m\vec{v}^2 + k\vec{x}^2) = m\vec{v}^2 = k\vec{x}^2 \quad (2)$$

Applying the equivalence principle in section 6.3 of this paper, these two kinds of energy are equivalent to the form of kinetic energy, that is, the energy of electromagnetic wave is equivalent to the energy with mass $\boldsymbol{m}$ and velocity $\vec{c}$, and the energy of mechanical wave is equivalent to the energy with mass $\boldsymbol{m_0}$ and velocity $\vec{v}$ (as shown in Eq.(2) has appeared), which correspond to the energy clusters of electromagnetic wave and mechanical wave respectively, so there is

Energy density of electromagnetic wave:

$$E_c = m\vec{c}^2 \quad (3)$$

Energy density of mechanical waves:

$$E_0 = m\vec{v}^2 \quad (4)$$

(Note: The above two equations are not mass-energy equations, but describe the energy of mechanical waves and electromagnetic waves by using the energy of a mass object.)

For the following description, the generalized field $\vec{\Phi}(\vec{r},t)$ and the generalized quantity $\boldsymbol{M}$ are used to uniformly name the two quantities in Eq.(3) and Eq.(4). The energy density of electromagnetic waves and mechanical waves and the total energy of

space where the generalized field spreads are all in this form, which is the product of generalized quantity and the square of generalized field, and can be uniformly written as these two formulas:

Density energy:

$$w = M\left|\vec{\Phi}(\vec{r},t)\right|^2 \qquad (5)$$

Total energy:

$$W = M\int_V \left|\vec{\Phi}(\vec{r},t)\right|^2 d\tau \qquad (6)$$

By analyzing the situation of **electric field** and **kinetic energy**, we can find out the reason of **micro-substance fluctuation**.

There is a generalized field $\vec{\Phi}(\vec{r},t)$ that forms a potential barrier with the energy generated by its corresponding generalized quantity ***M*** in a certain spatial region. Let's take the electric field and momentum field as examples to illustrate the relationship between another same (or different) generalized field and the barrier.

2.1. Penetration of Electric Field in Electric Field Energy Barrier

The charge matters with the electric quantity of ***Q*** forms an electric field energy barrier in space ("barrier penetration" is a typical problem discussed in quantum mechanics), as shown in Fig.1(1). Another charge matters with a quantity of ***q*(*q*<*Q*)** moves closer to ***Q*** from a distance, and the electric field of ***q*** will affect the electric field distribution of ***Q***. When *q* and ***Q*** have the same symbols, the electric field line is shown in Fig.1(2). In the figure, the electric field in areas **A** and **B** becomes stronger, while the electric field in area **C** becomes weaker, which is equivalent to the superposition effect after the electric field of ***q*** passes through the barrier and reaches area **A**, and part of it is reflected back to areas **B** and **C** by the barrier, but the electric field of ***q*** is "negative" to the barrier at this time, as shown in Fig.1(3). When $Q\to\infty$ (or $Q>>q$), the potential barrier is infinitely high. At this time, the electric field of ***q*** does not affect the electric field distribution of ***Q***, that is to say, the electric field cannot pass through the infinitely high potential barrier, but is totally reflected back, as shown in Fig.1(4). Infinitely high barrier plays the role of shielding the external field.

A potential well is formed when there is a low barrier between two high barriers, such as a charged conductor box (this is the case with electrons in metals). When a charge moves in a potential well, its **electric field will reflect back and forth in the potential well and oscillate to form a standing wave**, which is equivalent to a resonant cavity. **If the potential well is finite in depth, the oscillating electric field passes through the wall of potential well to form a traveling wave, and a plane wave is formed in the field-free region. Microscopic particles are moving in a potential well formed by surrounding substances when they are not emitted, so the generalized field generated by them oscillates to form fluctuations, and after emission, plane waves are formed in the field-free region.** This is the reason why "**microscopic particles have fluctuation**" in the quantum mechanics theory of Copenhagen school, which is actually **generalized field** $\vec{\Phi}(\vec{r},t)$ **is fluctuating**.

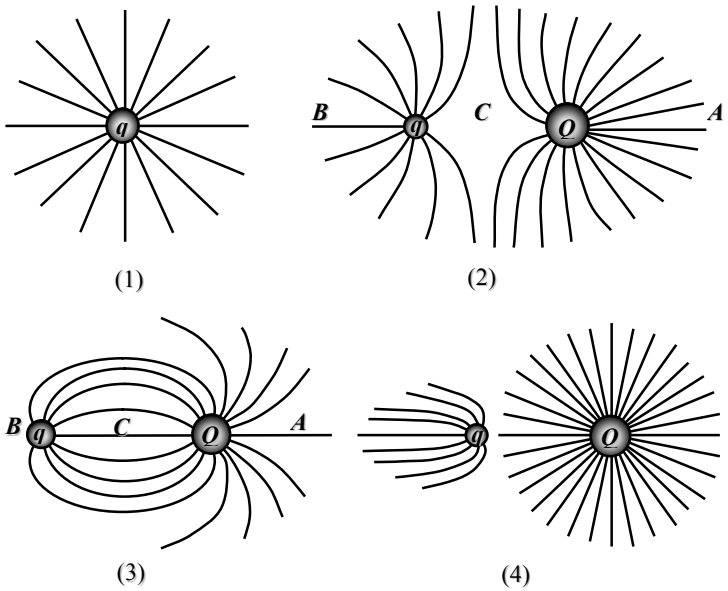


Fig.1. Penetration of electric field in potential barrier

2.2. Penetration of Momentum Field in Kinetic Energy Barrier

The penetration of momentum field (or velocity field) in kinetic energy barrier can be discussed by using the collision phenomenon of two balls. The velocities of two balls ***M*** and ***m*** are $\vec{V}$ and $\vec{v}$, respectively, and ***M>m***, $M\vec{V}^2/2 > m\vec{v}^2/2$, then ***M*** ball forms a kinetic energy barrier. When two balls collide in the same direction, $\vec{V}$ increases and $\vec{v}$ decreases or reverses, as shown in Fig.2(1). When two balls collide in opposite directions, $\vec{V}$ is "negative" with respect to the potential barrier, and $\vec{V}$ decreases and $\vec{v}$ decreases or reverses after the collision, as shown in Fig.2(2). In both cases, momentum field (or velocity field) of ball passes through the barrier, and part of it is reflected by the barrier and superimposed with the original field. When $M\to\infty$(or ***M>>m***), ***m*** ball bounces back at full velocity after collision, which does not affect the momentum of ***M*** ball, which means that the momentum field cannot pass through the infinite high kinetic energy barrier, as shown in Fig.2(3). When the oscillator with initial kinetic energy moves in the kinetic energy barrier, it bounces back and forth by the well wall, and its momentum changes periodically and oscillates to form standing waves or traveling waves.

Obviously, from the Eq.(5) or Eq.(6), the **barrier can only hinder or shield the corresponding generalized field that forms this barrier (the role of force), and has no effect on other generalized fields. Because the generalized field can only produce energy and force with the corresponding generalized quantity**, that is **Generalized field or function of momentum**. In the above example, the generalized field runs through the high barrier.

On this basis, a unique **New physical model of quantum mechanics** can be established:

Generalized fields form waves, Generalized fields are wave functions.

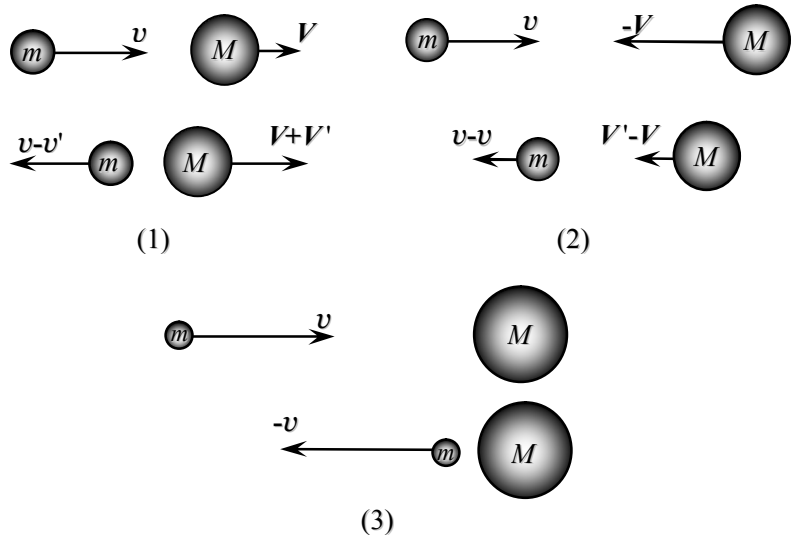


Fig.2. Penetration of momentum field in kinetic energy barrier

3. Energy Relation

Starting from this physical model, every conclusion has clear and obvious physical significance. Now, a vibrator with mass m is placed in an infinite potential well with width λ_0 and oscillates periodically at frequency ν_0, and the vibrator wave forms a wave packet with wavelength λ_0.

According to the Compton wavelength $\lambda=h/mc$ summarized by the **X**-ray scattering experiment, generally speaking, for a vibrator with mass m and velocity $\vec{v}$, the fluctuation of vibrator forms a wave packet (energy group) with wavelength λ, and there is a relationship $\lambda=h/m\upsilon$, that is,

$$m\upsilon\lambda=h \tag{7}$$

Let the kinetic energy of oscillator be a constant, and $\upsilon=\lambda_0\nu_0$, and $c=\lambda\nu$, which can be obtained from equations (3) and (4).

Electromagnetic wave energy:

$$E_c = m\vec{c}^{\,2} = (m\vec{c}\lambda)\frac{\vec{c}}{\lambda} = h\nu = \hbar\omega \tag{8}$$

Mechanical wave energy:

$$E_0 = m_0\vec{v}^{\,2} = (m_0\vec{v}\lambda_0)\frac{\vec{v}}{\lambda_0} = h\nu_0 = \hbar\omega_0 \tag{9}$$

(Note: The above two equations are not mass-energy equations, but describe the energy of mechanical waves and electromagnetic waves by using the energy of a mass object.)

When Planck deduced the formula of blackbody radiation, he put forward the quantum hypothesis of energy. Planck considered that the energy of electromagnetic field should be distributed according to different vibration modes of charged vibrators in matter. It was assumed that the energy of tiny vibrators in a cavity formed in a closed area (that is, atoms constituting matter) could only take integer multiples of some basic energy units, which were only related to the frequency of electromagnetic waves and were proportional to the frequency, that is, $E=h\nu$, such an energy was called **Energy Quantum**. Planck failed to give more physical explanation for this quantization hypothesis, but he only believed that it was a mathematical deduction method, which could make the theory conform to the empirical experimental data in the whole band.

Generally speaking, Planck's Energy Quantum hypothesis is expressed as that radiation is emitted and absorbed discontinuously in the black body cavity, and further expressed as that the energy of electromagnetic wave radiation emitted and absorbed in the black body cavity is one share.

What needs to be clear is that Planck's Energy Quantum hypothesis means that the energy of black body radiation emitting and absorbing electromagnetic waves is one copy, and each copy is ***E=hv***. It doesn't mean that quantum is the smallest unit of matter, let alone matter particles. The Energy Quantum and Quantum mentioned in this paper refer to the meaning of Planck's Energy Quantum.

4. Standing Wave Condition

Then we consider that the oscillator gains kinetic energy from the wall of potential well and increases the frequency. In the wave, we already know that only standing waves can exist stably, but **to form standing waves, the number of wave packets must be an integer**, that is, **standing wave condition**:

$$n\frac{\lambda}{2} = l, (n = 1,2,3\ldots) \qquad (10)$$

Where ***l*** is the width of potential well and ***λ/2*** is the linearity of wave packet (because there are two wave packets in a wavelength), this condition is only applicable to the system where the generalized field is uniformly distributed within the width of potential well, because the energy in each wave packet with the same size is equal.

If the generalized field is not uniform, the standing wave condition should be Sommerfeld's quantization principle【1】:

$$L = \oint Pdq = (n - \frac{1}{2})h, (n = 1,2,3\ldots) \quad (11)$$

If the width ***l*** of potential well is ***λ/2*** (that is, the length of one standing wave packet), the wavelength of N wave packets formed by the oscillator after absorbing energy is obtained by the standing wave condition (10):

$$\lambda_n = \frac{\lambda}{n} \qquad (12)$$

Substituting into Eq.(9), we can get:

$$E_0 = nhv = n\hbar\omega \qquad (13)$$

That is to say, **the energy of oscillator can only be changed by an integer multiple of $\hbar\omega$, and the frequency can also be changed by an integer multiple of ω.**

That is to say, **energy can only be emitted or absorbed one by one**, which is the essence of Energy Quantum hypothesis, which Planck first discovered when studying blackbody radiation.

When electrons are not emitted, they can all be regarded as being in a potential well formed by surrounding substances, and the electric field of surrounding substances will oscillate to form a standing wave, which will absorb or radiate Energy Quantum. Electrons will be affected by the standing wave of electric field in the potential well and move with the change of standing wave of electric field. When the electrons are emitted, they form free electrons, which break away from the standing wave of electric field and carry a certain amount of energy, maintaining the velocity and direction when they break away, and continue to make inertial motion.

Sommerfeld's general quantization formula Eq.(11) is a general equation about wave function, which is an important equation

in this theory and completely replaces Schrodinger equation.

5.Field Significance of Wave Function

What is the relationship between generalized field and wave function in this physical model? What exactly is the wave function? What is the probability explanation of wave function in the quantum mechanics theory of Copenhagen School?

The generalized field of a vibrator in the system forms a wave with ***n*** wave packets, and its energy is $n\hbar\omega$. That is to say, each wave packet is equivalent to an energy cluster with energy $\hbar\omega$, which is called an **Energy Quantum**, and its range is the volume ***V*** of a wave packet.

An Energy quantum is the energy generated by the generalized field $\vec{\Phi}(\vec{r},t)$ of system in the volume *V* of a wave packet. Then the total energy ***W*** in the system ***V*** and the energy dw in the volume element $d\tau$ are respectively:

$$W = M\int_V \left|\vec{\Phi}(\vec{r},t)\right|^2 d\tau = n\hbar\omega \quad (14)$$

$$dw = M\left|\vec{\Phi}(\vec{r},t)\right|^2 d\tau = \hbar\omega dn = \hbar\omega\frac{dn}{d\tau}d\tau \quad (15)$$

Integrate this formula and compare the two formulas, we to get:

$$\left|\frac{\vec{\Phi}(\vec{r},t)}{\sqrt{\int_V \left|\vec{\Phi}(\vec{r},t)\right|^2 d\tau}}\right|^2 = \frac{w}{W} = \frac{1}{n}\frac{dn}{d\tau} = \left|\vec{\Psi}(\vec{r},t)\right|^2 \quad (16)$$

Conversely, this formula can also be derived. If an Energy Quantum is regarded as a matter particle, this formula can also be obtained from the statistical (probability) explanation of wave function in the quantum mechanics theory of Copenhagen School. Taking ***n*** energy particles with energy $\hbar\omega$ as ***n*** material particles, and putting them into the system to test the probability distribution of material particles in the system, we can know from the probability knowledge that the probability distribution of ***n*** material particles will be determined according to the wave function. That is, at time ***t***, at $\vec{r}$, the number of material particles distributed in unit volume element $d\tau$ is:

$$dn = n\left|\vec{\Psi}(\vec{r},t)\right|^2 d\tau \quad (17)$$

And the energy of each material particle is $\hbar\omega$, so the energy in volume element $d\tau$ is

$$dw = \hbar\omega dn = n\hbar\omega\cdot\frac{1}{n}\frac{dn}{d\tau}\cdot d\tau = W\left|\vec{\Psi}(\vec{r},t)\right|^2 d\tau \quad (18)$$

By integrating and sorting this formula, we can get:

$$\left|\vec{\Psi}(\vec{r},t)\right|^2 = \frac{1}{n}\frac{dn}{d\tau} = \frac{w}{W} = \left|\frac{\vec{\Phi}(\vec{r},t)}{\sqrt{\int_V \left|\vec{\Phi}(\vec{r},t)\right|^2 d\tau}}\right|^2 \quad (16')$$

Where $\frac{1}{n}\frac{dn}{d\tau}$ is the probability of material particles appearing in unit volume at time *t*, at $\vec{r}$. This is the meaning of square $\left|\vec{\Psi}(\vec{r},t)\right|^2$ of wave function in the probability explanation of wave function in quantum mechanics theory of Copenhagen School【2】, $\vec{\Psi}(\vec{r},t)$ is the normalized wave function of system. From this **important relationship** Eq.(16), the following conclusions can be drawn:

$\left|\vec{\Psi}(\vec{r},t)\right|^2$ indicates that at time *t*, at $\vec{r}$, the ratio of energy of system per unit volume to the total energy of system *w/W*; the generalized field $\vec{\Phi}(\vec{r},t)$ is the normalized wave function of system.

Let $\vec{\Phi}$ (or $\vec{\phi}$) be a non-normalized wave function, then there is

$$\vec{\Psi} = \frac{1}{\sqrt{\int_V \left|\vec{\Psi}\right|^2 d\tau}} \vec{\Phi} = \sqrt{\frac{M}{W}} \vec{\Phi} \tag{19}$$

With normalization constant

$$\frac{1}{\sqrt{\int_V \left|\vec{\Psi}\right|^2 d\tau}} = \sqrt{\frac{M}{W}} \tag{20}$$

$\vec{\Psi}(\vec{r},t)$ is normalized wave function with.

$$\int_V \left|\vec{\Psi}(\vec{r},t)\right|^2 d\tau = 1 \tag{21}$$

It can be seen from the derivation of above-mentioned important relation Eq.(16) that only the wave energy of generalized field is used, but the matter and its mass are not used, that is, it has nothing to do with the matter particles. In the process of deducing Eq.(16') in reverse, it is assumed that an Energy Quantum is regarded as a matter particle, and that such matter particles are distributed according to the probability of wave function, so that Eq.(16') can be obtained. Sure enough, **the statistical (probability) explanation of wave function in the quantum mechanics theory of Copenhagen school treats energy quantum as a matter particle**. In fact, the wave function is derived from the fluctuation of generalized field, not from the particle of matter, and the wave packet of fluctuation of generalized field has volume and size, not a mass particle. It is natural to see that **the volume of wave packet is the volume of an Energy Quantum**. Now we see that **the wave function is the field (Generalized field), and the product of square of wave function and the generalized quantity is the energy density.**

Wave packet, energy and matter particles have completely different concepts and meanings, and they cannot be confused. The author of this paper has clearly pointed out in his article on relativity【3】that matter and energy are not intrinsically related, and they cannot be transformed into each other. This paper will continue to analyze them later.

In the microscopic world, the scale of matter and space is already very small, and the movement velocity is very fast. If we still look at it from macro perspective, ignoring its volume, shape and size, and treating it as a particle, then the position of each particle within the wave packet is "uncertain", and the degree of uncertainty is the range of "uncertain relationship".

In addition, when the total energy of system is $n\hbar\omega$ as a material particle, its position is within ***n*** wave packets, which can only mean a wider range of probability, and there is a wider range of "uncertainty". The generalized field and its energy dispersed in the whole space can't be regarded as a matter particle, so the "probability density" is meaningless.

6.Superposition, Orthogonality and Equivalent Principle of Wave Functions and Their Physical Significance

6.1. Superposition of wave function

The generalized field is an intensity quantity and a directional spread quantity, so it has superposition. The generalized field is a wave function, and the wave function has **superposition**. **If the system has multiple similar generalized field sources, then the**

generalized field at any point is the vector superposition of multiple generalized field sources at this point. namely

$$\vec{\Phi}=c_1\vec{\phi}_1+c_2\vec{\phi}_2+\ldots+c_n\vec{\phi}_n=\sum_n c_n\vec{\phi}_n \qquad (22)$$

The above-mentioned barrier penetration phenomenon of two charge matterss and two balls is actually the superposition of generalized fields, rather than the fact that material particles really cross the high barrier.

The superposition of wave functions is completely different from the superposition of wave function states in the quantum mechanics theory of Copenhagen School. The wave function of latter represents the states of microscopic particles, such as momentum, position, spin, etc. It is inconceivable that two or more particles are in the same position, or one particle is in multiple positions, and **the superposition of wave function states does not exist**.

6.2. Orthogonal Normalization

The two wave functions Ψ_k and Ψ_l satisfy the relation:

$$\int_V \vec{\Psi}_k^* \cdot \vec{\Psi}_k d\tau = \delta_{kl} = \begin{cases} 1, (\text{when } k=l) \\ 0, (\text{when } k\neq l) \end{cases} \qquad (23)$$

Here, its physical meaning is obvious: **The generalized field $\vec{\Phi}(\vec{r},t)$ can only constitute energy with its corresponding generalized quantity *M*.**

The proof is as follows. Because only when $k = l$, there is.

$$\begin{aligned} W &= M_k \int_V \vec{\phi}_k^* \cdot \vec{\phi}_k d\tau \\ &= M_l \int_V \vec{\phi}_l^* \cdot \vec{\phi}_l d\tau = M \int_V \vec{\phi}_k^* \cdot \vec{\phi}_l d\tau \\ &= M \cdot \frac{W}{M} \int_V \left(\sqrt{\frac{M_k}{W}}\vec{\phi}_k^*\right) \cdot \left(\sqrt{\frac{M_l}{W}}\vec{\phi}_l^*\right) d\tau \\ &= W \int_V \vec{\psi}_k^* \cdot \vec{\psi}_l d\tau \end{aligned} \qquad (24)$$

That is to say, when $k=l$, $W=W$, $\int_V \vec{\psi}_k^* \cdot \vec{\psi}_l d\tau = 1$ (can form energy); When $k\neq l$, $W=0$, $\int_V \vec{\psi}_k^* \cdot \vec{\psi}_l d\tau = 0$ (can't constitute energy).

Orthogonality has no physical meaning and explanation in the quantum mechanics theory of Copenhagen School, only "Hermite" in mathematics. Here, its physical significance is obvious. When $k=l$, $W=W$, which can constitute energy; When $k\neq l$, $W=0$, which cannot constitute energy. Understood as, **a generalized field can only constitute energy with its corresponding generalized quantity, otherwise it cannot constitute energy.**

For example: Mass m and velocity v can form kinetic energy, and dielectric constant ε and electric field E can form electric field energy (i.e. $v \cdot v = v^2$, $E \cdot E = E^2$, which means $W=W$ when $k=l$); On the other hand, the mass m and the electric field E cannot constitute energy, and neither can the dielectric constant ε and the velocity v (because $m \cdot E = ?$, $\varepsilon \cdot v = ?$, $W=0$ when $k\neq l$ is mentioned above).

6.3. Equivalence Principle

When different generalized fields act on a system at the same time, the total energy can be equivalent to the energy formed by any generalized field $\vec{\phi}_n$ and its corresponding generalized quantity M_n. Its expression:

$$\begin{aligned} W &= M \int_V \vec{\Phi}^* \cdot \vec{\Phi} d\tau \\ &= \sum_n W_n = \sum_n M_n \int_V \vec{\phi}_n^* \cdot \vec{\phi}_n d\tau \end{aligned} \qquad (25)$$

Normalize $\vec{\phi}$ to $\vec{\Psi}$

$$\begin{aligned} \frac{M}{W} \int_V \vec{\Phi}^* \cdot \vec{\Phi} d\tau &= \sum_n \frac{M_n}{W} \int_V \vec{\phi}_n^* \cdot \vec{\phi}_n d\tau \\ &= \sum_n \frac{W_n}{W} \frac{M_n}{W_n} \int_V \vec{\phi}_n^* \cdot \vec{\phi}_n d\tau \end{aligned} \qquad (26)$$

Namely:

$$\int_V \vec{\Psi}^* \cdot \vec{\Psi} d\tau = \sum_n \frac{W_n}{W} \int_V \vec{\psi}_n^* \cdot \vec{\psi}_n d\tau = \sum_n \frac{W_n}{W} = \sum_n |C_n|^2 = 1 \quad (27)$$

Combine n integral terms in the above formula with quadratic term theorem, where k, l=1,2,3,…,n, and $k \neq l$ (that is, the case of **0** added in the following formula):

$$\begin{aligned} \int_V \vec{\Psi}^* \cdot \vec{\Psi} d\tau &= \sum_n \int_V |C_n \vec{\psi}_n|^2 d\tau + 0 \\ &= \sum_n \int_V |C_n \vec{\psi}_n|^2 d\tau + \sum_n 2 |C_k^* C_l| \int_V \vec{\psi}_k^* \cdot \vec{\psi}_l d\tau \\ &= \int_V (\sum_n |C_n \vec{\psi}_n|)^2 d\tau \end{aligned} \quad (28)$$

Another expression of equivalence principle can be obtained: $\vec{\Psi}$ can be expanded into series $\vec{\Psi} = \sum_n C_n \vec{\psi}_n$ according to $\vec{\psi}_n$. This is the essence of **completeness**. The relation can be obtained again:

$$|C_n|^2 = \frac{W_n}{W} \quad (29)$$

$$\sum_n |C_n|^2 = 1 \quad (30)$$

$$C_n = \int_V \vec{\psi}_k^* \cdot \vec{\psi}_l d\tau \quad (31)$$

This formula shows that $|C_n|^2$ **represents the proportion of energy generated by the *n* generalized field in the total energy of system.**

Here, **its square is also the ratio *w/W* of energy formed by one of generalized field systems in the total energy of system. It also indicates the ratio *w/W* of energy of system per unit volume to the total energy of system at time *t*.**

For example, charged particles move in electric and magnetic fields. They have kinetic energy, electric field energy and magnetic field energy, but their total energy can be replaced by any one of kinetic energy, electric field energy or magnetic field energy. It can even be replaced by another kind of energy, or it can be replaced by multiple energies.

The equivalence principle here is a new principle, which is the embodiment of law of conservation of energy.

In mathematical form, in fact, the principle of equivalence means **completeness** in the quantum mechanics theory of Copenhagen School. The expansion coefficient of **completeness** is the third of five basic assumptions of quantum mechanics, and its square is the probability of finding particles, which is the expression form of Born's statistical explanation of wave function. The probability explanation of wave function leads to the confusion of whole theory.

7. Typical Application Examples

Knowing the reason and essence of fluctuation, using the standing wave condition, we can solve some typical problems and all other parameters with only a few simple algebraic operations.

7.1.One-Dimensional Infinite Potential Well

The oscillator (such as an electron) in a one-dimensional infinite potential well with a width of **2*a*** 【4】 obviously has only kinetic energy and no energy change, which can be obtained from the standing wave condition (8).

Wavelength:

$$\lambda_n = \frac{4a}{n} \quad (32)$$

And then get the energy level:

$$E_n = \frac{P^2}{2m} = \frac{4\pi^2\hbar^2}{2m\lambda_n^2} = \frac{\pi^2 n^2 \hbar^2}{8ma^2} \quad (33)$$

Velocity:

$$v_n = \pm\sqrt{\frac{2E}{m}} = \pm\frac{\pi n\hbar}{2ma} \quad (34)$$

And frequency:

$$\nu_n = \frac{v_n}{\lambda} = \frac{\pi n^2 \hbar}{8ma^2} \quad (35)$$

Then by vibration energy:

$$E_n = \frac{1}{2} m\omega^2 A_n^2 \quad (36)$$

The amplitude can be obtained:

$$A_n = \frac{4a}{\pi n} = \frac{1}{\pi}\lambda_n \quad (37)$$

The wave packet can be regarded as a rotating body with sinusoidal vibration, and then its volume is obtained:

$$V = \int_0^{\pi} \pi(A_n \sin\theta)^2 d\theta = \frac{\pi^2 A_n^2}{2} = \frac{8a^2}{n^2} \quad (38)$$

Because the potential well is infinitely deep, the energy level has nothing to do with the depth of potential well, so there is no orbital radius, which shows that the energy level can be stable at any depth.

7.2.One-Dimensional Linear Harmonic Oscillator

The motion equation of one-dimensional linear harmonic oscillator is $\ddot{X} + \omega^2 X = 0$, and its solutions are $X = A\cos(\omega t + \delta)$ and $\dot{X} = -\omega A \sin(\omega t + \delta)$.

There are many solutions. Because the generalized field X or $\dot{X}$ is changing, the quantization formula Eq.(11) is used, and the maximum kinetic energy is the total energy, then

$$\begin{aligned} \oint Pdq &= m\oint \dot{X}^2 dt \\ &= \frac{1}{2} m\omega^2 A^2 \cdot 2\int_0^{\frac{2\pi}{\omega}} \sin^2(\omega t + \delta) dt \\ &= (n - \frac{1}{2})h \end{aligned} \quad (39)$$

Integral in a period $0 \to 2\pi/\omega$, you can get Energy level:

$$E_n = \frac{1}{2} m\omega^2 A^2 = (n - \frac{1}{2})\hbar\omega \quad (40)$$

The coordinates of turning point of wave function can be obtained by other solutions, that is

Location:

$$X_n = \pm\sqrt{\frac{2(n - \frac{1}{2})\hbar}{m\omega}} \quad (41)$$

Velocity:

$$v_n = \dot{X}_n = \pm\sqrt{\frac{2(n - \frac{1}{2})\hbar\omega}{m}} \quad (42)$$

It can be seen that **amplitude, energy level radius and position are equivalent with**

$$v_n = \omega X_n = \omega r_n \quad (43)$$

Where the position $\boldsymbol{X_n}$ is equivalent to the energy level radius $\boldsymbol{r_n}$, combined with the energy level $E_n = m\omega^2 A^2/2 = (n - 1/2)\hbar\omega$, we can obtain

Amplitude:

$$A_n = r_n = X_n = \pm\sqrt{\frac{2(n - \frac{1}{2})\hbar}{m\omega}} \quad (44)$$

Wavelength:

$$\begin{aligned} \lambda_n &= \frac{2\pi}{\omega} v_n = 2\pi A_n \\ &= \pm 2\pi\sqrt{\frac{2(n - \frac{1}{2})\hbar}{m\omega}} \end{aligned} \quad (45)$$

The wave packet can be regarded as a rotating body with sinusoidal vibration, and its volume is:

$$V = \int_0^{\pi} \pi (A_n \sin\theta)^2 d\theta$$
$$= \frac{\pi^2 A_n^2}{2} = \frac{\pi^2 (n - \frac{1}{2})\hbar}{m\omega} \quad (46)$$

It can be seen that its wavelength is 2π times the amplitude.

$$\frac{\lambda_n}{A_n} = 2\pi \quad (47)$$

7.3. Hydrogen-Like Atom

Hydrogen-like atoms are nuclei or ions with only one electron outside the nucleus【5】. If the potential energy at infinity is zero, and the reduced mass of system is $\mu = mM/(m+M)$ and the nuclear charge matters number is ***Z***, then

Equation of motion:

$$\mu \frac{v^2}{r} = \frac{Ze_s^2}{r^2}, \quad (\text{其中} e_s = \frac{e}{\sqrt{4\pi\varepsilon_0}}) \quad (48)$$

Potential energy:

$$U = -\frac{Ze_s^2}{r} \quad (49)$$

Total energy:

$$E = \frac{1}{2}\mu v^2 + U = -\frac{Ze_s^2}{2r} \quad (50)$$

The oscillating electric field propagates along the extranuclear space to form a closed standing wave, which can be obtained from the standing wave condition (8)

Wavelength:

$$\lambda_n = \frac{2\pi r}{n} \quad (51)$$

The relation $\hbar = \mu v\lambda / 2\pi$ can be solved by substituting into the above formula.

Energy level:

$$E_n = -\frac{\mu Z^2 e_s^4}{2n^2\hbar^2} \quad (52)$$

Track radius (i.e. position):

$$r_n = \frac{n^2\hbar^2}{\mu Ze_s^2} = \frac{n^2}{Z}a_0 \quad (53)$$

Velocity:

$$v_n = \pm\sqrt{\frac{Ze_s^2}{\mu r_n}} = \pm\frac{Ze_s^2}{n\hbar} \quad (54)$$

Wavelength:

$$\lambda_n = \frac{2\pi n\hbar^2}{\mu Ze_s^2} = \frac{2\pi}{n}r_n \quad (55)$$

Then it can be obtained from vibration energy $E_n = \mu\omega^2 A_n^2 / 2$

Amplitude:

$$A_n = \frac{2n\hbar^2}{\mu Ze_s^2} = \frac{2}{n}r_n = \frac{1}{\pi}\lambda_n \quad (56)$$

Fine structure constant of ratio of electron velocity $v_1 = e_s^2/\hbar$ of first energy level of hydrogen atom to speed of light $c = 1/\sqrt{\varepsilon_0\mu_0}$ in vacuum;

$$\frac{v_1}{c} = \frac{e^2}{4\pi\hbar}\cdot\sqrt{\frac{\mu_0}{\varepsilon_0}} = \frac{e^2}{2\varepsilon_0 ch} = \frac{1}{137} \quad (57)$$

In fact, in general, different nuclear charge matterss ***Z*** and different energy levels ***n*** correspond to different fine structure constants:

$$\frac{v_n}{c} = \frac{Ze^2}{4\pi n\hbar}\cdot\sqrt{\frac{\mu_0}{\varepsilon_0}} = \frac{Z}{n}\cdot\frac{e^2}{2\varepsilon_0 ch} = \frac{Z}{n}\cdot\frac{1}{137} \quad (58)$$

(Take the first energy level of hydrogen atom as an example, the above observable measurements are: energy level −13.6 eV, Bohr radius 5.29×10^{-11}m, velocity 2.19×10^6 m/s, wavelength 3.32×10^{-10}m, frequency 6.54×10^{15} Hz and amplitude 1.06×10^{-10}m. These data can be used for experimental verification.)

The meaning of r_n is that the generalized field (electric field) with energy E_n (frequency and wavelength are determined) can only form

a standing wave when it fluctuates in the region with radius r_n, and its frequency is constant. Such a wave packet will not "gradually expand and disappear", and the electrons can move stably at the energy level. When its energy changes (that is, jumps between energy levels), it is emitted and absorbed in the form of fluctuating electromagnetic fields (electromagnetic waves).

In these three examples, the system is symmetrical. From the velocity expression, it can be seen that the **fluctuations formed by the generalized field can propagate in two directions, thus forming a standing wave.**

The wavelength of standing wave formed by the electric field is π times the amplitude.

$$\frac{\lambda_n}{A_n} = \pi \tag{59}$$

8.The velocity of Motion of Matter and the Velocity of Wave Propagation

The above examples are all analyzed from the perspective of energy, where υ_n is the velocity of matter. Let's analyze the velocity υ_n from the angle of wave.

From the wave point of view, $\upsilon_n=\lambda_n\nu_n$ is the wave velocity. In the above examples, matter is in a bound state and its wave is a standing wave. There are two wave packets in a wavelength, each wave packet is a quantum, and the energy of each quantum should be half $h\nu_n/2$ of quantum of two wave packets in a wavelength. Now let's substitute the velocity vn of matter in each example solved above as the propagation velocity of wave into $E_n = h\nu_n/2$, and work out the energy of each quantum in each example separately to see what we can get.

8.1.One-Dimensional Infinite Potential Well

$$\begin{aligned} E_n &= \frac{1}{2}h\nu_n = \frac{1}{2}\cdot 2\pi\hbar\cdot\frac{\upsilon_n}{\lambda_n} \\ &= \frac{1}{2}\cdot 2\pi\hbar\cdot\frac{\pi n\hbar}{2ma}\cdot\frac{n}{4a} = \frac{\pi^2 n^2\hbar^2}{8ma^2} \end{aligned} \tag{60}$$

8.2.One-Dimensional Linear Harmonic Oscillator

$$\begin{aligned} E_n &= \frac{1}{2}h\nu_n = \frac{1}{2}h\cdot\frac{\upsilon_n}{\lambda_n} = \frac{1}{2}h\cdot\upsilon_n\cdot\frac{m\upsilon_n}{h} \\ &= \frac{1}{2}m\upsilon_n^2 = \frac{1}{2}m\cdot\frac{2(n-\frac{1}{2})h\omega}{m} = (n-\frac{1}{2})h\omega \end{aligned} \tag{61}$$

8.3. Hydrogen-Like Atom

$$\begin{aligned} E_n &= \frac{1}{2}h\nu_n = \frac{1}{2}h\cdot\frac{\upsilon_n}{\lambda_n} = \frac{1}{2}\cdot 2\pi\hbar\cdot\upsilon_n\cdot\frac{n}{2\pi r_n} \\ &= \frac{1}{2}n\hbar\cdot\frac{\upsilon_n}{r_n} = \frac{1}{2}n\hbar\cdot\frac{Ze_s^2}{n\hbar}\cdot\frac{mZe_s^2}{n^2\hbar^2} = \frac{mZ^2e_s^4}{2n^2\hbar^2} \end{aligned} \tag{62}$$

This is the energy level in each example, that is, the energy of each energy group. From this point of view, **the velocity of motion of matter is equal to the velocity of wave propagation**. Matter moves with waves, or waves drive matter to move together.

The equation $\upsilon_n=\lambda_n\nu_n$ is used in above discussion, where υ_n is not only the velocity of wave, but also the velocity of matter. This conclusion shows that **wave is a real physical wave that exists objectively**, rather than "probability wave" in the mathematical sense as described in the quantum mechanics theory of Copenhagen School.

In these three cases, it can also be verified and satisfied.

$$E_n = \frac{1}{2}m\upsilon_n^2 \tag{63}$$

This also shows that the energy of each

quantum should be half of that of two wave packets within a wavelength.

Within a wavelength, the energy satisfies the formula (9)

$$E = m\upsilon_n^2 = h\nu_n \tag{9}$$

9. New Atomic Model

9.1. New Atomic Model

Now it should be possible to redefine **new atomic model** like this: **The electric field outside the nucleus (generalized field) fluctuates at r_n in the space limited by energy level, forming a closed standing wave. The waveform of this standing wave rotates around the nucleus at the velocity υ_n as a whole, and the electrons rotate around the nucleus at the velocity υ_n stably under the constraint and drive of electric field standing wave.**

The electric field standing wave fluctuates on a shell with a radius r_n corresponding to a certain Energy level E_n. This shell has a certain thickness, the thickness is **2** times of amplitude of antinode. The ratio of length $\lambda_n = 2\pi r / n$ of electric field standing wave to the waist diameter $2An$ is a constant $\pi/4$, and the half wavelength of standing wave is $\lambda_n / 2$, which shows that the shape of electric field standing wave is fixed.

The size of space occupied by a standing wave packet can be regarded as a rotating body with sinusoidal vibration, and its volume is:

$$\begin{aligned} V &= \int_0^{\pi} \pi (A_n \sin\theta)^2 d\theta \\ &= \frac{\pi^2 A_n^2}{2} = \frac{2\pi^2 n^2 \hbar^4}{\mu^2 Z^2 e_s^4} \end{aligned} \tag{64}$$

(The volume of electric field standing wave packet at the first energy level of hydrogen atom is 5.59×10^{-20} m^3)

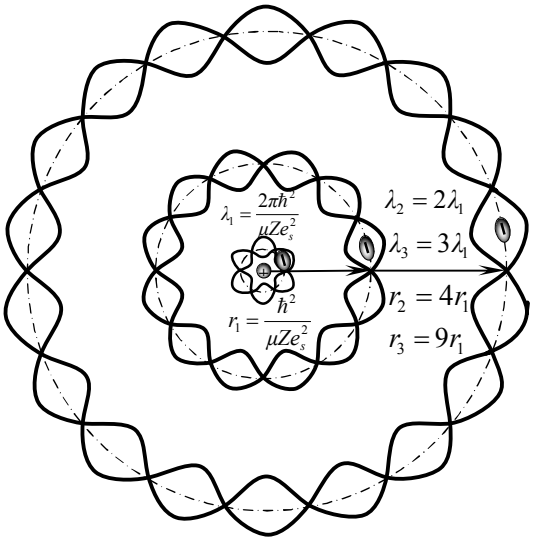


Fig.3. Electric field standing waves of hydrogen-like atoms at three energy levels.

It can be seen from the wavelength expression of standing wave packet of electric field of hydrogen-like atom that at the first and second energy levels, it has wrapped the nucleus and rotated around it. Its relationship between phase and azimuth is described by several other quantum numbers l and m in its wave function, which can be solved by the

general principle of quantization Eq.(11).

Fig.3 shows the fluctuation of electric field standing waves of hydrogen-like atoms at three energy levels, which is drawn according to the calculation results of energy levels, orbital radius, velocity and wavelength of hydrogen-like atoms above. It is a wave formed in the three-dimensional space outside the nucleus. Because the circle in the figure can't draw **1** wave packets in the ground state, ***6n*** waves are drawn here.

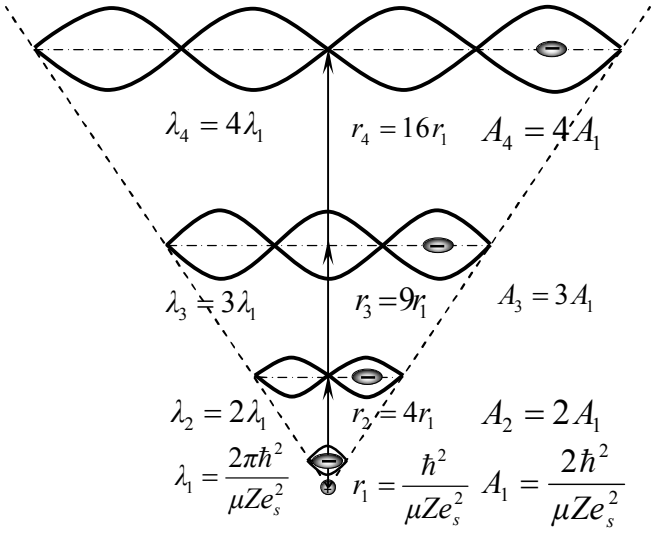


Fig.4. Development diagram of electric field standing wave of hydrogen-like atom at three energy levels.

In fact, there are only **1** wave packets in the ground state, **2** wave packets in the **2** energy level and **3** wave packets in the **3** energy level ... If the figure is cut straight along the radius of node, it is Fig.**4**, which shows the fluctuation of four energy levels, and its envelope (dotted line in the figure) is a straight line. When the two envelope lines are rotated downward and closed, the wave packets are stretched around the nucleus, which is this paper.

The standing wave is stable but not dispersed, just like the standing wave on a rope. It is like a stationary wave, and it is a wave packet with a length of half a wavelength. In this model, his whole body is in motion, and the electric field waves outside the nucleus form a closed standing wave, and the whole body is rotating around the nucleus, which can rotate in both forward and reverse directions. When it rotates once, it itself rotates once. As shown in fig.5. The first layer of ground state has only one wave packet, that is, the electron has only one position; There are two wave packets on the second level of second layer, that is, the electron has two positions … and so on.

The two wave packets mentioned here do not mean that there are two electrons, but that this electron can be in two stable positions on the second energy level. There is a large space between energy levels. There is no electric field and no stable position in these spaces. Electrons cannot be stably located in these spaces. When the energy of electrons changes, they can only jump between energy

levels. Or more precisely, when the energy of this energy group formed by electric field changes, the standing wave condition that this standing wave needs to meet is destroyed and dissolved, and it jumps to other energy levels to form a stable standing wave again.

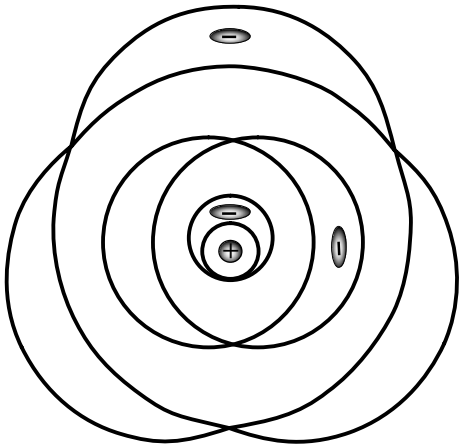


Fig.5. The shape of generalized field fluctuation of hydrogen-like atoms

The electric field standing wave on the energy level can have two directions of rotation, and electrons move with the rotation of electric field standing wave, and there are also two directions of movement.

Textbook [6] says: "According to classical electrodynamics, the movement of electrons around the nucleus is accelerated, so energy is constantly emitted in the form of radiation, and the radius of curvature of electron's orbit is constantly reduced, and electrons will eventually fall into the nucleus. In addition, the frequency of radiation generated by accelerating electrons is continuously distributed, which is inconsistent with the fact that the atomic spectrum is a discrete spectral line. According to the classical theory, if a system emits a wave with a frequency of V, it may also emit various harmonics with a frequency that is an integer multiple of V, which is also inconsistent with the experimental results of spectrum. Experiments have proved that the frequency distribution of spectral lines follows the principle of union. " In this paper, the author thinks that the classical electrodynamics is wrong about whether the charge will generate electromagnetic radiation when it is accelerating. When the charge is moving at a constant velocity, especially when it is moving in a uniform circular motion, there is no change in energy, so the charge will not generate electromagnetic radiation, but will move in a uniform circular motion steadily. Only when the charge is moving at a variable velocity with a variable velocity will the energy of charge change, and electromagnetic radiation will be generated. Mr. Mei Xiaochun from Fuzhou Institute of Original Physics has the same view and wrote an article on this issue【7】.

9.2. Electron Transition

In fact, the energy level is the position where the stable state is located. At this position, the standing wave condition can be met and the electric field can form a stable standing wave. When electrons absorb the energy of electromagnetic waves, or excite

electromagnetic waves, the energy of electric field standing wave changes, the original standing wave will be destroyed and dissolved, and the electric field will form a new stable standing wave in a new position, and the position of electrons will change with the change of electric field standing wave. This process is called **Electron transition**.

When electrons jump from high energy level to low energy level, the standing wave packet of electric field is dissolved, resulting in a changing electric field, which in turn excites a changing magnetic field and emits it in the form of electromagnetic waves. This is **Luminescence**, and the electric field re-forms a new standing wave at the low energy level.

$$h\nu = E_m - E_n \tag{65}$$

When the electron receives the energy of electromagnetic wave from the outside, the standing wave packet of electric field is dissolved, and the standing wave is formed again at the high energy level, and the position of electron changes with the change of standing wave of electric field. This process satisfies the following relationship:

$$E_m - E_n = h\nu \tag{66}$$

When the external electromagnetic wave energy is large enough, the electrons jump to the outermost energy level and get rid of coulomb force constraint of nucleus to become free electrons, which is **Ionization**. When the external electromagnetic wave energy is large enough, electrons even fly off the surface of metal body, which is **Photoelectric effect**. It can be seen that the photoelectric effect absorbs high-frequency and high-energy electromagnetic waves, and this process satisfies the photoelectric effect equation:

$$\frac{1}{2} m v_m^2 = h\nu - W_0 \tag{67}$$

In the previous example when the two charged balls are close, their electric fields are dynamically redistributed. Similarly, there is a large space between the energy levels outside the nucleus, and the electric field wave transition of electrons is also the result of dynamic redistribution of electric field.

9.3.Spin of Electric Field Standing Wave and Electron Spin

In this atomic model, the electric field wave outside the nucleus is a standing wave fluctuating around the nucleus, and its shape is not a sphere, but **Like a football or like a spindle**, which is the shape of standing wave formed on the rope we see, but it is not fixed, but rotates at a velocity vn. When it orbits once, it also rotates once, which forms the **Spin of electric field standing wave**, as shown in Fig.6.

Now that we know that electrons spin, let's analyze how electrons spin. If the electron is spherical in shape and its material distribution is isotropic, then no matter how it spins, it is isotropic, so it is impossible to distinguish whether it is spinning or not, which is equivalent to no spinning, so it is meaningless to assume that it is spinning. From this, **we know that the shape of electron is not a sphere, but it should also be like a football or a spindle, and its two ends are consistent with the direction of standing wave packet of electric field.**

The velocity calculated above is positive and negative, which means that the fluctuation of oscillating electric field can propagate in two directions, and it also means that the

electron can move in two directions, which also corresponds to the spin of electron in two directions. This is consistent with Pauli's incompatibility principle.

There are also clockwise and counterclockwise directions in which electrons fluctuate around the nucleus, and there are also clockwise and counterclockwise directions corresponding to the direction of electron spin. Fig.6 vividly depicts an electric field standing wave packet when its shell (three-dimensional) rotates to six directions, and the "→" sign in the figure only indicates its rotation direction. In this way, both angular momentum and magnetic moment are clear.

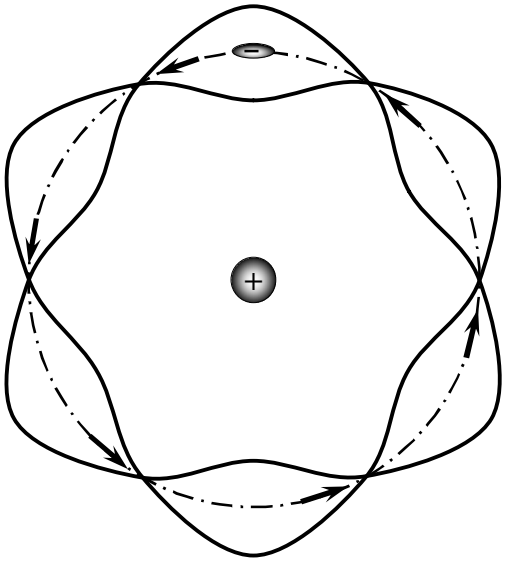


Fig.6. Spin of electric field standing wave and electron spin

When an electron moves around the nucleus with the electric field standing wave packet, it also spins around its own center, so the frequencies of electron spin and electric field standing wave packet spin are equal to each other, so the frequencies of electron moving around the nucleus and spinning around its own center are also the same and equal to $\boldsymbol{\nu_n}$. When the electric field standing wave packet spins around its center, the maximum radius is at its endpoint, which is $r_n^{'} = \lambda_n / 4$, Then **the maximum relative linear velocity of electric field standing wave packet spin** is

$$\upsilon_n^{'} = \pm 2\pi r_n^{'} \nu_n = \pm \frac{1}{2}\pi \lambda_n \nu_n = \pm \frac{\pi Z e_s^2}{2n\hbar} \quad (68)$$

(The maximum relative linear velocity of first energy level electric field standing wave packet spin of hydrogen atom is 3.44×10^6 m/s)

The ratio of maximum relative linear velocity of electric field standing wave packet spin to the velocity of electron moving around the nucleus is

$$\frac{\upsilon_n^{'}}{\upsilon_n} = \frac{\pi}{2} \quad (69)$$

When an electron spins around its center, it will also produce spin magnetic moment and spin precession in two directions. But it not be discussed in details here.

The volume of electron is much smaller than that of standing wave packet of electric field (its size is unknown so far), so the maximum relative linear velocity of electron spin is far less than Eq.(68) and far less than the speed of light ***c*** in vacuum. The angular momentum of electron spin is also much smaller than the estimated value of following formula:

$$L << \pm r_n' \mu v' = \pm \frac{1}{4} \cdot \frac{2\pi n\hbar^2}{\mu Z e_s^2} \cdot \mu \cdot \frac{\pi Z e_s^2}{2n\hbar} = \pm \frac{1}{2}\pi^2 n\hbar = \pm \frac{\pi}{4} nh \quad (70)$$

Solid matters【 **3** 】 with electrical properties (solid matters and field substances will be analyzed in section **11** of this paper) are called charge matters, such as electrons, protons and ions. Their movement changes the electric field distribution in the surrounding space and produces magnetic fields. The spin motion of charge matters also produces a magnetic field, forming a magnetic moment. The changing magnetic field of moving charge matters is the reason for forming the magnetic moment, not the "intrinsic magnetic moment". It is not discussed in details here.

9.4. Emission and Absorption of Electrons

When an electron absorbs energy and jumps to a high energy level, the energy increases (because the energy level is negative). When an electron leaves the nucleus, it carries the ionization energy and velocity given to it by the atom, keeps the state of detachment, breaks away from the constraint of electric field force outside the nucleus, and becomes a free state in a field-free region. This free electron keeps the velocity of detachment and flies tangentially. If there is no other substance in a vacuum, it will keep the original velocity and fly freely (inertial motion), which is **Electron emission**.

When the electron moves to the front object, the electric field of atom in this object captures it, and it moves around the atom of this object to become negative ions, or it is captured by the ions in this object. It is at the energy level matching the energy it carries and rotates around the core with the standing wave packet of electric field, which is **Electron absorption**.

10. The Essence of Light

10.1. Similarity Between String Vibration Equation and Maxwell Electromagnetic Wave Equation

Wave equation is a kind of partial differential equation, which mainly describes various wave phenomena in nature, including transverse waves and longitudinal waves, such as sound waves, light waves, radio waves (light waves) and water waves. Wave equation is abstracted from acoustics, physical optics, electromagnetism, electrodynamics, fluid mechanics and other fields. It is derived from the mechanical vibration of strings, and the mechanical wave equation is also the string vibration equation.

One-dimensional wave equation can be derived as follows: a series of small particles with mass ***m*** are connected by springs with length ***b***. The elastic coefficient of spring is ***k***, where $\vec{\Phi}(\vec{x},t)$ represents the distance of particle at ***x*** from the equilibrium position. Particle inertia force calculated by Newton's second law, spring force calculated by

Hooke's law, and the force exerted on particle ***m*** at ***x+b*** are:

$$\vec{F} = ma(t) = m \cdot \frac{\partial^2}{\partial t^2}\vec{\Phi}(\vec{x}+b,t) \quad (71)$$

$$\begin{aligned}\vec{F} &= \vec{F}_{x+2b} + \vec{F}_x \\ &= k[\vec{\Phi}(\vec{x}+2b,t) - \vec{\Phi}(\vec{x}+b,t)] \\ &\quad + k[\vec{\Phi}(\vec{x},t) - \vec{\Phi}(\vec{x}+b,t)]\end{aligned} \quad (72)$$

The spring force changes the state of motion, and the two equations are equal, and the equation is obtained. If the mass point and the spring are simplified as a tensioned string, the one-dimensional wave equation is obtained, and it is extended to the three-dimensional case to obtain the three-dimensional wave equation:

One-dimensional wave equation:

$$\frac{\partial^2\vec{\Phi}(\vec{x},t)}{\partial x^2} = \frac{1}{\vec{v}^2}\frac{\partial^2\vec{\Phi}(\vec{x},t)}{\partial t^2} \quad (73)$$

Three-dimensional wave equation:

$$\nabla^2\vec{\Phi}(\vec{r},t) = \frac{1}{\vec{v}^2}\frac{\partial^2\vec{\Phi}(\vec{r},t)}{\partial t^2} \quad (74)$$

Coefficient $\vec{v}$ is usually a fixed constant, representing **Wave propagation velocity**. In the problem of string vibration, the wave velocity has nothing to do with vibration and wave, but with the material, density and axial tension of string itself. Obviously, this string is the propagation medium of this wave, and the velocity of this wave is based on this string. The wave velocity is only related to the material, density and axial tension of this string, but has nothing to do with other factors. When these related factors are determined, the wave velocity of this string is a constant.

The solution of equation is a combination of two parts, $\vec{F}$ represents the right traveling wave and $\vec{G}$ represents the left traveling wave. The wave equation is a linear differential equation, and the amplitudes of two waves can be superimposed.

$$\vec{\Phi}(\vec{x},t) = \vec{F}(\vec{x} - \vec{v}t) + \vec{G}(\vec{x} + \vec{v}t) \quad (75)$$

When there is no external force, it is a homogeneous equation, and when there is no resistance, pluck the strings, and the strings will fluctuate with constant amplitude.

When there is a continuous external force (power or resistance), the wave equation is not a homogeneous equation, but

One-dimensional nonhomogeneous wave equation:

$$\frac{\partial^2\vec{\Phi}(\vec{x},t)}{\partial t^2} - v^2\frac{\partial^2\vec{\Phi}(\vec{x},t)}{\partial x^2} = f(\vec{x},t) \quad (76)$$

Three-dimensional inhomogeneous wave equation:

$$\frac{\partial^2\vec{\Phi}(\vec{r},t)}{\partial t^2} - v^2\nabla^2\vec{\Phi}(\vec{r},t) = f(\vec{x},t) \quad (77)$$

When $f(\vec{x},t)$ is positive, it is the driving force, and the continuous periodic driving force enhances the fluctuation; When $f(\vec{x},t)$ is negative, it is resistance, and continuous resistance attenuates fluctuations.

When the chord is infinitely long, there is no boundary, and the wave propagates in one direction forever, forming a sine wave:

$$\vec{\Phi}(\vec{x},t) = A\cos(\omega t \pm 2\pi\frac{\vec{x}}{\lambda}) \quad (78)$$

As long as you pluck the strings, an isolated sine wave will be formed on the infinite strings and spread. Pushing a water body with a straight plate produces one-dimensional sinusoidal plane waves in the water body.

Linear plane wave is only the simplest case, but it is not the real case. The wave source of real situation is usually a point,

which sends out to three-dimensional space, that is, spherical wave.

In fact, it is the most complicated to generate plane waves. It is impossible to generate plane waves by arranging a series of wave sources in an infinite straight line.

Mathematically, when a spherical wave propagates to infinity, a very small piece of its spherical wave is approximately regarded as a plane wave. Or the waves generated by a line of wave sources arranged in a straight line are approximately regarded as plane waves,

An elastic string with fixed tension at both ends and fixed points at both ends as boundary conditions, the solution of its equation is trigonometric function, that is, sine or cosine waves.

Toggle the string, give it a driving force, and the string vibrates to produce a series of forward propagating traveling waves. When this wave propagates to a fixed end point, another series of waves with the same frequency propagates in the opposite direction, and the two series of traveling waves with the same frequency are superimposed, and the **Standing wave equation** is obtained:

Right marching wave:

$$\vec{\Phi}_1(\vec{x},t) = A\cos(\omega t - 2\pi\frac{\vec{x}}{\lambda}) \quad (79)$$

Left traveling wave:

$$\vec{\Phi}_2(\vec{x},t) = A\cos(\omega t + 2\pi\frac{\vec{x}}{\lambda}) \quad (80)$$

Standing wave equation:

$$\begin{aligned}\vec{\Phi}(\vec{x},t) &= \vec{\Phi}_1(\vec{x},t) + \vec{\Phi}_2(\vec{x},t) \\ &= 2A\cos 2\pi\frac{\vec{x}}{\lambda}\cdot\cos\omega t\end{aligned} \quad (81)$$

Two standing waves with a phase difference of $\boldsymbol{\pi/2}$

$$\vec{\Phi}_1(x,t) = 2A\cos 2\pi\frac{\vec{x}}{\lambda}.\cos\omega t \quad (82)$$

$$\vec{\Phi}_2(x,t) = 2A\sin 2\pi\frac{\vec{x}}{\lambda}.\sin\omega t \quad (83)$$

When superimposed, it becomes a right traveling wave again:

$$\begin{aligned}\vec{\Phi}(x,t) &= \vec{\Phi}_1(x,t) + \vec{\Phi}_2(x,t) \\ &= 2A\cos(\omega t - 2\pi\frac{\vec{x}}{\lambda})\end{aligned} \quad (84)$$

Characteristics of standing waves All points are in simple harmonic vibration, the frequency is the same, and the amplitude of each point changes periodically, regardless of time. $\boldsymbol{n.\lambda/2}$ where the amplitude is **0** is called a node, and $\boldsymbol{(n\text{-}1/2).\lambda/2}$ where the amplitude is the largest $\boldsymbol{2A}$ is called an antinode. Standing wave conditions need to be met to form a standing wave, a string with a length of $\boldsymbol{L}$, and the standing wave conditions are:

10.1.1. Fixed at Both Ends:

$$L=n.\lambda/2 \quad (85)$$

10.1.2. Fixed at One end and Free at the Other:

$$L=(n\text{-}1/2).\lambda/2 \quad (86)$$

10.1.3. Freedom at Both Ends:

$$L=(n\text{-}1/2).\lambda/2 \quad (87)$$

10.1.4. Ring:

$$L=2\pi r=2.n.\lambda/2 \quad (88)$$

As shown in fig.7.

Maxwell electromagnetic wave Eq.(homogeneous equation of electromagnetic field):

$$\nabla^2\vec{E} = \varepsilon_0\mu_0\frac{\partial^2\vec{E}}{\partial t^2} \quad (89)$$

$$\nabla^2\vec{B} = \varepsilon_0\mu_0\frac{\partial^2\vec{B}}{\partial t^2} \quad (90)$$

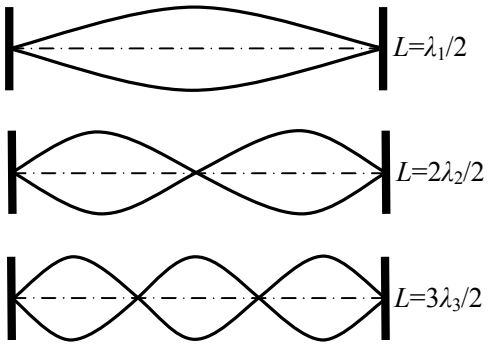
It can be seen that **The electromagnetic wave equation is exactly the same as the**

string vibration equation, where the wave velocity $\boldsymbol{v}$ is the speed of light $\boldsymbol{c}$.

$$\vec{c} = \frac{1}{\sqrt{\varepsilon_0 \mu_0}} \tag{91}$$

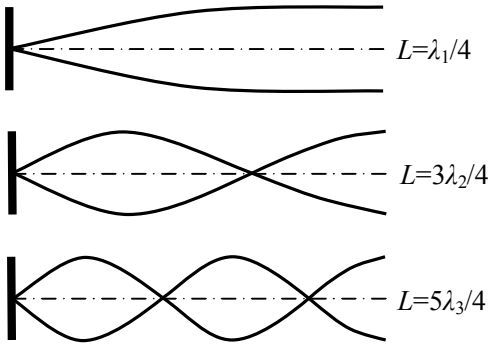
Just like the standing wave formed by mechanical waves, it is necessary to meet the standing wave condition for the generalized field to oscillate in a potential well to form a standing wave. **To form a standing wave, the number of wave packets must be an integer**.

Compared with the macroscopic mechanical standing wave, we can see from the knowledge of macroscopic standing wave that the idea of this theory coincides with it. Mechanical standing waves are fixed at both ends, one end is fixed and one end is free with half wave, and the two ends are free without reflection, and the annular standing waves propagate in two directions, and meet and overlap in half a cycle to form the annular standing waves, which is the reason why the standing waves in hydrogen-like atoms are half a cycle.



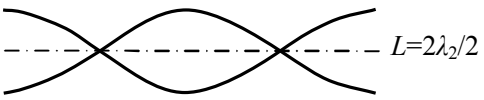
$L=n.\lambda_n/2$，n=1,2,3…

(1) Fixed at both ends



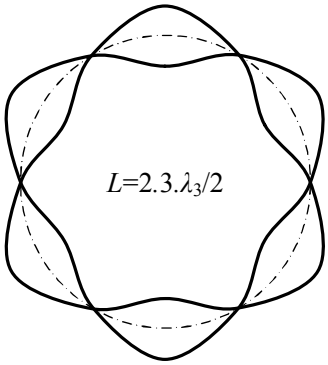
$L=(n-1/2).\lambda_n/2$，n=1,2,3…

(2) Fixed at one end and free at the other.



$L=(n-1/2).\lambda_n/2$，n=1,2,3…

(3) Freedom at both ends



$L=2\pi r_n=2.n.\lambda_n/2$，$n$=1,2,3…

(4) Annular

Fig.7. Several standing wave modes of string vibrations

The wave situations of one-dimensional infinite potential well, the one-dimensional linear harmonic oscillator and the hydrogen-like atom in the above examples correspond to the annular standing wave with two fixed ends and one fixed end and one free

end, respectively, and the electromagnetic wave corresponds to the standing wave with two free ends. One-dimensional infinite potential well is a typical **Bound state**, which is equivalent to a standing wave with fixed ends, and the standing wave conditions are exactly the same ($n\lambda/2=l$). One-dimensional linear harmonic oscillator is a typical **Emission state**, which is equivalent to a standing wave with only one end fixed. Its standing wave condition is similar to Sommerfeld's quantization principle, and there is a half wave ($(n-1/2).\lambda/2=l$). Hydrogen-like atom is a typical **Spherical shell state**, which is equivalent to a circular standing wave ($n\lambda/2=\pi r$), and its length is half circumference, but the actual situation is a three-dimensional standing wave, a circular standing wave on the plane, just like the new atomic model. Free electron is a typical **Free state**, which is equivalent to a plane wave with two free ends. It is formed by the transition of an emission state with one fixed end and one free end. As shown in fig.(7).

Electromagnetic wave (light wave) is a little special. Although electromagnetic wave is derived under the condition of no charge matters and no current, it can be seen that the string vibration equation is exactly the same as Maxwell's electromagnetic wave equation, and Maxwell's electromagnetic wave equation is also a string vibration equation. Because the string vibration equation produces a standing wave, then **Maxwell's electromagnetic wave equation also produces a standing wave, that is, the light wave is a standing wave**. And because electromagnetic wave is a wave formed by alternating excitation of electric field and magnetic field, its propagation medium is electric field and magnetic field, therefore, **electromagnetic waves are actually standing waves formed by self-restraint.**

From this point of view, **electromagnetic wave is also a kind of standing wave. The electromagnetic wave excited from a wave source is like a standing wave with one end fixed and one end free. In free space, it is like a standing wave with two ends free. This is because it is not the vibration of a solid material medium, but is generated by the alternating excitation of an electric field and a magnetic field (field-state matter), and it fluctuates while generating the electric field and the magnetic field**.

10.2. The Essence of Light

In the long-term research, the author of this paper has been emphasizing: **The problem of light has always been the most critical problem in the scientific community. As long as human beings solve the secret of light, all scientific problems can be solved!**

All kinds of atomic reactions, nuclear separation, electronic transitions and even chemical reactions are generally accompanied by changes in energy and the emission and absorption of light.

Light is electromagnetic wave, and electromagnetic wave is light, which is the fluctuation of electromagnetic field. Light and electromagnetic wave are completely equivalent concepts. The light, light wave or electromagnetic wave mentioned in this paper have exactly the same meaning. This has been clearly described by Maxwell's equations, and the problem of light is also the origin of

relativity and quantum mechanics.

However, all subsequent theories, including relativity and quantum mechanics, ignored the key problem that light is electromagnetic wave, and regarded light as a particle. Quantum mechanics insisted that the wave of light was a probability wave, or that it had another probability wave.

The electromagnetic wave itself can fully describe this wave, which is not introduced for the convenience of research, and there is no need to introduce another wave function to describe the light wave (electromagnetic wave). This electromagnetic wave has no meaning of probability, and there is no need to explain it otherwise.

The electromagnetic wave in free space (vacuum) is also emitted by the wave source (electric field outside the nucleus). In free space, it is a field-free region, which maintains the original standing wave state and propagates in free space.

According to Maxwell's electromagnetic theory, light has the following characteristics:

Light is an electromagnetic wave, which is a wave excited alternately by electric and magnetic fields, and propagates in space. Light can propagate in some media without medium. The propagation speed of light in vacuum is about 3.0×10^8m/s, which is lower than this velocity. Light has all the common characteristics of waves, such as reflection, refraction, diffraction, interference, superposition, polarization, and constant velocity.

After re-analyzing the nature of light, the author of this paper has the following deeper understanding of nature of light:

Light is a form of fluctuation, not a form of material movement. It can't be called the movement of light, but the propagation of light. Light propagates in fluctuating forms and fluctuating energy. Light is not matter, has no mass, has no inertia, is not affected by force, accelerates or decelerates, and is not dragged by light source, but can be dragged by electromagnetic field medium, that is, the speed of light can be superimposed on the velocity of electromagnetic field medium. In the same homogeneous substance, light does not change direction when it propagates. Light waves are generated immediately when the light source emits light, and they spread out at a uniform speed of light.

The movement of light source does not affect the velocity and direction of light propagation. Light spreads out immediately after it is generated from the light source, and has nothing to do with the light source since then. Each kind of light generates and propagates independently of each other, superposes when they meet, and propagates independently after separation. Light propagates energy without mass. These unique properties of light determine the unique behavior of light, which is obviously different from the nature of matter, which shows that light is not matter, but the form of fluctuation. When light is reflected by an object, the object becomes a new light source.

The principle that the speed of light is a constant is incorrect. Relative to the same homogeneous substance (the material medium of light), the speed of light is the same, which is the true meaning of constant speed of light.

In vacuum, relative to the reference frame of vacuum medium, the speed of light is c, which satisfies the laws of relativity and superposition of speed of light. The speed of light is not the upper limit of all velocitys, but the movement velocity of solid matter can exceed the speed of light. Vacuum is the most ideal medium for light (electromagnetic wave) propagation, with the fastest propagation velocity (c) and the lowest refractive index (**1**).

Although there is no solid matter as the medium in vacuum, it takes the substance in the form of electromagnetic field as the medium. The electric field and the magnetic field are alternately excited in space and propagate forward. The form of this fluctuation is electromagnetic wave. In the process of alternating excitation of electric field and magnetic field, the electric field and magnetic field at the back weaken and disappear, and the electric field and magnetic field at the front are excited, which are generated in the process of excitation, and the changes are one after another. It can be seen that the propagation velocity of electromagnetic wave is the velocity at which electric field and magnetic field are alternately excited in space and propagate forward, so **electromagnetic field is the medium of electromagnetic wave propagation**.

Maxwell solved the electromagnetic wave equation from the equations. Electromagnetic wave equation and mechanical wave Eq.(string vibration equation) have exactly the same form. The mechanical wave velocity solved by the mechanical wave equation is relative to the medium and has nothing to do with the motion of wave source. Similarly, the electromagnetic wave velocity solved by electromagnetic wave equation is $c=1/\sqrt{\varepsilon_0\mu_0}$ (where ε_0 is the dielectric constant in vacuum and μ_0 is the permeability constant in vacuum), so the electromagnetic wave velocity in vacuum is also relative to the dielectric electromagnetic field of electromagnetic wave in vacuum, and has nothing to do with the motion of wave source. The dielectric electromagnetic field of electromagnetic wave in vacuum is the reference system of light velocity c in vacuum. With this definite frame of reference, Maxwell's electromagnetic theory and Galileo's relativity principle have no contradictory.

The dielectric constant in vacuum is ε_0**=8.854187817×10^{-12} F/m**, and the magnetic permeability constant in vacuum is μ_0**=1.256638504×10^{-6} N/A^2**, which are the values in the free space without matter, indicating that vacuum has no hindrance to electromagnetic waves, and it is determined that the electromagnetic wave velocity in vacuum reaches the fastest c**=299792458 m/s**.

In a solid matter, the velocity of electromagnetic wave is $c_w=1/\sqrt{\varepsilon(\nu)\mu(\nu)}=c/n$ (where ε is the dielectric coefficient of solid matter, μ is the magnetic permeability coefficient of solid matter, and they are not only related to the solid matter, but also related to the frequency ν of electromagnetic wave, and n is the refractive index of transparent solid matter to light). Similarly, the velocity of electromagnetic wave in a solid matter is relative to the medium electromagnetic field

of electromagnetic wave in a solid matter, and has nothing to do with the motion of wave source. As the electromagnetic wave medium in the solid matter, the electromagnetic field is the reference frame of light velocity c_w in the solid matter.

Similarly, the dielectric coefficient $\varepsilon(\nu)$ and the magnetic permeability coefficient $\mu(\nu)$ in the solid matter are determined by the state parameters such as the type, density, temperature and pressure of solid matter itself, and are also related to the frequency ν of electromagnetic waves, indicating that the solid matter has a blocking effect on electromagnetic waves, and the blocking effect on electromagnetic waves with different frequencies is different. They determine the electromagnetic wave velocity c_w in the solid matter, which is based on the electromagnetic wave velocity in the solid matter. For example, the velocity of visible light in water is $\mathbf{2.25 \times 10^8 m/s}$, which is determined by the frequency of visible light and the state parameters such as the type, density, temperature and pressure of water.

The mechanical wave equation and electromagnetic wave equation are in the same form, and the mechanical wave velocity is determined by the nature and state parameters of medium itself, rather than by the movement of medium. Similarly, the velocity of electromagnetic wave is determined by the nature and state parameters of electromagnetic field itself, which is relative to the velocity of electromagnetic field as the reference system, rather than by the movement of electromagnetic field. In vacuum, the electromagnetic field has no other state parameters, only a simple electromagnetic field, and its electromagnetic wave velocity is determined by the dielectric constant ε_0 and the permeability constant μ_0 in vacuum, which is relative to the velocity of electromagnetic field in vacuum as a reference system, not by the movement of electromagnetic field, let alone by the movement of any other medium.

In the solid material medium, electromagnetic waves are also propagated by the medium of electromagnetic field, not by the solid material medium. In the solid material medium, there is charge matters, so the electromagnetic field and the solid material medium will act as electromagnetic force. The transmission and distribution of electromagnetic field in the solid material medium are affected by the state parameters of solid material medium, and the dielectric constant $\varepsilon(\nu)$ and the permeability constant $\mu(\nu)$ are different from those in vacuum, thus affecting the fluctuation of electromagnetic field in the solid material medium and the velocity of electromagnetic field fluctuation. With the movement of solid material medium, the electromagnetic field in it also moves with it.

When light propagates in a (transparent) solid matter, the electromagnetic field is also used as the propagation medium. The (transparent) solid matter is not the propagation medium of light, but the electromagnetic field is the propagation medium of light. The slow propagation of electromagnetic field in solid matter leads to the slow propagation of light in (transparent) solid matter, which is $c_w=c/n$. The overall movement (flow) velocity of solid matter is

not synchronous with the propagation velocity of electromagnetic field in solid matter, which leads to the unsynchronized propagation speed of light in transparent solid matter, usually lagging behind. That is, the physical matter does not drag the electromagnetic field completely synchronously, nor does it drag the electromagnetic wave completely synchronously, but only partially. The solid matter drags the electromagnetic field in a certain proportion, and the two actions slow down the propagation speed of light through the whole moving (transparent) solid matter, which is related to the state parameters such as the type, density, temperature and pressure of solid matter, and also related to the frequency $\boldsymbol{\nu}$ of electromagnetic waves. These state parameters are generally manifested in the dielectric coefficient $\boldsymbol{\varepsilon(\nu)}$ and the magnetic permeability coefficient $\boldsymbol{\mu(\nu)}$ of solid matter medium.

All waves (including electromagnetic waves) are body waves inside the medium and surface waves at the interface of medium. There are both transparent waves and longitudinal waves in body waves. Surface waves at the interface of medium are transparent waves, while body waves in medium are longitudinal waves. Any surface parallel to the propagation direction in a medium is a transparent wave, and any surface perpendicular to the propagation direction in a medium is a longitudinal wave. As shown in Fig.8.

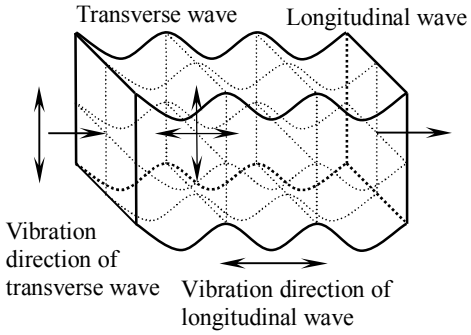


Fig.8. Body waves have both transparent waves and longitudinal waves

When the electric field and magnetic field are alternately excited to form electromagnetic waves, the electric field waves and magnetic field waves vibrate simultaneously in the propagation direction and perpendicular to the propagation direction, and the electromagnetic waves have both transverse waves and longitudinal waves. According to the conservation of energy when electric field and magnetic field are alternately excited, the phase difference between electric field wave and magnetic field wave is **90** degrees. As shown in Fig.9 and Fig.11.

Light is just the information transmission medium used by observers or instruments to observe substances, just as sound waves are the medium to transmit auditory information. In any case, light will not affect the motion of matter, let alone the essence and energy of matter. The parameter of light speed should not be included in coordinate transformation, motion equation and energy equation. It is impossible to be correct if these equations contain the physical theory of the parameter of

light speed.

The characteristic parameters of all waves are wavelength, frequency and phase, and their phenomena are reflection, refraction, diffraction, interference, superposition, polarization and constant velocity. Similarly, light also has the same parameters and phenomena. No experiment proves that light is particle-like. All phenomena and experiments prove that light is only wave-like, and that light is electromagnetic wave. No matter how short the wavelengths of **X**-rays and **γ**-rays are, they are still waves, light waves and electromagnetic waves, not particles.

In the monograph 【**3**,**8**】, the author made a detailed study on the relationship among wave , light and motion.

Then we will study how light is emitted, how it spreads, how it interacts with matter and how it passes through solid material medium, so that we can further understand the essence of light!

10.3. Luminescence Mechanism

Light is not emitted by a light source, but excited by a light source.

The electric field wave of energy level where the extranuclear electrons of light source are located loses stability and disbands when gaining the external electromagnetic field energy, and re-forms metastable wave at the high-energy level of metastable state. When it jumps to a more stable low-energy level, the fluctuating electric field re-forms stable wave at the low-energy level, and the redundant energy is emitted tangentially as a changing electric field, which excites the first non-uniformly changing electric field. When this electric field becomes weakens, it excites the first non-uniformly changing magnetic field, electric field and electric field.

Broadly speaking, **all bands of electromagnetic waves can be called light waves**, and the visible light of human eyes is only a very narrow band (**380~780nm**).

The level of matter determines the change of energy level. The macroscopic antenna oscillation circuit is low-level, its mechanism is well known, which produces long-band low-energy electromagnetic waves (radio waves). At the molecular level, the change of outermost electrons outside the nucleus is shallow, which excites high-energy short-wave electromagnetic waves (visible light and ultraviolet light). The micro-level changes of extra-nuclear electrons are middle-level, which excite high-energy ultra-short wave electromagnetic waves (ultraviolet light and **X** light). The nuclear reaction of proton neutrons and other nucleons at the microscopic level is deep-seated in matter, and the electromagnetic wave energy produced is extremely high, that is, **γ** light.

After the light is excited, it is broadcast in space, and it has nothing to do with the light source since then. The light source plays the role of energy conversion and electric field excitation.

Therefore, relative to the solid material medium, the speed of light is a constant.

10.4.The Structure, Shape and Size of Light

Light has structure, shape and size. It is not a "point particle" without structure, shape and size.

The structure of light is an electromagnetic field that is excited

alternately. The electric field and the magnetic field are transformed alternately, and the phases of both are not synchronous, but have $\pi/2$ different. The sum of electric field energy and magnetic field energy at any moment is the total energy $E=h\nu$, which conforms to the law fo energy of conservation. The electromagnetic wave propagation image should be one as shown in Fig.9:

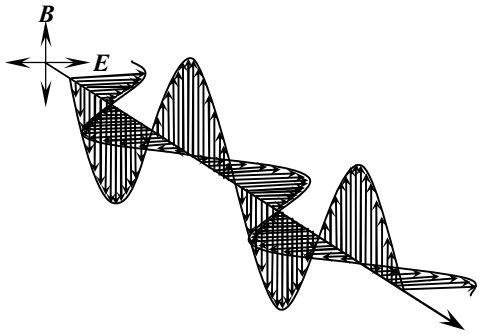


Fig.9. Electromagnetic wave propagation image

The author thinks that in the textbook of electrodynamics, the phase of electromagnetic wave and its propagation image (Fig.4-2)【9】is wrong, because it does not conform to the law of conservation of energy, nor to the mechanism of alternating excitation of electric field and magnetic field to form electromagnetic wave.

The shape of light is a spindle that rotates around the axis. Because there is no difference in the axial direction, and the vibration of electromagnetic field is directional, the difference is eliminated by rotating around the axial direction.

The length of a light wave is $\lambda/2$, and the half width is amplitude $A=\lambda/\pi$. As shown in Fig.10.

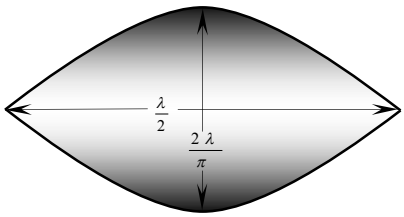


Fig.10. Shape and size of light

An extranuclear electron jumps from a high energy level to a low energy level once, exciting a wave packet of light; In the process of absorbing energy and jumping constantly, an electron can excite a series of light waves. When multiple electrons jump, a beam of light waves is excited; When jumping continuously, continuous light waves are excited. When jumping in pulse mode, pulse light waves are excited. When multiple electrons jump synchronously in the same frequency and phase, a monochromatic laser with the same frequency and phase is excited.

The shape and propagation of light are as shown in Fig.11. Alternating electric and magnetic fields rotate around the axis and propagate forward. The rotation of light is left-handed and right-handed, which is related

to the direction between electric field and magnetic field, and may conform to the right-handed spiral rule.

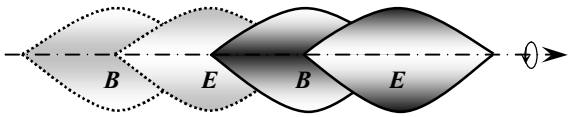


Fig.11. Shape and propagation of light

10.5.Propagation of Light Waves in Vacuum

Why do light waves (electromagnetic waves) travel forward in a vacuum?

When an electron jumps from a high energy level to a low energy level, it excites a changing electric field. When this electric field becomes weakens, it excites a stronger magnetic field. The original electric field becomes weakens and disappears, while the front magnetic field becomes the strongest. When the magnetic field weakens and disappears, a stronger electric field is excited in front. When excited alternately, the electromagnetic field is continuously generated in the front, and the electromagnetic field at the back disappears. According to the energy conservation law, the electromagnetic field changes mutually, and changes vertically (vibrates) in the **X** and **Y** directions, and propagates along the **Z** direction. When light travels there, it excites electromagnetism and electric field, which are the medium of electromagnetic waves. In the process of light propagation, the electric field and magnetic field medium of light are generated while propagating, rather than being full of space. In the process of light propagation, the generated electric field and magnetic field medium are also propagated. It can be seen that light propagates through the generated electric field and magnetic field medium, and its wave form.

Described vividly, just like people walking in the air wearing shoes, there is no ready-made road in the air. The shoes worn by people are like roads (electric field magnetic media), which produce roads while walking. The shoes worn by the left foot are like an electric field. When the left foot is lifted, the shoes worn by the left foot are also raised. When the left foot is put down, the shoes worn by the left foot are also lowered and transferred to the right foot, just like the electric field is transformed into a magnetic field; When the right foot is lifted forward, the shoes worn by the right foot are also raised, and when the right foot is put down, the shoes worn by the right foot are also lowered and transferred to the left foot, just as the magnetic field is transformed into an electric field, so that the shoes worn by the left foot and the shoes worn by the right foot and their alternate movement form spread forward. More like an earthworm, the tail at the back shrinks and becomes shorter, and the head grows in front; The tail shortens again, the head grows again, and it moves forward. As shown in fig.11.

From this, it can be seen that the light excited by electrons can propagate in the left and right directions, which is related to the phase when the electrons jump. The light emitted by a point light source propagates in

all directions without selectivity.

In a vacuum, it is an unconstrained, unrestricted and unobstructed free space. In the process of light propagation in a vacuum, all the states such as energy, velocity, direction, frequency, wavelength and mode remain unchanged, without any obstacles and turns, but the electric field and magnetic field are alternately excited, and the velocity reaches its fastest.

The above is the propagation process of an optical wave packet. In fact, multiple electrons continuously excite light waves and propagate continuously.

10.6.The Propagation of Light in Solid Material Media

According to the matching relationship between the energy of incident light and the electron energy level outside the nucleus of solid material medium, the medium has the effects of transparency, absorption, reflection and scattering of light.

Light travels in a transparent medium, which is a series of relay races.

The medium is transparent to light when the energy of incident light is equal to a certain energy level difference of electrons outside the core of medium, and the high energy level has no stable state.

The first atom of light entering the boundary of transparent medium is just completely absorbed by the electron, which makes the electron just jump to the last high energy level, but immediately jumps back to the original energy level, thus exciting light with the same frequency and direction as the original light. This light propagates to the second atom, and is also absorbed and jumped by electrons, and then bounces to excite light. This light thus propagates to the third atom and the **N** atom, reaches the boundary, and enters a vacuum or another medium.

Every time light enters an atom, the light excited is no longer the original light, but their energy is not lost. They are all in the same frequency, the same phase and the same direction, so there is no difference.

In this process, the propagation speed of light in transparent media is slowed down.

The transparency of medium, in this case, the energy of light just conforms to the electron energy level difference.

On the other hand, the energy of incident light is very small, which can't make electrons absorb and jump, and the electrons don't react, which can't hinder the passage of light, and the medium is also transparent to light.

10.7. Absorption of Light

The energy of incident light is equal to a certain energy level difference of electrons outside the nucleus of solid material medium. When the high energy level has a stable state, the medium absorbs light.

When light enters the boundary of opaque medium, electrons absorb energy and jump to the last high energy level, but this energy level is also a steady-state energy level, so electrons will not jump back to the original energy level, and they will not be able to excite light and relay.

10.8. Reflection of Light

The nucleus of medium has little constraint on the electrons outside the nucleus, and the outermost electrons have jumped to the highest energy level to become free

electrons. For example, in a metal medium, electrons can no longer absorb the energy of light, and the medium reflects light.

When light enters the boundary of medium, electrons can no longer absorb the energy of light, nor can they penetrate the medium, but can only return to the original vacuum or medium in the original state. This is why metals have high reflectivity.

10.9. Scattering of Light

The energy of incident light is not equal to a certain energy level difference of electrons outside the nucleus of solid material medium. The electrons absorb part of energy and jump to the high-energy level stable state, but some of energy is still emitted at different frequencies and directions, becoming scattered light.

10.10. The Speed of light

As long as the light is excited, it will spread out, and it will be out of starting point light source, which has nothing to do with the light source. It carries the energy, velocity and wavelength when it is excited, so **the speed of light has nothing to do with the light source**, its propagation velocity and direction will not change with the movement of light source, thus keeping the speed of light unchanged.

The light source does not emit light forcibly, but uses the energy difference $\boldsymbol{E_m - E_n}$ to excite the first changing electric field, and the task of light source is completed, and it has nothing to do with the light source when it propagates. The propagation direction of light is not given by the light source, but determined by the polarization direction of first changing electric field. The velocity $c = 1/\sqrt{\varepsilon_0 \mu_0}$ is determined by the dielectric constant $\boldsymbol{\varepsilon_0}$ and permeability $\boldsymbol{\mu_0}$ of propagation space, and the Doppler effect of wave also shows that the wave velocity has nothing to do with the wave source. This is the essence of constant speed of light.

10.11.Wavelength of Electromagnetic Wave

If it is an electromagnetic wave emitted by an electric vibrator (macro), it usually has a small energy and a long wavelength, which is called radio wave (long wave electromagnetic wave). It has obvious fluctuation, strong detour and weak penetration, and can spread around mountains. If it is an electromagnetic wave emitted by electrons (microscopic) outside the nucleus, it usually large energy, short wavelength, not obvious fluctuation, not obvious detour, obvious penetration and small volume. However, it is still an electromagnetic wave, not a substance, not a particle, and it cannot be regarded as a particle. The electromagnetic wave with the wavelength of 380 ~ 780 nm is induced to the human eye, which makes it reflected and seen by the human eye. It is called visible light (short wave electromagnetic wave). If the energy of electromagnetic wave is higher (UHF electromagnetic wave), the wavelength is shorter, the detour is not obvious, the penetration is obvious, and the size is less than 380nm, such as X-ray and γ-ray, but it is still electromagnetic wave, not matter, not particles.

11. Solid matter, Field Matter, Force and Energy

In this paper, matter with mass is called solid matter, and field is called field matter.

Broadly speaking, **matter is divided into solid matter and field matter**.

11.1. Solid matter

How much physical matter is measured? Mass is the physical quantity to measure how much material there is. It is a scalar. If there are more materials, there will be more mass, and the values will be accumulated. Solid matter is an entity with mass (an entity means that its interior is a single component, and other components cannot invade its interior), boundedness (with obvious boundaries), exclusive space, exclusivity, non-superposition, non-invasion, and non-duplication. It has shape, size, volume and structure (that is, a single quality).

Solid matter exists in the form of particles. The simplest and most basic particles are composed of a single component, called **Elementary particles**, such as electrons. Then, the elementary particle is the most basic, simplest, smallest, most stable, indivisible, unchangeable and non-decaying monomer, and its interior is a homogeneous composition of a single component, and it is full of its space, that is, solid, such as electrons. Physical matter is not infinitely divisible.

If a solid particle can decay or has a short life, it is not a basic particle, but a composite particle. Now 62 kinds of "elementary particles" may not be elementary particles, as long as they are short-lived, unstable and decaying.

A certain property of elementary particles produces corresponding field substances, and through the interaction of field substances, they form a motion relationship, and form a larger complex according to the motion relationship, which is called **Composite particles**, such as atoms, molecules and ions, thus forming various macroscopic substances and objects.

Particles are countable, and they are monomers, and the monomers are discontinuous and bounded.

Mass is an attribute of solid matter, which was defined as the amount of matter contained in an object at the earliest. This definition is clear, and it has never changed and there is no dispute. Particles, in particular, can be measured by how much (mass), which can occupy space, monopolize space, gather, be solid, be solid, and be countable. It is characterized by doing work, that is $W=\vec{F}\cdot\vec{s}$.

Each kind of solid material particle has an independent space existence position, and there cannot be more than two material particles in the same position. The physical quantities describing material particles include position (coordinates), volume and mass, and the space occupied by its volume is its shape, which is usually considered as spherical. Because it has the shape of exclusive space, it is called a particle.

Solid matter particles must have the property of mass, that is, how much must be used to measure it, and some matter particles also have the property of electricity. The attribute of quality here refers to the number of physical substances, not other quality meanings, not energy.

When the position of a solid matter particle changes in space, it shows motion, which is described by the velocity of motion (including the direction of motion). In free space, the position of a solid matter in space

either does not change, or changes continuously and evenly with time, showing a static state or a uniform linear motion state. In the non-free space, there are other solid matter particles in the space, or there are various field substances. In the non-free space, the solid matter particles will be affected by the forces generated by various field substances from outside, and their motion state will change, and their positions will no longer remain unchanged or change uniformly. The more solid matter is piled up, the more difficult it is to change, that is, the greater the inertia. This is the essence of Newton's first law.

11.2. Field Matter

Another existing form of matter is field, which is called field matter. It is a kind of special material existence form which is produced by some attribute of solid matter, can fill space, is not exclusive, can be superimposed, can be invaded, is uncountable, is dispersed in space and has no mass. Its distribution in space is described and measured by intensity, and it is characterized by energy, that is $w=\frac{1}{2}(\varepsilon\vec{E}^2+\frac{1}{\mu}\vec{B}^2)=\varepsilon\vec{E}^2=\frac{1}{\mu}\vec{B}^2$.

The basic property of field matter is to exert a force on the corresponding kind of property (charge matters) of solid matter in it. In essence, this function is called the basic force, and in macro, it is directly called the force.

At present, there are four basic forces known, namely, universal gravitation, electromagnetic force (electric field force and magnetic field force), weak interaction force and strong interaction force, which correspond to five basic field state substances, namely, gravitational field state substances, electric field state substances, magnetic field state substances, weak nuclear force field state substances and strong nuclear force field state substances, and the category attributes of corresponding substances are mass, charge matters, current. This kind of attribute is called **Charge matters.**

The properties of various field substances are as follows: field substances are a kind of intensity, which is described by field intensity, not by how much. Field matter is a vector, which follows the law of vector superposition (that is, superposition in quantum mechanics). In the same position in space, multiple field matter or multiple field matter can coexist and overlap, without monopolizing the space. However, when multiple field matter coexist, they follow the principle of orthogonal normalization, instead of being intertwined with random collocation. Field matter is a fluid state without obvious shape and boundary, and it is distributed in gradient transition at the limited spatial boundary.

Disturbance of field matter also forms waves and propagates in space, such as electromagnetic waves. It is a whole form presented by the distribution change of intensity of field matter in space.

$\vec{\Phi}$ is used to represent the field strength of field substance, and $\boldsymbol{Q}$ is used to represent the quantity of category attribute of solid matter, which is called **charge matters**, such as mass, charge matters, current, etc. charge matters quantity is the inherent attribute of matter, the basic attribute and essential feature of matter, and the real intrinsic attribute. It does not depend on external conditions or the

measurement method of observers, and it has no origin or reason. Mass and charge matters do not originate from a certain field (Higgs field), on the contrary, field matter originates from the charge matters of physical matter.

Field matter is produced by the charge matters of physical matter, and at the same time exerts a force on the charge matters of other physical matters. The physical matter that produces field matter is the field source. For example, the mass attribute charge matters ***m*** of a physical substance produces a gravitational field substance, which in turn exerts a gravitational effect on the mass attribute charge matters ***M*** of other physical substances. The charge matters attribute charge matters ***q*** of a physical substance produces an electric field state substance, which in turn produces an electric field force on the charge matters attribute charge matters ***Q*** of other physical substances. The current attribute charge matters ***i*** of a physical substance produces a magnetic field substance, which in turn produces a magnetic force on the current attribute charge matters ***I*** of other physical substances.

The generation of field matter and the interaction between field matter and physical matter follow the above-mentioned orthogonal normalization principle (that is, orthogonal normalization in quantum mechanics), which means that only the corresponding charge matters can produce the corresponding field matter, and only the corresponding field matter and its corresponding charge matters can produce the force, and only the corresponding charge matters and the corresponding field matter can produce the energy. For example, charge matters can only produce electric field matter, but not gravitational field matter. Electric field matter only produces electric field force on charge matters, but not gravitational force on mass.

According to the law of universal gravitation, Coulomb's law and Biot-Savart's law, $\vec{\Phi}$ is used to represent the strength of field matter, and ***M*** is used to represent the charge matters of category attribute of solid matter, so the strength of field matter at the distance from the field source $\vec{r}$ is

$$\vec{\Phi} = K\frac{Q\vec{r}}{r^3} \tag{92}$$

11.3. Force

The acting force generated by the field substance on the charge matters ***Q***' of category attribute of other physical substances is:

$$\vec{F} = Q'\vec{\Phi} \tag{93}$$

$$\vec{F} = Q'\vec{\Phi} = K\frac{QQ'\vec{r}}{r^3} \tag{94}$$

Eq.(93) can be regarded as the definition of force: **Force is the product of charge matters of a solid matter and the strength of corresponding field substance**.

The intensity of field matter produced by solid matter as field source is distributed in space according to some laws, such as the law of universal gravitation, Coulomb's law and Biot-Savart's law. In a local area far away from the field source, there is no physical matter, only field matter. At this time, it can be considered that field matter can exist independently of field source.

From the definition of force Eq.(93), it can be seen that in classical mechanics, under the condition that the strength of field matter

is determined, the magnitude of force $\vec{F}$ generated by field matter on solid matter is directly proportional to the mass charge ***m*** of solid matter, and the strength $\vec{\Phi}$ of field matter is similar to the acceleration $\vec{a}$, which is consistent with Newton's second law.

In classical mechanics, there is an interaction between two (solid) objects, and the two objects are the force-exerting objects and the force-exerting objects. According to Newton's third law, they are a pair of acting forces and reaction forces, and the properties (types) of forces are the same.

In essence, force is the action of field matter on solid matter, and the interaction between two solid matters is transmitted through field matter, not through particles.

Gravitational field substance transfers the gravity of mass charge matters between two physical substances, electric field substance transfers the electric power of charge matters charge matters between two physical substances (as shown in Fig.1), magnetic field substance transfers the magnetic force of current charge matters between two physical substances, and weak nuclear force and strong nuclear force are also transferred by its weak nuclear force field substance and strong nuclear force field substance. They are not transmitted by gravitons, photons, gluons and other propagators, and there are no propagators at all, as shown in Fig.12.

Lorentz force $\vec{F} = q\vec{E} + q\vec{v} \times \vec{B}$ in electromagnetic theory is the force that the moving charge matters is subjected to in the magnetic field (and electric field), that is, the force of magnetic field (and electric field) on the moving charge matters. According to classical mechanics, there is no force applying object of Lorentz force, so there is no force and reaction, which does not meet Newton's third law, and so is ampere force $\vec{F} = \vec{B}\vec{I}L$. Now, according to the theory in this paper, **Lorentz force is the force of magnetic field state substance *B* on moving charge matters (that is, current *i*)**, which conforms to the definition of above force.

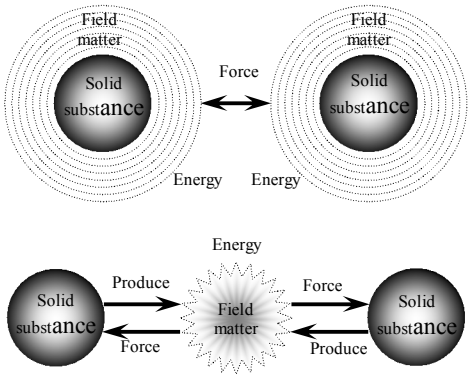


Fig.12. Physical matter produces field matter, and the effect of field matter on the force of physical matter.

11.4. Energy

The acting force produced by the field matter on the solid matter is conservative, so the solid matter in the field matter has potential energy, which is shared by the solid matter and the field matter. The potential energy of solid matter at the distance from the

field source ***R*** is

$$E_P = \int \vec{F} \cdot d\vec{r} = Q' \int \vec{\Phi} \cdot d\vec{r} = K \frac{QQ'}{2R} \quad (95)$$

The charge matters of nuclear substance in the nucleus produces nuclear force field substances (weak nuclear force field substances and strong nuclear force field substances), and the nuclear force field substances simultaneously produce nuclear force (weak nuclear force and strong nuclear force) on the charge matters of nuclear substance in the nucleus. The nuclear substance in the nuclear force field substance has the nuclear force potential energy. Because the nuclear force field substance, especially the strong nuclear force field substance, is very strong, the nuclear force potential energy is very large. When a nuclear reaction occurs, it will release a huge nuclear force potential energy, which is **Nuclear energy**.

The author of this paper may disclose the feasibility of artificial controlled nuclear fusion energy utilization device in subsequent articles.

Eq.(1) and Eq.(2) show that the field matter itself also has energy.

Energy expression

$$w = M \left| \vec{\Phi}(\vec{r}, t) \right|^2 \quad (5)$$

$$W = M \int_V \left| \vec{\Phi}(\vec{r}, t \right|^2 d\tau \quad (6)$$

Can be written in this form:

$$w = 2M \int \vec{\Phi}(\vec{r}, t) d\vec{\Phi} = 2M \int \vec{\Phi}(\vec{r}, t) \frac{d\vec{\Phi}}{dt} dt \quad (96)$$

$$W = 2M \int\int \vec{\Phi}(\vec{r}, t) d\vec{\Phi} d\tau = 2M \int\int \vec{\Phi}(\vec{r}, t) \frac{d\vec{\Phi}}{dt} dt d\tau \quad (97)$$

This shows that **energy is the accumulation of changes of field matter (generalized field) in time and space.** This is the essence of energy.

Physical matter produces field matter, which exerts a force on physical matter. Physical matter and field matter have potential energy together, and field matter itself has energy. Their relationship is shown in Fig.12.

The author of this paper has made a preliminary study on this in 【3】.

12.A New Explanation of Davisson-Gemma Experimental Pattern

12.1.Davisson-Gemma Experimental Pattern is Not Electron Diffraction

Imitating light is a kind of wave. Combining with Einstein's hypothesis, De Broglie extended this hypothesis, thinking that matter also has waves, and that all matter has the nature of waves, and that all matter has both particle and fluctuation, that is, "wave-particle duality".

The Davisson-Germain experiment in 1927 was considered as the diffraction experiment of electron matter wave, which provided undeniable evidence for De Broglie's hypothesis of matter wave.

However, the author of this paper gives a completely different new explanation to the Davisson-Germer experiment.

The author of this paper thinks that **there is no matter wave, the solid matter is only particle, without fluctuation, and there is no matter wave. Electrons are only particle-like, but have no volatility.**

In the Davisson-Gemma experiment, when electrons pass through the nickel single crystal powder, the electric field of electrons

interacts with the electric field of nickel atom, which produces scattering and forms a circular distribution, but it is not the diffraction of electron waves.

Fig.13 is a comparison between Davisson-Gemma experiment and light wave diffraction experiment. In Fig.13(1), **a** is the original picture of Davisson-Gemma experiment in the textbook 【**10**】(Fig.1.4 is a picture of electrons diffracted by ordered alloy **Cu_8Au**), **a** and **c** are polycrystalline patterns, **b** is quasicrystal patterns, and **d** is amorphous patterns; Fig.13(2) is the experimental pattern of light wave diffraction, **e** and **g** are the diffraction patterns of small circular holes, **f** is the diffraction pattern of circular plates, and **h** is the diffraction pattern of large circular holes. By comparison, we can see that there is a great difference between them. The spacing and width of light and dark stripes in Davisson-Gemma experiment are very uneven, while the spacing and width of light diffraction experiment are relatively uniform. Obviously, there is no similarity between them and they have different principles. The fringe of diffraction experiment pattern of light shows that light is diffracted, which is a characteristic of fluctuation, but **the electron pattern of Davisson-Gemma experiment is not a diffraction pattern, and the electron does not diffract, which shows that the electron has no fluctuation**.

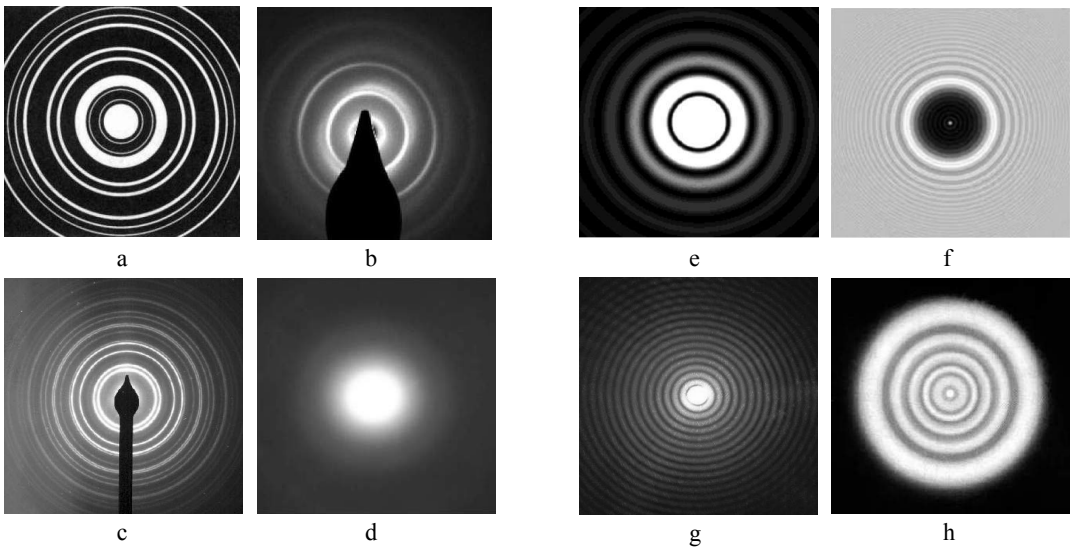


Fig.13. Comparison between Davisson-Gemma experimental pattern and light wave diffraction experimental pattern.

The correctness of "De Broglie Hypothesis" described in the textbook was confirmed by the electron diffraction experiment conducted by Davidson and Gemma in 1927. After a the electron beam passes through the fine crystal powder or thin metal sheet, it also produces diffraction like X-ray. This experiment also proves the correctness of Eq.(1.4.2) (De Broglie relation $p = h/\lambda \cdot \vec{n} = \hbar\vec{k}$). The fluctuation of electrons can also be shown by experiments equivalent to double-slit diffraction of light. In

addition, the diffraction phenomenon of microscopic particles such as atoms, molecules and neutrons has also been observed, and the analysis of experimental data confirms that there is a De Broglie relationship between diffraction wave length and particle momentum, which is obviously not true.

12.2.A New Explanation of Davisson -Gemma Experimental Pattern

In this paper, the author has a new explanation for the electronic pattern of Davisson-Gemma experiment, as shown in Fig.14, Fig.15 and Fig.16. Atoms in metal crystals are arranged regularly, and the electric field is generated in the surrounding space of electrons outside the nucleus. The electron beam emitted by the electron gun is accelerated by the electric field and then directed at the crystal. The electric field of crystal atoms interacts with the electric field of electrons, which is reflected by the crystal surface or enters the crystal. After many interactions, a small number of electrons are difficult to penetrate through the thin crystal and redistribute in the back space, carrying the characteristic information of crystal. The bright ring pattern on the screen is the area where electrons arrive, and the dark ring pattern is the area where no electrons arrive.

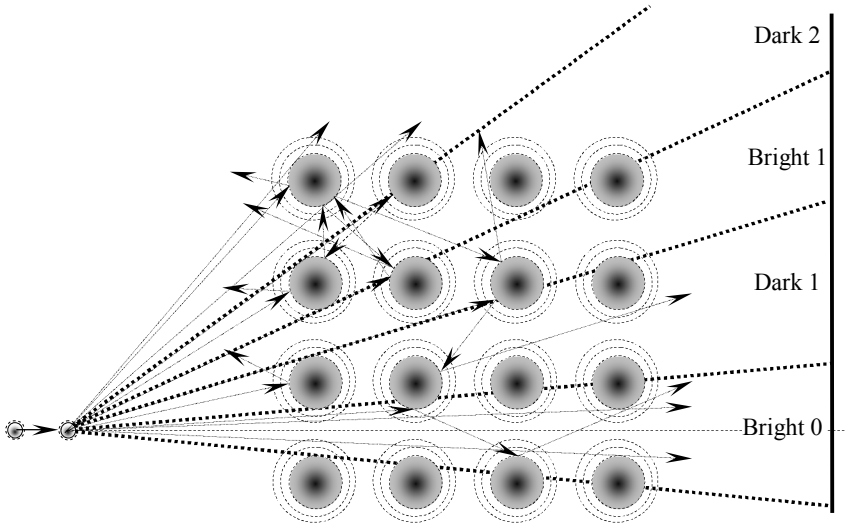


Fig.14. Microscopic mechanism of Davisson-Gemma experiment.

The electron beam has a certain width and divergence, and the electron density in the center of electron beam is large, so there are more electrons passing through the crystal, and the brightness in the center of screen is high. The electron density at the edge of electron beam is small, so there are fewer electrons passing through the crystal, and the brightness at the edge of screen is low.

The microscopic mechanism of Davisson-Gemma experiment is that when the electron beam hits the crystal surface, the surface atoms first block most of electrons, which are reflected by the surface atoms and spread back. It carries the characteristic information of crystal surface, and the pattern of crystal surface can be known by collecting and processing it. This is the principle of reflective electron microscope. Another part of electrons pass through the gap between atoms

on the surface of crystal and enter the second layer of atoms, and most of them are reflected by atoms. Only a small part of electrons can pass through the gap between atoms and enter the atoms at the back. Finally, only a small part of electrons can penetrate all atomic layers of crystal and finally reach the screen, exciting visible light and forming patterns. This is the principle of transmission electron microscope, as shown in Fig.14. The thicker the crystal is, the less electrons can pass through the crystal, or even cannot pass through the crystal. On the contrary, the thinner the crystal thickness, the more electrons can penetrate the crystal and the brighter the pattern.

In the process of electrons passing through the gap between crystal atoms, the electric field of electrons constantly interacts with the electric field of atoms, constantly changing the path of electrons, so that the path of electrons forms a broken line or bends. After passing through multilayer crystal atoms, electrons are also distributed in areas that cannot be directly penetrated. In a crystal with a regular array of atoms in a stable electron beam, such an electron distribution is stable, forming a stable pattern.

An angle between the electron at the edge of electron beam and the crystal surface, the path through the crystal is longer, and it interacts with more atoms, thus creating a more complicated situation. There are dark areas in the bright areas, and there are bright areas in the dark areas, forming a pattern of alternating light and dark.

The patterns of electron beam passing through single crystal, quasicrystal, polycrystal and amorphous are different. The patterns passing through single crystal and quasicrystal are sharp and clear, which can show the arrangement of crystals. The patterns passing through single crystal are clearly arranged in a series of circular rings, while those passing through polycrystalline are relatively clear single circular rings, while those passing through quasicrystal are relatively vague single circular rings, and those passing through amorphous are very vague single circular rings.

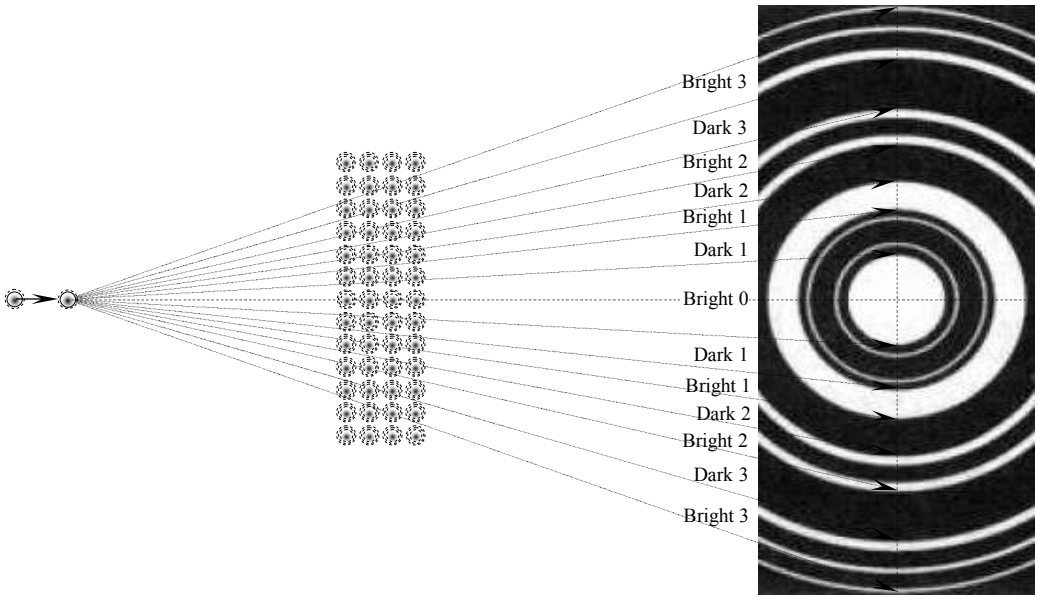


Fig.15. Pattern analysis of Davisson-Gemei experiment 1

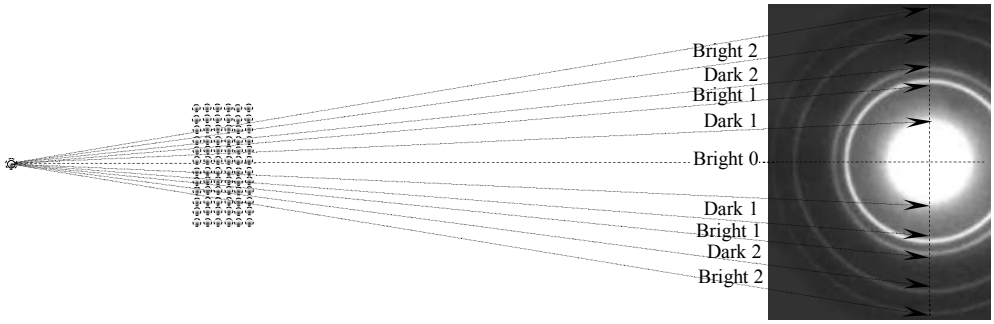


Fig.16. Pattern analysis of Davisson-Gemei experiment 2

If microscopic particles such as atoms, molecules and neutrons have similar patterns after passing through matter, they are different from those of electrons and protons after passing through matter, because they are charge mattersd differently and are affected by the electric field outside the nucleus of matter.

As shown in Fig.15 and Fig.16, the analysis of two patterns shows that the bright stripes in the dark region, the dark stripes in the bright region and the dark region are wider than the bright region, because the atoms in the first layer on the surface of crystal have a more obvious shielding effect on electrons, and the atoms in the later layers continue to shield them. At the center of electron beam, the incident angle of electrons is small, and the more difficult it is to be blocked by the atoms of crystal, there are few dark stripes, such as the bright **0** region and the bright **1** region in Fig.15. And there are also scattered electrons in dark areas, such as the dark **1** area in Fig.15. At the edge of electron beam, the electron incident angle is large, and it is easier to be blocked by the atoms of crystal, so there are few scattered electrons in the dark areas, such as the dark **2** and dark **3** areas in Fig.15. However, in the bright region, electrons are scattered by the atoms of the crystal, and more dark stripes appear, as shown in the bright **2** region and the bright **3** region in Fig.15. The more at the edge of electron beam, the more complicated the path of electrons passing through the crystal atoms, and the more dark stripes there are in the bright region.

As early as 1909, before the Davisson-Gemma experiment, Rutherford's α particle scattering experiment was to bombard gold foil with α particles, and discovered the nuclear structure model of atoms, which was also the principle, rather than the fluctuation of α particles.

Mr. Zeng Jiqing of south china botanical garden, Chinese Academy of Sciences has a similar view【11】.

12.3.A New Explanation of Principle of Electron Microscope

6Electrons are only particle-like, but have no fluctuation. Electrons have electricity and can be affected by electric fields, and moving electrons can be affected by magnetic fields, thus accelerating and changing the direction of electrons, thus forming a focusing effect. In the electron microscope, the electric field passing through the electron gun accelerates to emit an electron beam with uniform velocity, which passes through the observed substance and becomes transmitted electrons, or reflects off the surface of substance and becomes reflected electrons, with information inside the

substance or on the surface of substance. The magnetic field passing through the magnetic lens or the electric field of electrostatic lens bends the electron trajectory to the axis to form a focus, and its focus can be adjusted by the current of magnetic lens to form the distribution of electrons in space, thus producing an amplification effect, and then it is converted into visible light by the fluorescent screen, and amplification is seen.

Obviously, in order to make the image of electron microscope clear and sharp, it is necessary to increase the accelerating voltage and the electron velocity, thus increasing the electron momentum and reducing the influence of electric field of observed substance on the electrons. The thinner the electron beam is, the more concentrated the electrons are, the stronger the penetration ability of electrons is, and the clearer the image is.

12.4. Double Slit Interference

The phenomena such as diffraction and interference are some phenomena of Porter, and the phenomena such as diffraction and interference made by Thomas Young with ordinary light source are the strong evidence that light is a wave rather than a particle. Similarly, the Davisson-Gemma experiment is the strong evidence that electrons are particles rather than waves.

Whether the light passes through a single slit, a double slit, a multi-slit or a grating, the pattern generated is a diffraction or interference phenomenon of light waves. Whether electrons pass through single crystal, polycrystal, quasicrystal or amorphous, or through single slit, double slit or multi-slit, the pattern generated is not diffraction or interference phenomenon, but particle scattering phenomenon.

There will be no "terrible, horrible, incredible, creepy and unexplained" phenomenon described by some people. There will be no magical problems such as "path selection" and "multi-world" and "A particle passes through two slits at the same time".

13. New Uncertain Relationship

The uncertainty principle is an important principle in the quantum mechanics theory of Copenhagen School. It shows that it is impossible for a pair of conjugate observables to have certain values at the same time, and the more certain one quantity is, the more uncertain the other quantity is.

The new theory in this paper can also get a different uncertain relationship. In the new atomic model of Fig.3 ~ Fig.6, the center position of electron in the standing wave packet should be considered. If the electron is not in its center position, but is "uncertain" in the whole wave packet, the "uncertainty" range of position is within half a wavelength, that is, $\Delta x \le \lambda/2$. From $\boldsymbol{p=h/\lambda}$, the "uncertain" range $\Delta p = h/\lambda \le h/(2\Delta x)$ of momentum is obtained. The "uncertainty relation" of position and momentum is obtained:

$$\Delta x \Delta p \le \frac{h}{2} \tag{98}$$

the "uncertainty relation" between orbital radius and momentum in extranuclear electrons:

$$\Delta r \Delta p = \frac{1}{2\pi} \Delta x \Delta p \le \frac{\hbar}{2} \tag{99}$$

In the same way, the "uncertainty" range

of electron's time in the wave packet is within half a period, that is, $\Delta t \le T/2 = 1/2\nu$, and the "uncertainty" range $\Delta E = h\nu \le h/(2\Delta t)$ of energy is obtained from ***E=hν***. The "uncertain relation" between energy and time is obtained:

$$\Delta t \Delta E \le \frac{h}{2} \qquad (100)$$

For the exact meaning of these formulas, the author can only say: **If the electron is regarded as not in its central position, but the uncertain in the whole wave packet, the range of position uncertainty is within half a wavelength**.

However, from the above three examples, it can be seen that the physical quantities such as **energy level, position, velocity, wavelength, frequency, amplitude** of system at a certain moment can be solved at the same time, and there are no physical quantities that cannot be determined at the same time. From this point of view, the uncertainty is not an important principle, and there is no mystery.

14. Discussion on Other Issues

14.1.The essence of New Quantum Mechanics

From the above discussion, **it can be seen that the essence of new quantum mechanics is** the **Compton wavelength (*mυλ=h*), standing wave condition and quantization principle.**

From the above discussion, it can be seen that as long as the cause of fluctuation is clearly defined, its essence is only Compton wavelength relation Eq.(7), its standing wave condition Eq. (10) and quantization general rule Eq.(11). As long as the cause of fluctuation is clearly defined, two expressions of relations Eq.(8) and Eq.(9) can be derived by using Compton wavelength relation Eq.(7). In fact, the mystery of quantum mechanics lies in Eq.(7), which shows that any substance has fluctuation, and its wavelength is restricted by the quality of substance. When the mass of microscopic matter is small, its wavelength is long and its fluctuation is obvious. When the mass of macro-matter is large, its wavelength is short, and its fluctuation is not obvious. The standing wave condition Eq.(10) or the quantization general rule Eq.(11) provide conditions for solving specific problems, and even replace the Schrodinger equation and directly solve the results by it.

$$m\upsilon\lambda = h \qquad (7)$$

$$n\frac{\lambda}{2} = l \qquad (10)$$

$$L = \oint Pdq = (n - \frac{1}{2})h \qquad (11)$$

When solving hydrogen-like atoms, the nucleus is regarded as fixed, and it can be easily solved by standing wave condition Eq.(10). In fact, the nucleus and electrons move around its center of mass, and the movement of electrons is not a circle but an ellipse. Such a complex system can only be solved by Sommerfeld's general principle of quantization Eq.(11), so that the fine structure of hydrogen atomic energy level spectrum can be solved. Any other complex system can be solved by the Sommerfeld's general principle of quantization, without using the complex Schrodinger equation.

14.2.Wave Function and Probability Interpretation

In the quantum mechanics theory of Copenhagen School, the wave function

introduced is the core concept. As the core concept, the wave function actually doesn't know what it is, what it means and what it is fluctuating. From the very beginning, there are so many embarrassing problems in this theory, which doomed that the future road will not be smooth.

The significance and explanation of wave function is a great difficulty in this theory. Later, according to the diffraction pattern of electrons, Born thought that the stripes of pattern were the "probability distribution" of "particles" hitting the screen, and that the wave function was not a real wave, but a "probability wave" or "probability amplitude", and the square of wave function represented the "probability density of finding particles" 【12】, which became the key interpretation of Copenhagen's quantum mechanics theory.

In the process of deriving Eq.(16) above, if the generalized field standing wave packet is regarded as a material particle "particle" one by one, then the position of generalized field standing wave packet becomes a "probability density" (i.e. 1/n·dn/dt), but the generalized field standing wave is a wave, not a matter, not a particle, especially a light wave, not a material "particle". Light waves, electrons and waves cannot be regarded as waves, or even as wave functions. In addition, the wave function is a function of mathematical significance, which describes the relationship between wave parameters. It is only the solution of wave equation and cannot represent the matter itself. Eq.(16) shows very clearly that it is the generalized field (field state matter) that fluctuates, not the particle, not the probability density, and the wave function reflects the distribution and change of real generalized field (field state matter) in space, not the illusory probability density.

$$\left|\frac{\vec{\Phi}(\vec{r},t)}{\sqrt{\int_V \left|\vec{\Phi}(\vec{r},t)\right|^2 d\tau}}\right|^2 = \frac{w}{W} = \frac{1}{n}\frac{dn}{d\tau} = \left|\vec{\Psi}(\vec{r},t)\right|^2 \quad (16)$$

14.3. Schrodinger Equation is Not A Wave Equation.

Schrodinger equation is constructed by a plane wave function combined with energy relationship. **Without the form and characteristics of above wave equation, Schrodinger equation is not a wave equation, and its solution cannot represent wave, so it does not have the meaning of wave**.

Complex numbers in physics are introduced for the convenience of operation, and the operation results only take the real part, not the imaginary part. The Copenhagen School's quantum mechanics theory can only say that it is unique to the micro-world, and the imaginary part also has its real meaning, but it does not say what the specific meaning is. It can only be used to justify "probability" and "uncertainty", and the position of imaginary number in the Copenhagen School's quantum mechanics theory is very embarrassing.

Here, the Schrodinger equation with complex numbers is avoided, but the standing wave condition or the Sommerfeld's general principle of quantization is used to solve it.

14.4.Basic Assumptions of Quantum Mechanics Theory of Copenhagen School

There are five **basic assumptions** in the

quantum mechanics theory of Copenhagen School【13】: (1) wave function assumption, (2) mechanical quantity operator assumption, (3) eigenvalue probability and average value assumption (including probability explanation), (4) Schrodinger equation, and (5) identical principle.

In the quantum mechanics theory of Copenhagen School, there is no physical explanation for various conclusions, such as superposition, orthogonal normalization, completeness, "uncertainty relation", eigenvalue, Hermite, isotropy and spin, only that it has such properties. In particular, the "uncertain relationship" and spin are the most controversial issues. Quantum mechanics can only say that microscopic particles are like this, which is their "intrinsic nature", but it cannot answer why they are like this. Volatility hypothesis, quantization principle, Einstein-de Broglie relation, Bohr quantum hypothesis, electron spin, etc. were first put forward in the form of hypothesis.

In fact, the Copenhagen school's quantum mechanics theory has no "mechanics" or "kinematics" at all, nor does it study the nature of matter, but only studies the behavior of extranuclear electrons, and the result is uncertain probability distribution.

The purpose of forming a theoretical system is to give a reasonable explanation to these assumptions. But they are still only based on a hypothesis, and they have not been eliminated by theory.

Natural science cannot be ambiguous. Classical mechanics, electrodynamics and thermodynamics (including statistical thermodynamics) are all certain. Although statistical mathematics methods are used in statistical thermodynamics, the results obtained are also certain.

The material world, it is already there. Did you look at it and study it? It is already there. All its attributes are real and can be determined. Just because people don't understand it and can't determine it doesn't mean that it is not true. How can you say that "uncertainty is an inherent attribute of itself"?

The wave function of basic theory of quantum mechanics is solved by the equation, but the Schrodinger equation does not use the mathematical statistics method or the concept of probability. How can the solved wave function be said to be probability? The law of an equation is deterministic. How can the result of solution be said to be uncertain?

Physics studies the objective material world, and its task is to find out the most essential truth of objective material world. There should be no hypothesis that cannot be explained clearly at all. If there are too many "hypotheses" in a theory, its truth is also called "false".

The research of natural science has a method: guided by dialectical materialism philosophy, based on logical reasoning, and calculated by mathematics as a tool. It must be reasonable and self-consistent to explain the results combined with scientific practice, and then verified by experiments, and finally it can be applied in practice. Theory is the basis of application, and theory guides practice. Practice without theoretical guidance is blind practice, and practice guided by wrong theory is even more wrong practice, and it can't produce real results.

It seems that the quantum mechanics theory of Copenhagen School has not grasped a reliable "physical model". At the beginning, a physical model-light (electromagnetic wave), when Einstein explained the photoelectric effect, he mistakenly regarded it as a "particle" and ignored the fact that it was originally an electromagnetic wave, which led to the unclear explanation of various conclusions drawn later.

In this paper, there is only **one physical model: generalized field forms wave function**.

There is no need to attach other assumptions. Starting from this physical model, every conclusion has clear and obvious physical significance, and quantum mechanics no longer becomes mysterious, which also makes the problem simple and clear. According to this model, everyone can form a clear scene in people's minds.

14.5.A new Explanation of Photoelectric Effect

The photoelectric phenomenon was discovered by Hertz in 1887, and now it is widely accepted as an explanation put forward by Einstein. Photoelectric effect is the effect that the metal surface emits electrons under the action of optical radiation, and the phenomenon of photo-electrification is collectively called **Photoelectric effect**. When light strikes a metal, electrons escape from the metal. Experiments show that electrons are emitted only when the frequency of light is greater than a certain value. If the frequency of light is lower than this value, no matter how strong the light is and how long the irradiation time is, no electrons are generated. The energy of electrons is only related to the frequency of light, but has nothing to do with the intensity of light. The higher the frequency of light, the greater the energy of electrons. The intensity of light only affects the number of electrons. As the intensity increases, the number of electrons increases. These laws of photoelectric effect cannot be explained by classical theory. According to the electromagnetic theory of light, the energy of light only depends on the intensity of light, but has nothing to do with the frequency of light.

Einstein thought that light was not only wave-like, but also particle-like, and further thought that light had "wave-particle duality". Einstein called the emitted electrons photoelectrons. He believes that electromagnetic radiation not only appears in the form of particles with energy hv when it is emitted and absorbed, but also moves in space at velocity C in this form. This kind of particle is called light quantum. From this point of view, Einstein explained the photoelectric effect.

According to Einstein, when light strikes a metal surface, photons with hv energy are absorbed by electrons. Electrons use part of this energy to overcome the attraction of metal surface to it, and the other part is the kinetic energy of electrons after leaving the metal surface. This energy relationship can be written as:

$$\frac{1}{2}m\upsilon^2 = h\nu - W_0 \qquad (101)$$

Where $\boldsymbol{m}$ is the mass of electron, $\boldsymbol{\upsilon}$ is the velocity of electron leaving the metal surface, and $\boldsymbol{W_0}$ is the work that the electron needs to do to leave the metal surface, which is called

the work of leaving. If the energy $h\nu$ of photons absorbed by electrons is less than W_0, electrons cannot escape from the metal surface, so no photoelectrons are generated. The frequency of light determines the energy of light waves, and the intensity of light only determines the number of light waves. There are more photons and more photoelectrons. In this way, the photoelectric effect that can not be explained by classical theory is explained. Einstein won the Nobel Prize in physics for his explanation of photoelectric effect.

However, Einstein's explanation of photoelectric effect regards light as a particle. We all know that light is directional. If light is regarded as a particle, photons hit the metal plate and collide with electrons on the surface of metal. According to the law of conservation of momentum, when part of energy of photons is transferred to electrons, the energy of photons is reduced and bounced back, and electrons are punched into the metal without leaving the metal. The frequency of bounced photons decreases due to the decrease of energy. Thus, **Einstein's explanation of photoelectric effect is wrong.**

In addition, the current semiconductor photovoltaic cells, when the frequency of incident light is higher, should produce photoelectrons with higher efficiency, but they can't produce photoelectric effect, which can't be explained by Einstein's light wave theory.

Now the photoelectric effect can be well explained by the new quantum mechanics theory. From the analysis of essence of light in new quantum mechanics, we can know that light is electromagnetic wave, not material particles, and one part of energy carried by light wave is hv. Light waves enter the metal surface, and the electrons in the outer layer completely absorb the energy of a light wave, so that the electron energy increases, overcomes the bondage of atoms and leaves the metal surface, and enters the free space to become free electrons. The free electrons will continue to spread in the state of motion when they are detached, and the kinetic energy is mv2/2, which is the essence of photoelectric effect. The work that needs to be done to get rid of atom's constraint on electrons is called the work of getting rid of metal surface, and the energy relation still satisfies the above formula **Photoelectric effect equation**.

$$\frac{1}{2}m\upsilon^2 = h\nu - W_0 \qquad (102)$$

14.6. There is No "Wave-Particle Duality"

First of all, we must distinguish the characteristics and differences between waves and particles, and then we can judge whether the viewpoint of "wave-particle duality" is reasonable.

Wave is a manifestation of physical quantity. When a physical system is disturbed, the disturbance can form a wave when it propagates in space. The wave is the periodic dynamic distribution of field strength or medium in space.

There are usually rope waves, surface waves, water waves, sound waves, temperature waves, density waves and electromagnetic waves (light waves), which can be divided into mechanical waves and electromagnetic waves according to the nature of medium. Mechanical wave is the dynamic distribution of whole solid matter particle medium disturbed in space, and

electromagnetic wave is the dynamic distribution of electromagnetic field disturbed in space.

Physical quantities describing waves include wavelength, frequency, phase, wave velocity, amplitude and so on.

The characteristics of waves are reflection, refraction, superposition, diffraction, interference and polarization.

In addition to the above properties, waves also have the following obvious properties: the velocity of waves is determined by the type of media and its state factors. In homogeneous media, wave propagation is not affected by force, and it will not be accelerated or decelerated. Without the process of acceleration or deceleration, the direction of wave propagation will not be changed. When the wave source vibrates, it immediately fluctuates and propagates at a constant wave velocity.

Relative to the medium, the motion of wave source does not affect the propagation velocity and direction of wave. The wave propagates immediately after it is generated from the wave source, and has nothing to do with the wave source since then. Each wave generates and propagates independently of each other, and similar waves meet and overlap, and then propagate independently after separation. Waves propagate energy. Without mass, waves have no mass, so there is no inertia. These unique properties of wave determine the unique behavior of wave, which is also obviously different from the properties of solid matter.

Waves need a medium in the process of propagation. Matter is the medium for wave propagation, while solid matter propagates mechanical waves, and electric field matter and magnetic field matter propagate electromagnetic waves.

Wave is the form of movement and change of matter, not matter.

Particles, refers to the entity monomer, there are basic particles and composite particles, which are substances. The above analysis has been very clear.

Planck first put forward the concept of "Energy Quantum". When black body radiates and absorbs electromagnetic waves, it radiates and absorbs electromagnetic wave energy one by one. The concept of "quantum" is very clear. When Einstein explained the photoelectric effect, he extended the radiation energy of blackbody to the energy of light, and regarded the energy of light as light particles, which was called photons for short, and thought that such photons were matter particles. It is known that light is electromagnetic wave, and Einstein thinks that light is still particle, so he thinks that light has "wave-particle duality". De Broglie popularized Einstein's view that since electromagnetic waves are particle-like, particles of matter should also be wave-like, so he thought that all matter was wave-like, and put forward the concept of matter wave. Therefore, it is considered that both light and matter have the dual nature of fluctuation and particle, which is called the "wave-particle duality" of light and matter.

Wave and particle are completely different concepts, and their concepts and essence are very different. They have no similarity, are completely incompatible and

have no intersection. Fluctuation and particle nature cannot be used to describe the properties of same light wave or particle.

The author clearly points out that the "wave-particle duality" of light and matter is completely wrong. "Wave-particle duality" is like being half a devil and half an angel. There is no such double-faced monster in the real physical world. Any wave, even if the wavelength is shorter, is still a wave, still a movement or change form of medium, and it can't become a substance, let alone a substance particle. Any substance, when used as a medium of fluctuation, is only a medium of fluctuation, and cannot be the form of fluctuation itself. The concept of "wave-particle duality" is unimaginable and incomprehensible.

The experiment of photoelectric effect and Einstein's explanation of photoelectric effect can't say that bright light has particle property, let alone "wave-particle duality". His explanation is wrong. The Davisson-Gemma experiment, as well as other related experiments, can't show that the physical substance has volatility.

14.7. Compton Effect

When Compton studied the experiment of X-ray scattering through solid matter in 1923, he found that there were X-rays with longer wavelength in the scattered light, and the increment of its wavelength varied with the scattering angle. This phenomenon is called the **Compton effect.**

Now, the Compton effect can be well explained by the new quantum mechanics theory. X-ray waves enter the surface of matter, and electrons in the outer layer of matter absorb part of energy of an X-ray wave, and the scattered energy of X-ray waves decreases, the frequency decreases and the wavelength becomes longer. At the same time, when X-ray waves exchange energy with electrons, they obey the law of conservation of energy, so that the increment of its wavelength changes with different scattering angles, and its wavelength is $\lambda=h/mc$. This is the essence of above Eq.(3) $\boldsymbol{m\upsilon\lambda=h}$.

14.8. Barrier Penetration

A particle with low energy cannot pass through a barrier with higher energy than it, because it is against the law of conservation of energy.

In the expressions of energy density and total energy, as well as the orthogonal normalization of wave function, it can be seen that the barrier can only hinder or shield the corresponding generalized field (that is, field state matter) that forms this barrier, and has no effect on other generalized fields. Because the generalized field can only produce energy and force with the corresponding generalized quantity.

In the previous analysis of electric field between two charge matterss and the collision between two balls, it can be seen that **it is the field matter that runs through the high barrier, not the solid matter particles**, and the field matter has superposition and can cross the barrier. However, there is no case that the particles of solid matter can penetrate the barrier and move to another area of barrier.

14.9. Comparison of Three Atomic Models

14.9.1. Classical atomic model:**Orbit**, extranuclear electrons moving at high velocity

in orbit.

14.9.2. The atomic model of quantum mechanics of Copenhagen school: **Electron cloud**, the extranuclear electrons appear with a certain probability in the space limited by energy level.

14.9.3. The **a**tomic model of electric field fluctuation theory: **Electric field standing wave packet**, the electric field outside the nucleus fluctuates in the space limited by energy level to form a closed standing wave. The length of standing wave is half wavelength, the standing wave rotates around the nucleus as a whole, and electrons rotate around the nucleus with the standing wave, and each physical quantity is unique.

Make an image metaphor: **Orbit description is like ordinary video, electron cloud description is like photography, and electric field standing wave packet description is like 3D video**. There are no orbits outside the nucleus, electrons are not point particles, and the transition is not instantaneous. Electrons are moving at high velocity in the three-dimensional space outside the nucleus. If we only take pictures of them, of course, we can only take pictures of projection points on a plane, which looks like a random and dense point cloud. It is discrete, discontinuous, jumping, partial, one-sided, incomplete, rough, uncertain and probabilistic. The complete description is of course 3D video recording. Electrons have structure, size, volume and shape, and the transition of electrons between energy levels is also a process, which takes time, omnibearing and detailed.

14.10. Normalize

In the quantum mechanics theory of Copenhagen School, there are complex numbers in plane wave function and The Schrodinger equation, but the plane wave function representing free particles is divergent and cannot be normalized. In the process of solving three examples here, the results can be easily solved without Schrodinger equation, even the velocity, frequency and wavelength of standing wave that could not be solved before, and the wave function does not need to be normalized.

In the Copenhagen school's quantum mechanics theory, because the "probability" can only be less than **1**, quantum mechanics normalized the wave function and turned it into a dimensionless quantity, which lost the true meaning of the wave function and a lot of the most critical information. If the dimensions of wave function are the strength of generalized field and the amplitude of wave function, these two pieces of information are the most critical physical quantities, which precisely reflect the physical significance of wave function. Physical quantities such as speed, position, wavelength and amplitude are also lost.

14.11. Hidden Variable

In the theory of quantum mechanics of Copenhagen School, Einstein didn't believe in the "uncertain" material world, questioned the incompleteness of quantum mechanics with localized realism, and speculated that there might be "hidden variables" that could play a definite role, which led to uncertainty or randomness. Later, Bohm didn't find hidden variables, and EPR paradox and Bell inequality were all put forward based on this

problem. Bell inequality describes this locality relation, pointing out that if Bell inequality holds, there will be incompleteness of locality, and vice versa. It means that quantum mechanics violates the localization principle or counterfactual accuracy, and shows that some quantum effects seem to be able to travel at superluminal velocity. Experiments prove that Bell inequality is not established, which of course denies the necessity of existence of "hidden variables", but it is not certain that the quantum mechanics theory of Copenhagen School is complete. It can be seen from this that in fact, the concepts of "probability, uncertainty, superposition of states, electron cloud …" in quantum mechanics and later "quantum entanglement, wave function collapse, quantum fluctuation …" do not exist. **That's because we don't know what the wave function is and what it is caused by fluctuations**! As long as we know what the wave function is, then quantum mechanics can determine all the states of microscopic matter.

From the point of view of field and energy, if there is a "hidden variable", in this new theory, an important and basic thing that has not been taken into account is the field, which has been in front of people since the electromagnetic era. It is the most basic material form, and it will not be complete without it, but people turn a blind eye to it. This paper clearly points out that **field matter is fluctuating, and field matter is wave function**. With such a clear physical model, the wave is no longer a hypothesis, but a deduction. All the results are consistent with the original results, and the previously unsolvable **velocity, position, wavelength and amplitude** is solved. Each conclusion has a clear physical meaning, and each conclusion has its own physical mechanism and process.

14.12. Measure

Measurement is also an important concept in the quantum mechanics theory of Copenhagen School. Measurement is a process of quantifying things, which, like observation, makes people comprehensively perceive things. In measurement and observation, people use the sensors of instruments to interact with things, and a certain field substance of things exerts a force on the sensors, and the sensors change, and finally people feel the situation of things. Usually, the change of sensor is converted into optical signal, which makes people see and feel the existence and situation of things.

People can't directly measure and observe the situation of micro-material world, but indirectly measure and observe it with the help of sensors of instruments. The author of this paper has studied in【8】.

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Postscript

In this paper, the author studied physics in Guizhou University in 1987, and studied Quantum Mechanics Course (1979 edition) written by Zhou Shixun when he was in the fourth year of college in autumn of 1990. This is the first quantum mechanics textbook written by Zhou Shixun in China in 1962. At that time, after I learned the main theories in front of me, I couldn't understand many questions. I asked Mr. Yang Bangjun, who said that this is a new theory. Unlike the classical theory, there are still many problems that have not been solved, which is very controversial. I saw Zhou Shixun write in the conclusion at the end of book: "What is certain is that the current basic theory of quantum mechanics is neither the final theory nor the existing level, and it will certainly continue to develop further. As for which direction and how to develop, such problems should be solved through practice under the guidance of dialectical materialism. " I always think this theory is wrong, so I think about finding a solution.

When Planck first solved the blackbody radiation formula, he assumed that the electromagnetic radiation in the blackbody cavity was discontinuous, but one by one, and introduced the Energy Quantum hypothesis. For decades, 25 top physicists in the world participated in the creation of quantum mechanics, among which 12 physicists won the Nobel Prize in Physics, and later many physicists won the Nobel Prize in Physics.

I started thinking from light, and light is

electromagnetic wave. Comparing light with matter, I found a breakthrough.

In 1991, the author began to think and write when studying the Course of Quantum Mechanics. In 1992, he wrote New Quantum Mechanics, and was invited to participate in the academic seminar on the centenary of De Broglie's birth and the history of quantum physics sponsored by China Academy of Sciences, and distributed it to the participants.

So far, I have studied it for 33 years, and now I can finish the manuscript.

The abridged English version of field meaning of wave function has been published on the preprint website of Nature【14】.

The author always believes that the objective material world is like this:

1. Objective existence: the world is objective, the world is material, and man is only a fleeting moment in the material world. Before and after man's birth, the material world still exists and operates according to the existing laws, and the objective material world does not change because of man's will and cognition.

2. Universal connection: the objective material world is not isolated, but interrelated and universal, and the relationship between the parts forms a causal relationship according to the time sequence of occurrence.

Force is the motive force and reason for the universal connection of objective material world, and the order of movement of matter in space is the cause of causality and logical relationship.

3. Regularity: The relationship between the objective material world is not chaotic, but has certain laws, which operate in an orderly manner according to established laws and form natural laws.

4. Identity: the laws of objective material world are universally applicable, with spatial identity and time identity, and do not differ from place to place at different times.

5. The world is always right: the objective material world is always right, and people are wrong.

Man is just one of objective material worlds, and the objective material world is not special because of man.

Only when there is material can there be people, only then can there be people's thoughts and cognition. Only when human cognition conforms to the laws of objective material world can it be a correct theory.

People have a wrong understanding of objective material world. There is a "convention" in people's minds as a standard, but it is the objective material world that thinks "unconventional". Modern scientific theory has made such a mistake.

6. Cognition: The laws of objective material world are there, expressed in complex forms, and people can feel and see them.

People think, analyze and judge the perceived information, dig out and sort out the laws, constantly improve and sublimate, and get the laws close to the truth of world.

The objective material world can be recognized by people. Although it is difficult, it can be gradually recognized by following the above methods. The objective material world is unwilling to reveal its truth easily, and the objective material world observed by human beings is not its truth. The objective material world only opens a small window for

human beings and only reveals the truth for a moment.

7. Avenue to Jane: The world is simple, but people are complicated.

The world is simple, and the complexity is people, and people intentionally or unintentionally complicate the objective material world. If it is too complicated to express, unclear and incomprehensible, the concept is chaotic and illogical, and it is definitely wrong.

The objective material world is simple, the more basic it is, the more simple it is, and the lower it is. It is combined by the interaction of forces to form a complex objective material world, following the basic and simple logical relationship. Therefore, complex theories and huge formulas are often wrong.

8. From simplicity to complexity: the objective material world develops and changes from low to high, from simple to complex, from basic to extensive, from simple to complex, and from basic to extensive. There are few simple types and many complex types.

9. Scientific spirit: seeking truth from facts, respecting facts and nature.

Mr. Zeng Jiqing has repeatedly stressed that scientific theory should conform to common sense, rationality and objective facts, and adhere to scientific unity and consistency, which has great guiding role in scientific research. Basic facts and basic logic are the basis of objective existence and laws of real objective world, and they are the criteria for testing the theory. First, these two criteria are used to test the error of theory, then the correctness of theory, and finally the correctness of theory is tested by experiments.

10. Scientific theory: In the process of understanding the objective material world, people summed up some methods, including prophetic, philosophical and scientific. The effective method is scientific, which uses the processes of observation, practice, experiment, induction, logic, dialectics, mathematics, reasoning, analysis, conclusion and inspection to form a theoretical system, spread it to others and future generations, form a knowledge system, and constantly deepen and improve it to make it closer to the truth.

11. Compatibility: The objective material world is interrelated, universal and not isolated. The objective material world has its reasons, laws and logics, and the laws are compatible and unified.

Everything is interrelated, not isolated, and has identity, that is, it is formed by the combination or evolution of basic substances, and the physical laws are universal. Their combination has its laws and logic, and finding out their laws is the purpose of theoretical physics research. This requires logic. Mathematics is an advanced form of logic, which is more rigorous than elementary logic. Physics is born out of philosophy, and dialectical materialism philosophy provides a reliable world outlook and methodology, pointing out the direction and providing methods for us to study the world.

First, the objective material world has its own laws and logical relations, rather than no laws to follow. Second, its laws follow the principle of identity, that is, the laws of matter are the same everywhere, and their laws are universally applicable. Third, its laws can be

perceived, recognized and explored by intelligent human beings, and fourth, its laws can be verified and reproduced. Fifth, its law can be approached to the truth, but it is difficult to know the whole truth, rather than someone (God) knowing its law in advance, let alone making up the law artificially. These are the meanings of scientific research.

Physics is the truth about things. Thing is a matter and an objective existence.

Matter is not chaotic, but has its laws, and this law is the truth of matter. Matter and its laws are identical. Everything is the same and follows the same law, which contains two meanings. My matter here is the same as yours, and the laws I study are applicable to yours. These substances and laws have always existed, which is the underlying meaning of physics. From the perspective of physical science, physics is a science that studies and explores the laws of matter. The purpose of our study is to discover the laws of matter, not to invent them. Law has its internal connection, that is, logic, which is linked by the interaction between substances, and has a sequential and causal relationship. In the process of people's understanding of its law, thinking is formed, and this thinking is composed of a series of concepts, connotations, conditions, boundaries, ranges, restrictions, etc., which is to study people's thinking activities in their minds. Mathematics is more rigorous logic, and quantitative relationship is more accurate logic. The relationship between substances is expressed in mathematical language, laws are concluded by reasoning, and checked by numerical values, and the laws obtained are more reliable. The reason why we must use mathematics to study physical theory can make the theory more rigorous and reliable. Otherwise, if we only use logical thinking, we can only get a rough understanding, but we can't get accurate laws, and even more are unconstrained nonsense. In particular, many enthusiasts don't have the ability to describe mathematics, thinking irrelevant things and wasting energy and time.

These are just basic experimental phenomena, not rules. Without rules, we don't know why this is the case, and without rules, we don't know the internal relations. When people know the law, they can use the law to combine substances and produce more phenomena purposefully. For example, electricity is a common natural phenomenon. If you don't know its law, you won't understand that lightning, friction electrification, power generation and battery electricity are the same thing, let alone that electricity and magnetism are related, and you can't deliberately change it to become generators and motors, let alone use electricity to do useful things, let alone have televisions, electronic computers and mobile phones.

Judge things, think for yourself from limited information, and choose by weight. Method is the dialectical materialism thought and methodology of philosophy. Most things are in the environment where we live, all around us, observing phenomena, summarizing universality, forming laws, looking for interrelationships, forming logical chains, quantifying and deducing, and drawing more rigorous conclusions. Things are not independent before, but are generally related, with universality, identity, causality and logic.

The commonness of these properties is the law, which forms the theory.

The world is made up of matter, and all follow the same operating rules. The basic laws studied are universal and suitable for the whole world. The laws I am studying at home are also suitable for your home. This is the principle of world identity. Matter is not isolated, but interactive, interrelated and restricted. Matter has the reason of material existence and movement, not chaotic and unpredictable. This reason is logic. From this point of view, logic is both basic and simple, and the more basic and simple the law, the more universal it is, and the complex is composed of simple ones. Logic is truth and basic relationship, because it is simple and everyone can understand it. When people judge the laws of things, they often start with logic, which is the first level. If there is reason and logic, they will continue to judge, otherwise there is no need to continue. Logical judgment is a human thinking process, and everyone can judge without hands-on and expensive experimental devices.

The explanation of experimental phenomena can only show that it conforms to the surface characteristics of objective world, but it does not necessarily represent the essence of objective world.

However, testing by experiment is not a basic and simple method, but a simulation method. Due to the limitations of conditions, the object cannot be simulated as it is, and even if it is done seriously, the real result may not be obtained. Modern scientific experiments are expensive, and it is possible to build them with the strength of whole country. It is difficult for others to reproduce them and do repeated tests. Often form a monopoly of right to speak, he said what he said, others can not repeat the test from the experimental method, can not be questioned. There are too many such examples, such as colliders, astronomical interferometers and Mozi satellites.

People don't know the microscopic material world, so they use light to illuminate it. Only when light enters people's eyes through instruments can they see it. But we can only see the pixels on the negative or fluorescent screen, so we can guess that it may be "the probability of finding particles", not to mention the details and processes of microscopic material world. It can be seen that in the quantum mechanics theory of Copenhagen school, people's research on the micro-world is the "observation effect" when "people" look at the world. If you can't see the details and process of micro-material world, you won't see the real micro-world, not the truth of micro-world. What the theory describes is not the "real" movement law of micro-material world, but only a rough and vague outline.

However, in fact, the objective world is there. Whether people look at it or not, it is just like that. When people see it, they feel what it is like. It is a matter of people and has nothing to do with the world. People are just a moment of dust in the objective world, and the idea of "people-oriented" to see the world is not a scientific materialistic view. The moon is

there, whether you see it or not. It is impossible to "it doesn't exist without looking at the moon".

Only a theory that can accurately describe the details and process of microscopic material world can truly reflect the "real" movement law of microscopic material world.

People live in the macro world, are familiar with the macro world, and are unfamiliar with the micro world, so they are full of mystery about the micro world, artificially divided into macro and micro, and think that macro and micro follow different physical laws, which is an idealistic world outlook.

People should not artificially divide the objective world into macro and micro, high-speed and low-speed, let alone follow several incompatible laws, but unified laws. If there are several incompatible theories that are treated differently, it must be wrong.

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