# New Theory of Quantum Mechanics

## ——The Rebuilding of Quantum Mechanics

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**Abstract** This paper starts from the behavior of the field in a potential well and concludes that the field exists in the form of a standing wave with energy in the potential well, thereby finding the cause of the fluctuation in quantum mechanics. Using only one physical model, **the field forms fluctuations, which is the wave function**, and using the Compton wavelength, the relationship between electromagnetic wave energy and mechanical wave energy and frequency is derived. It is concluded that the wave function has the meaning of a generalized field, and it is noted that Sommerfeld's quantization rule is the basic equation of quantum mechanics, thus establishing a new quantum mechanics theory. The superposition, orthogonality, normalization, and equivalence principles of the wave function are analyzed, and the superposition of wave function states does not exist. Each conclusion given herein has a clear and obvious physical meaning, making the problem of quantum mechanics simple and clear. A new atomic model is established, and problems such as electron transitions, electron spin, electron emission and absorption are discussed. Matter is divided into solid matter and field-state matter. The essence of light is particularly analyzed, and it is clear that light is an electromagnetic wave and that light is not a material particle. Experiments such as the electron pattern of the Davisson–Germer experiment, the principles of electron microscopy, the photoelectric effect, the Compton effect, and double-slit interference are reinterpreted. A new uncertainty relation is proposed. Notably, there is no wave, no "wave–particle duality", no quantum entanglement, and the Schrödinger equation is not a wave equation.

**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. The quantum mechanics theory of Copenhagen School is generally accepted by the scientific community.

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

Einstein, De Broglie and Schrodinger, and even Planck, who pioneered the concept of quantum mechanics and strongly opposed it. Einstein believed that "quantum mechanics is incomplete". Dirac also said, "I cannot 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 has developed quantum field theory, the standard model of particle physics and string theory, the debate on the quantum mechanics theory of Copenhagen School has not yet progressed, but it is becoming increasingly intense.

In this paper, the author determines the reason for and essence of fluctuations in quantum mechanics, **determines that the generalized field forms fluctuations and that the generalized field is a wave function**, and clearly explains the physical meaning of the 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 waves, the problem of light has been clearly studied in Maxwell's equation of electrodynamics, so the quantum mechanics of studying matter waves should be as follows:

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. Reasons for the Fluctuation of Micromatter

A comparison of the energy density of electromagnetic waves reveals that the energy densities of electromagnetic waves and mechanical waves have the same form:

Energy density of electromagnetic waves:

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

Energy density of mechanical waves:

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

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 the electromagnetic wave is equivalent to the energy with mass $\boldsymbol{m}$ and velocity $\vec{c}$, and the energy of the mechanical wave is equivalent to the energy with mass $\boldsymbol{m_0}$ and velocity $\vec{\upsilon}$ (as shown in Eq. (2)), which correspond to the energy clusters of the electromagnetic wave and mechanical wave, respectively, as follows:

Energy density of electromagnetic waves:

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

Energy density of mechanical waves:

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

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

Density energy:

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

Total energy:

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

By analyzing the situation of the **electric field** and **kinetic energy**, we can determine the reason **for microsubstance fluctuations**.

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 us 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 the Electric Field in the Electric Field Energy Barrier

The charge 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 with a quantity of ***q***(***q***<***Q***) moves closer to ***Q*** from a distance, and the electric field of ***q*** affects 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, whereas 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***→∞ (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, the electric field cannot pass through the infinitely high potential barrier but is completely reflected, as shown in Fig. 1(4). An infinitely high barrier shields 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 reflects back and forth in the potential well and oscillates 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 the 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 fluctuations**" in the quantum mechanics theory of the Copenhagen school, which is actually a **generalized field** $\vec{\Phi}(\vec{r},t)$ **that fluctuates**.

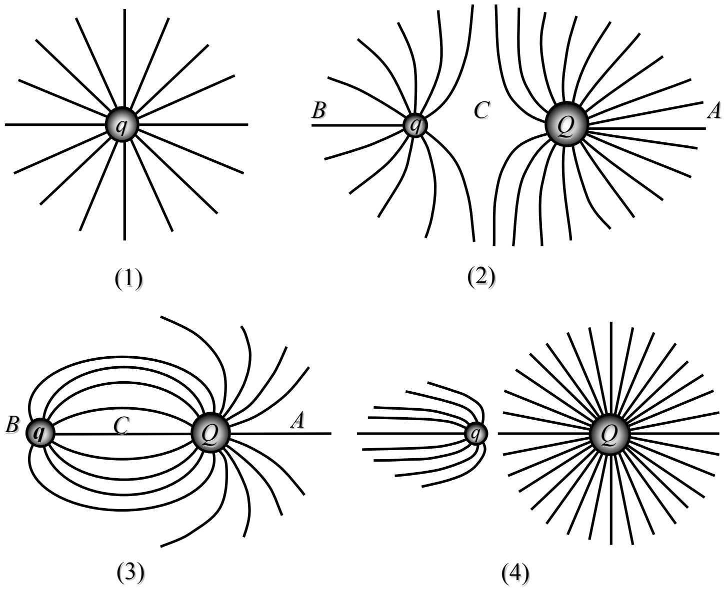



**Fig. 1.** Penetration of the electric field at the potential barrier

### 2.2. Penetration of the Momentum Field in the Kinetic Energy Barrier

The penetration of the momentum field (or velocity field) in the 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 when ***M>m***, $M\vec{V}^2/2 > m\vec{v}^2/2$; then, the ***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, the momentum field (or velocity field) of the ball passes through the barrier, and part of it is reflected by the barrier and superimposed with the original field. When ***M***→∞ (or ***M>>m***), ***m*** balls bounce back at full velocity after collision, which does not affect the momentum of the ***M*** ball, which means that the momentum field cannot pass through the infinitely 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 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**, it is **a 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:

**The generalized fields form waves, and the generalized fields are wave functions.**

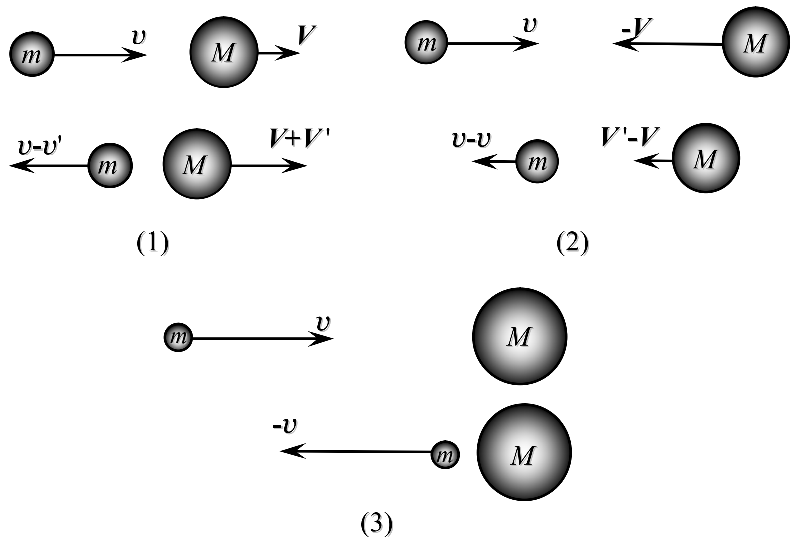



**Fig. 2.** Penetration of the momentum field at the kinetic energy barrier

## 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 $\lambda_0$ and oscillates periodically at frequency $\nu_0$, and the vibrator wave forms a wave packet with wavelength $\lambda_0$.

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 $\vec{\upsilon}$, the fluctuation of the vibrator forms a wave packet (energy group) with wavelength $\lambda$, and there is a relationship $\lambda=h/m\upsilon$, that is,

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

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

Electromagnetic wave energy:

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

Mechanical wave energy:

$$E_0 = m_0\vec{\upsilon}^2 = (m_0\vec{\upsilon}\lambda_0)\frac{\vec{\upsilon}}{\lambda_0} = h\nu_0 = \hbar\omega_0 \quad (9)$$

(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 proposed the quantum hypothesis of energy. Planck considered that the energy of the electromagnetic field should be distributed according to the different vibration modes of charged vibrators. 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 related only to the frequency of electromagnetic waves and were proportional to the frequency, that is, $E=h\nu$; such an energy was called **the energy quantum**. Planck failed to provide a 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.

In general, Planck's energy quantum

hypothesis states that radiation is emitted and absorbed discontinuously in the black body cavity and that the energy of electromagnetic wave radiation emitted and absorbed in the black body cavity is one share.

Notably, Planck's energy quantization hypothesis means that the energy of black-body radiation that emits and absorbs electromagnetic waves is one copy, and each copy is $\boldsymbol{E=hv}$. This does not mean that quantum matter is the smallest unit of matter, let alone matter particles. The energy quantization and quantization mentioned in this paper refer to Planck's energy quantization.

## 4. Standing Wave Conditions

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

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

where $\boldsymbol{l}$ is the width of the potential well and $\boldsymbol{\lambda/2}$ is the linearity of the 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 the 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 satisfy Sommerfeld's quantization principle[1]:

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

If the width $\boldsymbol{l}$ of the potential well is $\boldsymbol{\lambda/2}$ (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):

$$\lambda_n = \frac{\lambda}{n} \tag{12}$$

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

$$E_0 = nhv = n\hbar\omega \tag{13}$$

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

That is, **energy can be emitted or absorbed only one by one**, which is the essence of the 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 oscillates to form a standing wave, which absorbs or radiates the energy quantum. Electrons are affected by the standing wave of the electric field in the potential well and move with changes in the standing wave of the electric field. When the electrons are emitted, they form free electrons, which break away from the standing wave of the electric field, carry a certain amount of energy, maintain 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 for the wave function, which is an important equation in this theory and completely replaces the

Schrodinger equation.

## 5. Field Significance of the Wave Function

What is the relationship between the generalized field and wave function in this physical model? What exactly is the wave function? What is the probability explanation of the 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, 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 the system in the volume *V* of a wave packet**. The total energy ***W*** in system ***V*** and the energy dw in the volume element $d\tau$ are as follows:

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

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

By integrating this formula and comparing the two formulas, we obtain:

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

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 the 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 as follows:

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

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 obtain:

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

**where $\frac{1}{n}\frac{dn}{d\tau}$ is the probability of material particles appearing in a unit volume at time *t* at $\vec{r}$**. This is the meaning of the square $\left|\vec{\Psi}(\vec{r},t)\right|^2$ of the wave function in the probability explanation of the wave function in the quantum mechanics theory of Copenhagen School[2], where $\vec{\Psi}(\vec{r},t)$ is the normalized wave function of the system. From this **important relationship** in 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 the energy of the system per unit volume to the total energy of the system *w/W*; the generalized field $\vec{\Phi}(\vec{r},t)$ is the normalized wave function of the system.**

Let $\vec{\Phi}$ (or $\vec{\phi}$) be a nonnormalized wave function; then,

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

With normalization constant

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

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

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

It can be seen from the derivation of the abovementioned important relation in Eq. (16) that only the wave energy of the 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 quantization is regarded as a matter particle and that such matter particles are distributed according to the probability of the wave function so that Eq. (16') can be obtained. **The statistical (probability) explanation of the wave function in the quantum mechanics theory of the Copenhagen school treats the energy quantum as a matter particle**. In fact, the wave function is derived from the fluctuation of the generalized field, not from the particle of matter, and the wave packet of the fluctuation of the generalized field has a volume and size, not a mass particle. **The volume of a wave packet is the volume of an energy quantum. The wave function is the field (generalized field), and the product of the square of the wave function and the generalized quantity is the energy density.**

Wave packets, 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 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 a 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 within the range of "uncertain relationships".

In addition, when the total energy of the 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 cannot be regarded as a matter particle, so the "probability density" is meaningless.

## 6. Superposition, orthogonality and equivalent principles of wave functions and their physical significance

### 6.1. Superposition of the 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 the generalized fields of**

**multiple generalized field sources at this point.** namely,

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

The abovementioned barrier penetration phenomenon of two charged and two balls is actually the superposition of generalized fields rather than the fact that material particles truly 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 the latter represents the states of microscopic particles, such as momentum, position, and spin. It is inconceivable that two or more particles are in the same position or that one particle is in multiple positions and **that the superposition of wave function states does not exist**.

### 6.2. Orthogonal normalization

**The two wave functions $\Psi_k$ and $\Psi_l$ satisfy the relation:**

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

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. Only when $\boldsymbol{k = l}$ is there.

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

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

**Orthogonality** has no physical meaning or 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*≠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, the mass ***m*** and velocity ***v*** can form kinetic energy, and the dielectric constant ***ε*** and electric field ***E*** can form electric field energy (i.e., ***v·v*=*v*²**, ***E·E*=*E*²**, which means ***W*=*W*** when ***k*=*l***). On the other hand, the mass ***m*** and electric field ***E*** cannot constitute energy, and neither the dielectric constant ***ε*** nor the velocity ***v*** (because ***m·E*=?**, ***ε·v*=?** , ***W*=0** when ***k*≠*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 $\boldsymbol{M_n}$. Its expression:

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

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

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

Namely:

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

The ***n*** integral terms in the above formula are combined with the quadratic term theorem, where ***k***, ***l***=1,2,3,⋯,n, and ***k≠l*** (that is, the case of **0** added in the following formula):

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

Another expression of the 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:

$$|C_n|^2 = \frac{W_n}{W} \tag{29}$$

$$\sum_n |C_n|^2 = 1 \tag{30}$$

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

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

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

For example, charged particles can 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 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 the law of conservation of energy.

In mathematical form, the principle of equivalence actually 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 of Born's statistical explanation of the wave function. The probability explanation of the wave function leads to confusion in the whole theory.

## 7. Typical application examples

Given the reason for and essence of fluctuation, when the standing wave condition is used, 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:

$$\lambda_n = \frac{4a}{n} \tag{32}$$

Then, the energy level is obtained:

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

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 as follows:

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

The wave packet can be considered a rotating body with sinusoidal vibration, and its volume can be obtained as follows:

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

Because the potential well is infinitely deep, the energy level has nothing to do with the depth of the 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 a 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.

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

Integral in a period $0 \to 2\pi/\omega$, one can obtain

Energy level:

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

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

Location:

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

Velocity:

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

The **amplitude, energy level radius and position are equivalent to**

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

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 considered a rotating body with sinusoidal vibration, and its volume is as follows:

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

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

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

### 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, the reduced mass of the system is $\mu = mM/(m+M)$ and the nuclear charge number is $\boldsymbol{Z}$; then,

Equation of motion:

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

Potential energy:

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

Total energy:

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

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:

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

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

Energy level:

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

Track radius (i.e., position):

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

Velocity:

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

Wavelength:

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

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

Amplitude:

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

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

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

In fact, in general, different nuclear charges $\boldsymbol{Z}$ and different energy levels $\boldsymbol{n}$ correspond to different fine structure constants:

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

(Taking the first energy level of a hydrogen atom as an example, the above observable measurements include an energy level of −13.6 eV, a Bohr radius of $5.29\times10^{-11}$ m, a velocity of $2.19\times10^{6}$ m/s, a wavelength of $3.32\times10^{-10}$ m, a frequency of $6.54\times10^{15}$ Hz and an amplitude of $1.06\times10^{-10}$ m. These data can be used for experimental verification.

The meaning of $\boldsymbol{r_n}$ is that the generalized field (electric field) with energy $\boldsymbol{E_n}$ (frequency and wavelength are determined) can only form a standing wave when it fluctuates in the region with radius $\boldsymbol{r_n}$, 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. The velocity expression reveals that the **fluctuations formed by the generalized field can propagate in two directions, thus forming a standing wave.**

The wavelength of the standing wave formed by the electric field is $\pi$ times the amplitude.

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

## 8. The velocity of motion of the material and the velocity of wave propagation

The above examples are all analyzed from the perspective of energy, where $\upsilon_n$ is the velocity of matter. Let us analyze the velocity $\upsilon_n$ from the angle of the 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 $h\nu_n/2$ that of the quantum of two wave packets in a wavelength. Now, let us substitute the velocity vn of matter in each example solved above as the propagation velocity of the wave into $E_n = h\nu_n/2$ and determine the energy of each quantum in each example separately to determine what we can obtain.

### 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

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

### 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**. The matter moves with waves, or waves drive matter to move together.

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

These three cases 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 range, the energy

satisfies formula (9):

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

## 9. New Atomic Model

### 9.1. New Atomic Model

Now, it should be possible to redefine a **new atomic model** such as this: **the electric field outside the nucleus (generalized field) fluctuates at $r_n$ in the space limited by the energy level, forming a closed standing wave. The waveform of this standing wave rotates around the nucleus at velocity $\upsilon_n$ as a whole, and the electrons rotate around the nucleus at velocity $\upsilon_n$ stably under the constraint and drive of the 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, which is **2** times greater than the amplitude of the antinode. The ratio of the length $\lambda_n = 2\pi r / n$ of the electric field standing wave to the waist diameter **2*An*** is a constant **$\pi/4$**, and the half-wavelength of the standing wave is $\lambda_n / 2$, which shows that the shape of the electric field standing wave is fixed.

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

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

(The volume of the electric field standing wave packet at the first energy level of the hydrogen atom is $5.59\times10^{-20}$ $m^3$)

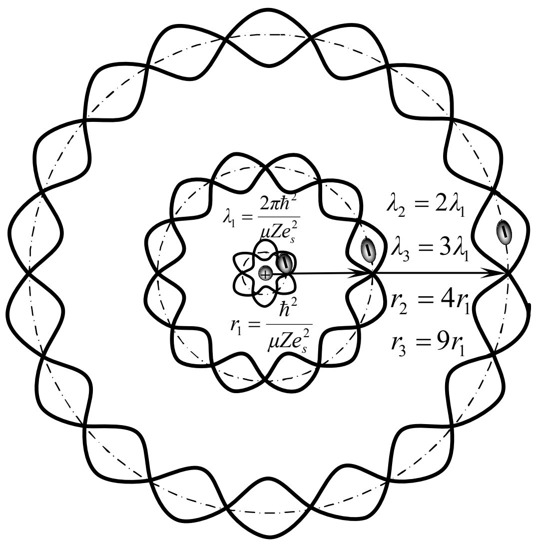



**Fig. 3.** Electric field standing waves of hydrogen-like atoms at three energy levels.

The wavelength expression of the standing wave packet of the electric field of the hydrogen-like atom shows 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 in Eq. (11).

Fig. 3 shows the fluctuations in the

electric field standing waves of hydrogen-like atoms at three energy levels, which are drawn according to the calculation results of the energy levels, orbital radii, velocities and wavelengths of the hydrogen-like atoms above. It is a wave formed in the three-dimensional space outside the nucleus. Because the circle in the figure cannot draw **1** wave packet in the ground state, **6*n*** waves are drawn here.

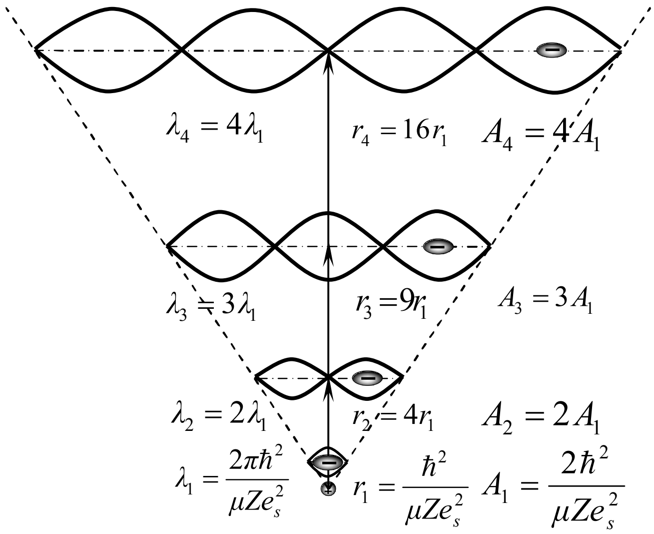



**Fig. 4.** Development diagram of the electric field standing wave of a hydrogen-like atom at three energy levels.

In fact, there is only **1** wave packet 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 the node, it is Fig. **4**, which shows the fluctuations of the 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 the case in this study.

The standing wave is stable but not dispersed, similar to the standing wave on a rope. It is similar to a stationary wave, and it is a wave packet with a length of half a wavelength. In this model, the whole body is in motion, the electric field waves outside the nucleus form a closed standing wave, and the whole body rotates 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 the 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 the 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 these electrons 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. More precisely, when the energy of this energy group formed by the 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.

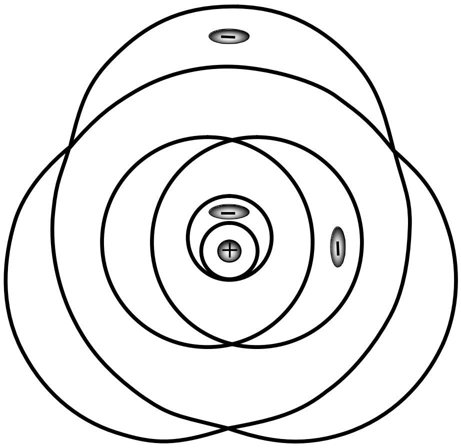


**Fig. 5.** The shape of the generalized field fluctuation of hydrogen-like atoms

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

Textbook [6] states that "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 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 the spectrum. Experiments have shown that the frequency distribution of spectral lines follows the principle of union. In this work, the authors suggest that the classical electrodynamic method is incorrect in terms of 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 steadily in a uniform circular motion. Only when the charge is moving at a variable velocity will the energy of the charge change, and electromagnetic radiation is generated. Mr. Mei Xiaochun from Fuzhou Institute of Original Physics has the same view and wrote an article on this issue［7］. Mr. Zeng Jiqing of South China Botanical Garden, Chinese Academy of Sciences, also expressed the same view in his article[8].

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

When electrons jump from a high energy level to a low energy level, the standing wave packet of the 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 **the luminescence**, and the electric field reforms a new standing wave at a low energy level.

$$hv = E_m - E_n \tag{65}$$

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

$$E_m - E_n = hv \tag{66}$$

When the external electromagnetic wave energy is large enough, the electrons jump to the outermost energy level and eliminate the Coulomb force constraint of the nucleus to become free electrons, which is **Ionization**. When the external electromagnetic wave energy is large enough, electrons even fly off the surface of the metal body, which is known as the photoelectric effect. The photoelectric effect absorbs high-frequency and high-energy electromagnetic waves, and this process satisfies the photoelectric effect equation:

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

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 the dynamic redistribution of the electric field.

### 9.3. Spin of Electric Field Standing Waves 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 **rather a football or a spindle**, which is the shape of the standing wave formed on the rope we see; however, it is not fixed but rotates at a velocity vn. When it orbits once, it also rotates once, which forms the **spin of the electric field standing wave**, as shown in Fig. 6.

Now that we know that electrons spin, let us analyze how electrons spin. If the electron is spherical in shape and its material distribution is isotropic, then regardless of how it spins, 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 an electron is not a sphere but should also be like a football or a spindle, and its two ends are consistent with the direction of the standing wave packet of the electric field.**

The velocity calculated above is positive and negative, which means that the fluctuation of the 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 the 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 in six directions, and the "→" sign in the figure indicates only its rotation direction. In this way, both the angular momentum and magnetic moment are clear.

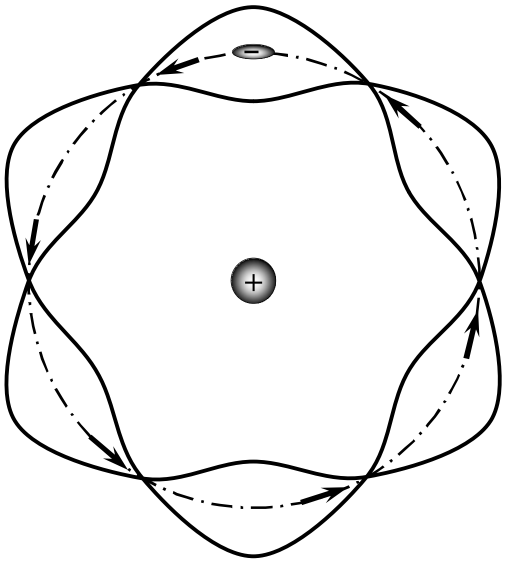


**Fig. 6.** Spin of electric field standing wave and electron spin

When an electron moves around the nucleus with an 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 electrons moving around the nucleus and spinning around its own center are also the same and equal to $\nu_n$. 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 the electric field standing wave packet spin** is

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

(The maximum relative linear velocity of the first energy level electric field standing wave packet spin of the hydrogen atom is $3.44\times10^6$ m/s.)

**The ratio of the maximum relative linear velocity of the electric field standing wave packet spin to the velocity of the 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 a spin magnetic moment and spin precession in two directions. However, this is not discussed in detail here.

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

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

Solid substances[3] with electrical properties (the solid substances and field substances analyzed in section **11** of this paper), such as electrons, protons and ions, are called charges. Their movement changes the electric field distribution in the surrounding space and produces magnetic fields. The spin motion of charge also produces a magnetic field, forming a magnetic moment. The changing magnetic field of the moving charge is the reason for the formation of the magnetic moment, not the "intrinsic magnetic moment". This is not discussed in detail 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 the 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 maintain the original velocity and fly freely (inertial motion), which is **electron emission**.

When the electron moves to the front object, the electric field of the atom in this object captures it, and it moves around the atom of this object to become a negative ion or 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 the electric field, which is **electron absorption**.

## 10. The Essence of Light

### 10.1. Similarity between the String Vibration Equation and the Maxwell Electromagnetic Wave Equation

The wave equation is a type of partial differential equation that 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. The 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.

The 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 the spring is ***k***, where $\vec{\Phi}(\vec{x},t)$ represents the distance of a 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:

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

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

The spring force changes the state of motion, the two equations are equal, and the following 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:

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

Three-dimensional wave equation:

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

The coefficient $\vec{\upsilon}$ is usually a fixed constant **that represents the wave propagation velocity**. In the problem of string vibration, the wave velocity is not related to vibration or waves but rather to the material, density and axial tension of the 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 related only to the material, density and axial tension of this string but is not related to other factors. When these related factors are known, the wave velocity of this string is a constant.

The solution of the 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.

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

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

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

One-dimensional nonhomogeneous wave equation:

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

Three-dimensional inhomogeneous wave equation:

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

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 **resistant**, 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.

The linear plane wave is only the simplest case, but it is not the real case. The wave source of a real situation is usually a point, which is sent to three-dimensional space, that is, a spherical wave.

In fact, generating plane waves is the most complicated process. 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. Alternatively, the waves generated by a line of wave sources arranged in a straight line can be approximately regarded as plane waves:

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

The string is togled, a driving force is given, 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, 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 ***π*/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:

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

**The characteristics of standing waves** at all points are simple harmonic vibration, the frequency is the same, and the amplitude of each point changes periodically, regardless of time. ***n*.*λ*/2,** where the amplitude is **0,** is called a node, and **(*n*-1/2).*λ*/2,** where the amplitude is the largest **2*A*,** is called an antinode. The standing wave conditions need to be met to form a standing wave, a string with a length of ***L***, and the standing wave conditions are as follows:

**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:**

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

**10.1.3. Freedom at Both Ends:**

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

**10.1.4. Ring:**

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

As shown in Fig. 7.

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

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

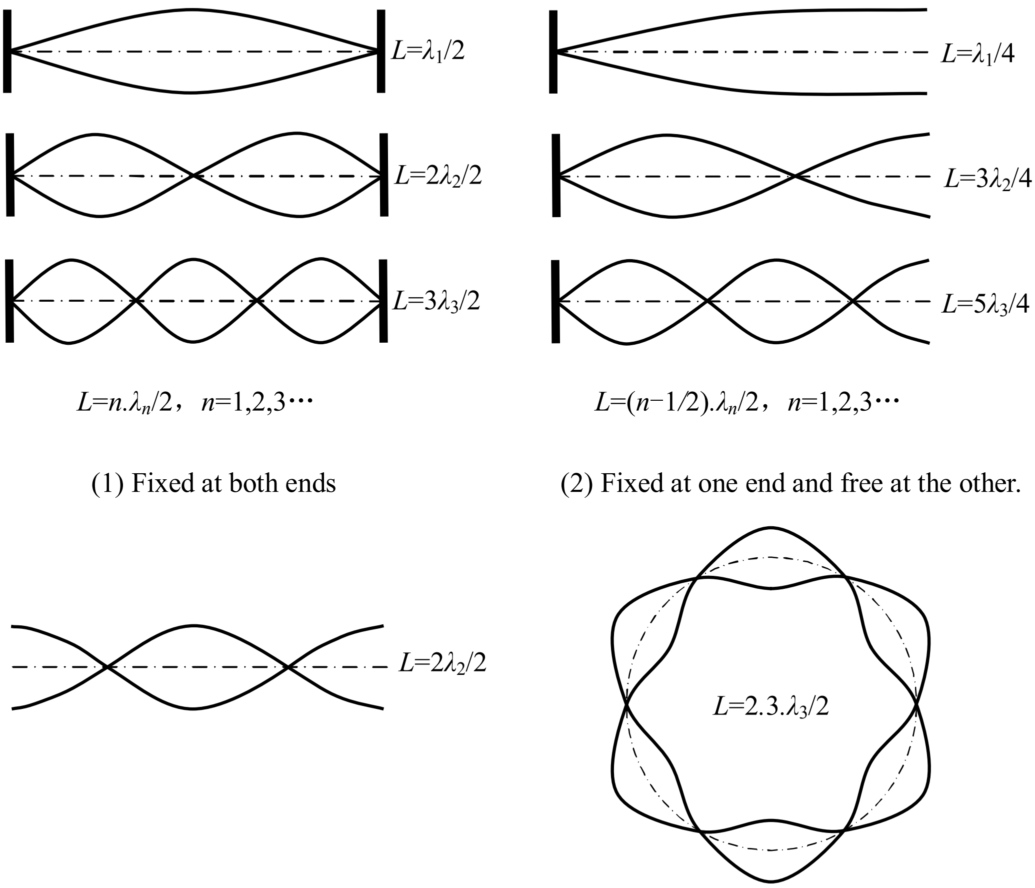
$$\nabla^2\vec{B} = \varepsilon_0\mu_0\frac{\partial^2\vec{B}}{\partial t^2} \quad (90)$$

**The electromagnetic wave equation is exactly the same as the string vibration equation**, where the wave velocity $\boldsymbol{v}$ is the speed of light $\boldsymbol{c}$.

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

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




$L=n.\lambda_n/2$, $n=1,2,3\cdots$

(1) Fixed at both ends

$L=(n-1/2).\lambda_n/2$, $n=1,2,3\cdots$

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

$L=(n-1/2).\lambda_n/2$, $n=1,2,3\cdots$

(3) Freedom at both ends

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

(4) Annular

**Fig. 7.** Several standing wave modes of string vibrations

The wave situations of the 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. A 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 ($n\lambda/2=l$). A 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 ($(n-1/2)\lambda/2=l$). A hydrogen-like atom is in a typical **spherical shell state**, which is equivalent to a circular standing wave ($n\lambda/2=\pi r$), and its length is half the circumference, but the actual situation is a three-dimensional standing wave, a circular standing wave on the plane, similar to the new atomic model. Free electrons are in 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).

An electromagnetic wave (a light wave) is a little special. Although electromagnetic waves are derived under the conditions of no charge and no current, the string vibration equation is exactly the same as Maxwell's electromagnetic wave equation is, and Maxwell's electromagnetic wave equation is also a string vibration equation. Because the string vibration equation produces a standing wave, **Maxwell's electromagnetic wave equation also produces a standing wave, that is, the light wave is a standing wave**. Because an electromagnetic wave is a wave formed by the alternating excitation of an electric field and a magnetic field, its propagation medium is an electric field and a magnetic field; therefore, **electromagnetic waves are actually standing waves formed by self-restraint.**

From this perspective, **electromagnetic waves are also standing waves. The electromagnetic wave excited from a wave source is similar to a standing wave with one end fixed and one end free. In free space, it is similar to a standing wave with two ends free. This is because it is not the vibration of a solid substance 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 long-term research, the author **emphasized that 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 separations, electronic transitions and even chemical reactions are generally accompanied by changes in energy and the emission and absorption of light.

**Light is an electromagnetic wave, and an electromagnetic wave is light, which is the fluctuation of the electromagnetic field. Light and electromagnetic waves 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, ignore the key problem that light is an electromagnetic wave and regard 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). Free space is a field-free region that 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 that is 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 approximately 3.0×108 m/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 reanalyzing the nature of light, the author of this paper has the following deeper understanding of the nature of light:

Light is a form of fluctuation, not a form of material movement. This phenomenon cannot be called the movement of light but rather the propagation of light. Light propagates in fluctuating forms and fluctuating energy. Light is not limited by mass, has no inertia, is not affected by force, accelerates or decelerates, and is not dragged by the light source but can be dragged by the electromagnetic field medium; that is, the speed of light can be superimposed on the velocity of the 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 the light source does not affect the velocity or 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 type of light is generated and propagated independently of each other, superposes when it meets, 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, indicating that light does not matter but rather fluctuates. 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 true for a constant speed of light. In vacuum, relative to the reference frame of the vacuum medium, the speed of light is $c$, which satisfies the laws of relativity and superposition of the speed of light. The speed of light is not the upper limit of all velocities, but the movement velocity of solid substances can exceed the speed of light. A 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 substance as the medium in vacuum, it takes the substance in the form of an 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 an electromagnetic wave. In the process of alternating excitation of the electric field and magnetic field, the electric field and magnetic field at the back weaken and disappear, the electric field and magnetic field at the front are excited, which are generated in the process of excitation, and the changes occur one after another. The propagation velocity of the electromagnetic wave is the velocity at which the electric field and magnetic field are alternately excited in space and propagate forward, so the **electromagnetic field is the medium of electromagnetic wave propagation**.

Maxwell solved the electromagnetic wave equation from the equations. The 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 the wave source. Similarly, the electromagnetic wave velocity solved via the electromagnetic wave equation is $c=1/\sqrt{\varepsilon_0\mu_0}$ (where $\varepsilon_0$ is the dielectric constant in vacuum and $\mu_0$ is the permeability constant in vacuum), so the electromagnetic wave velocity in vacuum is also related to the dielectric electromagnetic field of the electromagnetic wave in vacuum and has nothing to do with the motion of the wave source. The dielectric electromagnetic field of electromagnetic waves 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 are not contradictory.

The dielectric constant in vacuum is $\varepsilon_0$**=8.854187817×10$^{-12}$ F/m**, and the magnetic permeability constant in vacuum is $\mu_0$**=1.256638504×10$^{-6}$ N/A$^2$**, which are the values in free space without matter, indicating that vacuum has no hindrance to electromagnetic waves and that the electromagnetic wave velocity in vacuum reaches the fastest $c$**=299792458 m/s**.

In a solid substance, the velocity of the electromagnetic wave is $c_w=1/\sqrt{\varepsilon(\nu)\mu(\nu)}=c/n$ (where $\varepsilon$ is the dielectric coefficient of the solid substance and where $\mu$ is the magnetic permeability coefficient of the solid substance, which are related not only to the solid substance but also to the frequency $\boldsymbol{v}$ of the electromagnetic wave and where $\boldsymbol{n}$ is the refractive index of the transparent solid substance to light). Similarly, the velocity of electromagnetic waves in solid substances is related to the medium electromagnetic field of electromagnetic waves in solid substances and has nothing to do with the motion of the wave source. As the electromagnetic wave medium in solid substances, the electromagnetic field is the reference frame of the light velocity $\boldsymbol{c_w}$ in solid substances.

Similarly, the dielectric coefficient $\boldsymbol{\varepsilon(v)}$ and the magnetic permeability coefficient $\boldsymbol{\mu(v)}$ in solid substances are determined by state parameters such as the type, density, temperature and pressure of the solid substance itself and are also related to the frequency $\boldsymbol{v}$ of electromagnetic waves, indicating that solid substances have a blocking effect on electromagnetic waves and that the blocking effect on electromagnetic waves with different frequencies is different. They determine the electromagnetic wave velocity $\boldsymbol{c_w}$ in the solid substances, which is based on the electromagnetic wave velocity in the solid substances. For example, the velocity of visible light in water is **2.25 ×108 m/s**, which is determined by the frequency of visible light and state parameters such as the type, density, temperature and pressure of the water.

The mechanical wave equation and electromagnetic wave equation have the same form, and the mechanical wave velocity is determined by the nature and state parameters of the medium itself rather than by the movement of the medium. Similarly, the velocity of an electromagnetic wave is determined by the nature and state parameters of the electromagnetic field itself, which are related to the velocity of the electromagnetic field as the reference system rather than to the movement of the 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 $\boldsymbol{\varepsilon_0}$ and the permeability constant $\boldsymbol{\mu_0}$ in vacuum, which is relative to the velocity of the electromagnetic field in vacuum as a reference system, not by the movement of the electromagnetic field, let alone by the movement of any other medium.

**In the solid substances medium, electromagnetic waves are also propagated by the medium of the electromagnetic field, not by the solid substances medium**. In the solid substance medium, there is charge, so the electromagnetic field and the solid substance medium act as electromagnetic forces. The transmission and distribution of the electromagnetic field in the solid substance medium are affected by the state parameters of the solid substance medium, and the dielectric constant $\boldsymbol{\varepsilon(v)}$ and the permeability constant $\boldsymbol{\mu(v)}$ are different from those in vacuum, thus affecting the fluctuation of the electromagnetic field in the solid substance medium and the velocity of the electromagnetic field fluctuation. The electromagnetic field also moves with the movement of solid substances.

When light propagates in a (transparent) solid substance, the electromagnetic field is also used as the propagation medium. The (transparent) solid substance is not the propagation medium of light, but the electromagnetic field is the propagation medium of light. The slow propagation of the electromagnetic field in solid substances leads to the slow propagation of light in (transparent) solid substances, which is $c_w=c/n$. The overall movement (flow) velocity of solid substances is not synchronous with the propagation velocity of the electromagnetic field in solid substances, which leads to the unsynchronized propagation speed of light in transparent solid substances, which usually lag behind. That is, the solid substances do not drag the electromagnetic field completely synchronously, nor do they drag the electromagnetic wave completely synchronously, but only partially. The solid substances drag the electromagnetic field in a certain proportion, and the two actions slow down the propagation speed of light through the whole moving (transparent) solid substances, which is related to state parameters such as the type, density, temperature and pressure of the solid substances and the frequency $\nu$ of the electromagnetic waves. These state parameters are generally manifested in the dielectric coefficient $\varepsilon(\nu)$ and the magnetic permeability coefficient $\mu(\nu)$ of the solid substance medium.

All waves (including electromagnetic waves) are body waves inside the medium and surface waves at the interface of the medium. Both transparent waves and longitudinal waves are present in body waves. The surface waves at the interface of the medium are transparent waves, whereas the body waves in the 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.

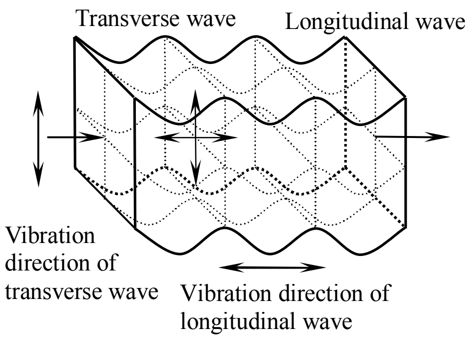



**Fig. 8.** Body waves have both transparent waves and longitudinal waves

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. Owing to the conservation of energy when the electric field and magnetic field are alternately excited, the phase difference between the 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 used 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 the coordinate transformation, motion equation or 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 has shown that light is particle-like. All these phenomena and experiments prove that light is only wave-like and that light is an electromagnetic wave. Regardless of how short the wavelengths of **X**-rays and **γ**-rays are, they are still waves, light waves and electromagnetic waves, not particles.

In [3,9], the author conducted a detailed study on the relationships among waves, light and motion.

We will then study how light is emitted, how it spreads, how it interacts with matter and how it passes through solid substances so that we can further understand the essence of light.

### 10.3. Luminescence mechanism

**Light is not emitted by a light source but is instead emitted by a light source.**

The electric field wave of the energy level where the extranuclear electrons of the light source are located loses stability and disbands when the external electromagnetic field energy is gained and reforms a metastable wave at the high-energy level of the metastable state. When it jumps to a more stable low-energy level, the fluctuating electric field reforms a stable wave at the low-energy level, and the redundant energy is emitted tangentially as a changing electric field, which excites the first nonuniformly changing electric field. When this electric field weakens, it excites the first nonuniformly 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 the human eye is only a very narrow band (**380~780 nm**).

**The level of matter determines the change in the energy level.** The macroscopic antenna oscillation circuit is low-level, and its mechanism, which produces long-band low-energy electromagnetic waves (radio waves), is well known. At the molecular level, the change in the outermost electrons outside the nucleus is shallow, which excites high-energy shortwave electromagnetic waves (visible light and ultraviolet light). The microlevel changes in extranuclear electrons are at the middle level, which excites high-energy ultrashort 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 no relationship with the light source since then.** The light source plays a role in energy conversion and electric field excitation.

**Therefore, relative to that of solid substances, the speed of light is a constant. In essence, the electromagnetic field is the medium in which electromagnetic waves propagate, and the speed of light is constant relative to the electromagnetic field in the solid substance medium.**

### 10.4. The Structure, Shape and Size of Light

Light has a structure, shape and size. It is not a "point particle" without structure, shape or 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 $\pi/2$ differences. The sum of the electric field energy and magnetic field energy at any moment is the total energy** $E=h\nu$, which conforms to the law of energy conservation. The electromagnetic wave propagation image should be one, as shown in Fig. 9:

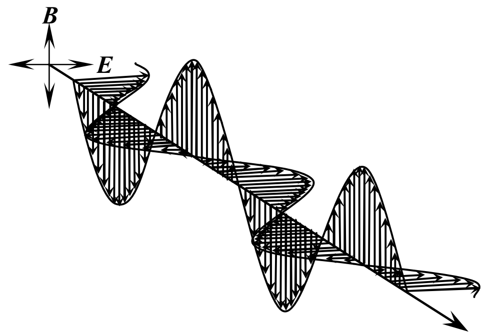



**Fig. 9.** Electromagnetic wave propagation image

The author suggested that in the field of electrodynamics, the phase of an electromagnetic wave and its propagation image (Figs. 4-2)[9] is wrong because it does not conform to the law of conservation of energy or to the mechanism of alternating excitation of the electric field and magnetic field to form electromagnetic waves.

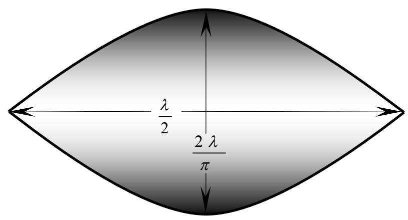



**Fig. 10.** Shape and size of light

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

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

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 they jump continuously, continuous light waves are excited. When pulse mode is used, 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 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 the electric field and magnetic field and may conform to the right-handed spiral rule.

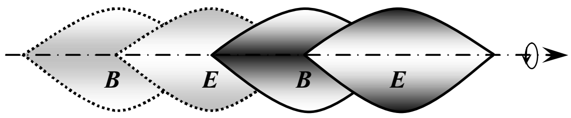



**Fig. 11.** Shape and propagation of light

### 10.5. Propagation of Light Waves in a 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 weakens, it excites a stronger magnetic field. The original electric field weakens and disappears, whereas 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 front, and the electromagnetic field at the back disappears. According to the energy conservation law, the electromagnetic field changes mutually, changes vertically (vibrates) in the **X** and **Y** directions, and propagates along the **Z** direction. When light travels there, it excites electromagnetism and an electric field, which are the media of electromagnetic waves. In the process of light propagation, the electric field and magnetic field media 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 also propagate. Light propagates through the generated electric field and magnetic field medium, and its wave forms.

Like people walk in the air wearing shoes, there is no ready-made road in the air. The shoes worn by people are similar to roads (electric field magnetic media), which produce roads while walking. The shoes worn by the left foot are similar to 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, similar to when 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. 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.

Thus, 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 or turns, but the electric field and magnetic field are alternately excited, and the velocity reaches its fastest value.

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 Substituent Media

Owing to the matching relationship between the energy of incident light and the electron energy level outside the nucleus of the solid substance 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 the medium, and the high energy level has no stable state.

The first atom of light entering the boundary of the 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, 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 then 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 decreases.

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

On the other hand, the energy of the incident light is very small, which prevents electrons from absorbing and jumping, the electrons do not react, which cannot hinder the passage of light, and the medium is also transparent to light.

### 10.7. Absorption of Light

The energy of the incident light is equal to the energy level difference of the electrons outside the nucleus of the solid substance medium. When the high energy level is stable, the medium absorbs light.

When light enters the boundary of an opaque medium, electrons absorb energy and jump to the last high energy level; however, 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 the 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 a medium, electrons can no longer absorb the energy of the light, nor can they penetrate the medium; instead, they 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 the solid substance medium. The electrons absorb part of the energy and jump to the high-energy stable state, but some of the 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 spreads, and it exits the 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 do not change with the movement of the light source, thus keeping the speed of light unchanged.

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

### 10.11. Wavelength of the Electromagnetic Wave

If an electromagnetic wave is emitted by an electric vibrator (macro), it usually has a small energy and a long wavelength, which is called a radio wave (long wave electromagnetic wave). It has obvious fluctuations, strong detours and weak penetration and can spread around mountains. If it is an electromagnetic wave emitted by electrons (microscopic) outside the nucleus, it usually has a large energy, short wavelength, no obvious fluctuation, no obvious detour, obvious penetration and a small volume. However, it is still an electromagnetic wave, not a substance, not a particle, and it cannot be regarded as a particle. An electromagnetic wave with a wavelength of 380 ~ 780 nm, which is reflected and seen by the human eye, is transmitted to the human eye. It is called visible light (short wave electromagnetic wave). If the energy of the electromagnetic wave is greater (UHF electromagnetic wave), the wavelength is shorter, the detour is not obvious, the penetration is obvious, and the size is less than 380 nm, such as X-ray and γ-ray, but it is still an electromagnetic wave, not only a particle.

## 11. Solid substances, field matter, force and energy

In this work, matter with mass is called solid substances, and the field is called field matter. Broadly speaking, **matter is divided into solid substances and field matter**.

### 11.1. Solid substances

The amount of solid substances is measured by how much mass is the physical quantity used to measure how much (solid) matter there is; mass is the quantity of (solid) matter contained in an object. It is a scalar. If there are more substances, there will be more masses, and the values will accumulate. A solid substance 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, nonsuperposition, noninvasive, and nonduplication. It has shape, size, volume and structure (that is, a single matter).

Solid substances exist in the form of particles. The simplest and most basic particles are composed of a single component, called **an elementary particle**, such as an electron. The elementary particle is the simplest, smallest, most stable, indivisible, unchangeable and nondecaying monomer, its interior is a homogeneous composition of a single component, and it is full of its volume space, that is, solid, such as electrons. Solid substances are not infinitely divisible.

If a solid particle can decay or has a short life, it is not a basic particle but a composite particle. Currently, 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.

The particles are countable, they are monomers, and the monomers are discontinuous and bounded.

Mass is an attribute of solid substances and is defined as the amount of matter contained in an object at the earliest stage. This definition is clear; it has never changed, and there is no dispute. It is necessary to clarify the concept of particles, which refers to how much (mass) can be measured, 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 type of solid substance particle has an independent spatial 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 spherical. Because it has the shape of an exclusive space, it is called a particle.

The mass of solid substances must be a property, 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 solid substances, not other quality meanings, and not energy.

When the position of a solid substance 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 substance in space either does not change or changes continuously and evenly with time, resulting in a static state or a uniform linear motion state. In the nonfree space, there are other solid substance particles in the space, or there are various field substances. In the nonfree space, the solid substance particles are affected by the forces generated by various field substances from the outside, their motion state changes, and their positions no longer remain unchanged or change uniformly. The more solid substances that accumulate, 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 matters

Another existing form of matter is the field, which is called field matter. It is a special form of material that is produced by solid substances, 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 involves exerting a force on the corresponding property (charge amount) of the solid substances in it. In essence, this function is called the basic force, and macroscopically, 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 (magnetic) field state substances, magnetic field state substances, weak nuclear force field state substances and strong nuclear force field state substances, and the categories of the corresponding substances are mass charge (mass), charge, weak force charge and strong force charge. In this paper, this type of attribute is called the **charge amount**.

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

The 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 in the intensity of field matter in space.

$\vec{\Phi}$ is used to represent the field strength of a field substance, and ***Q*** is used to represent the quantity of category attributes of solid substances, which are called **charge amounts**, such as mass charge (mass), charge, weak force charge and strong force charge. The quantity of charge 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 amounts do not originate from a certain field (Higgs field); in contrast, field matter originates from the charge amounts of solid substances.

Field matter is produced by the charge amounts of solid substances and simultaneously exerts a force on the charge amounts of other solid substances. The solid substances that produce field matter constitute the field source. For example, the mass attribute charge amounts ***m*** of a solid substance produce a gravitational field substance, which in turn exerts a gravitational effect on the mass attribute charge amounts ***M*** of other solid substances. The charge amounts attributed to the charge amounts ***q*** of a solid substance produce an electric (magnetic) field state substance, which in turn produces an electric (magnetic) field force on the charge amounts attributed to the charge amounts ***Q*** of other solid substances.

The generation of field matter and the interaction between field matter and solid substances follow the abovementioned orthogonal normalization principle (i.e., orthogonal normalization), which means that only the corresponding charge amounts can produce the corresponding field matter; only the corresponding field matter and its corresponding charge amounts can produce the force, and only the corresponding charge amounts and the corresponding field matter can produce the energy. For example, charge amounts can only produce electric (magnetic) field matter but not gravitational field matter. The electric (magnetic) field matters only produce an electric (magnetic) field force on the charge amounts but not a gravitational force on the mass.

According to the laws 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 amounts of the category attributes of solid substances, so the strength of field matter at a 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 amounts $\boldsymbol{Q}'$ of the other solid substances is as follows:

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

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

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

The intensity of field matter produced by solid substances as field sources is distributed in space according to several laws, such as the laws of universal gravitation, Coulomb's law and Biot–Savart's law. In a local area far from the field source, there are no solid substances and only field matter. At this time, field matter can exist independently of the field source.

The definition of force in Eq. (93) shows that in classical mechanics, when the strength of the field matter is known, the magnitude of force $\vec{F}$ generated by the field matter on solid substances is directly proportional to the mass charge $\boldsymbol{m}$ of solid substances, and the strength $\vec{\Phi}$ of the 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 force-exerting objects and force-exerting objects. According to Newton's third law, they are a pair of acting forces and reaction forces, and the properties (types) of the forces are the same.

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

The gravitational field substance transfers the mass charge between two solid substances, the electric (magnetic) field substance transfers the electric power of the charge amount between two solid substances (as shown in Fig. 1), and the 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 or other propagators, and there are no propagators at all, as shown in Fig. 12.

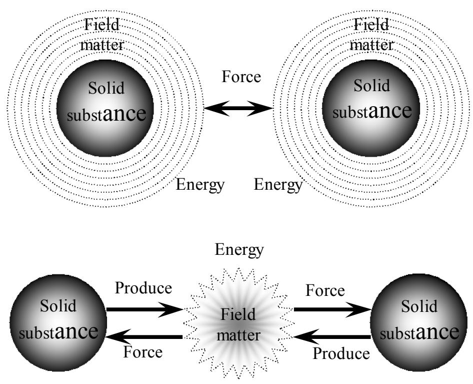



**Fig. 12.** The solid substances produce field matter, and the effect of the field matter on the force of the solid substances.

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

### 11.4. Energy

The force produced by the field matters on the solid substances is conservative, so the solid substances in the field matter have potential energy, which is shared by the solid substances and the field matter. The potential energy of solid substances at a 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 amounts of nuclear substances in the nucleus produce nuclear force field substances (weak nuclear force field substances and strong nuclear force field substances), and the nuclear force field substances simultaneously produce nuclear forces (weak nuclear forces and strong nuclear forces) on the charge amounts of nuclear substances in the nucleus. The nuclear substance in the nuclear force field has 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, a very large amount of nuclear force potential energy, which is **nuclear energy, is released**.

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

Eq. (1) and Eq. (2) indicate that the field 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:

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

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

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

Solid substances produce field matter, which exerts a force on the solid substances. Together, solid substances and field matter have potential energy, and field matter itself has energy. Their relationship is shown in Fig. 12.

The author of this paper has conducted a preliminary study on this topic in [3].

## 12. A New Explanation of the Davisson–Gemma Experimental Pattern

### 12.1. The experimental pattern of the Davisson–Gemma model is not electron diffraction

Imitating light is a kind of wave. Combined with Einstein's hypothesis, De Broglie extended this hypothesis, considering that matter also has waves, that all matter has the nature of waves, and that all matter has both particles and fluctuations, that is, "wave–particle duality".

The Davisson–Germain experiment in 1927 was considered a diffraction experiment involving electron matter waves, which provided undeniable evidence for De Broglie's hypothesis of matter waves.

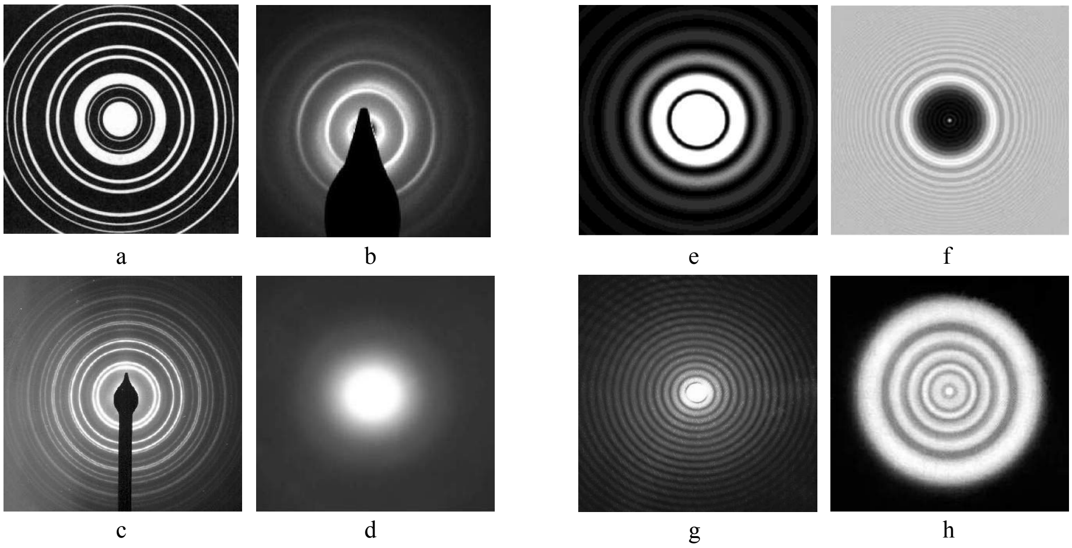
However, the author of this paper provides a completely different explanation for the Davisson–Germer experiment.

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

In the Davisson–Gemma experiment, when electrons pass through a single-crystal nickel powder, the electric field of electrons interacts with the electric field of the nickel atom, which results in scattering and a circular distribution; however, electron waves are not diffracted.

Fig. 13 shows a comparison between the Davisson–Gemma experiment and the light wave diffraction experiment. In Fig. 13(1), **a** is the original picture of the Davisson-Gemma experiment in the textbook [11] (Fig. 1.4 is a picture of electrons diffracted by the ordered alloy **$Cu_3Au$**), **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 the light and dark stripes in the Davisson–Gemma experiment are very uneven, whereas the spacing and width in the light diffraction experiment are relatively uniform. Obviously, there is no similarity between them, and they have different principles. The fringe of the diffraction experiment pattern of light shows that light is diffracted, which is characteristic of fluctuation, but **the electron pattern of the Davisson–Gemma experiment is not a diffraction pattern, and the electron does not diffract, which shows that the electron has no fluctuation**.

The correctness of the "De Broglie Hypothesis" described in the textbook was confirmed by electron diffraction experiments conducted by Davidson and Gemma in 1927. After an electron beam passes through a fine crystal powder or thin metal sheet, it also results in diffraction, such as X-ray diffraction. 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 the diffraction wavelength and particle momentum, which is obviously not true.




(1) Davisson–Gemma experimental pattern

(2) Experimental pattern of light wave diffraction

**Fig. 13.** Comparison between the Davisson–Gemma experimental pattern and the light wave diffraction experimental pattern.

### 12.2. A New Explanation of the Davisson–Gemma Experimental Pattern

In this paper, the author provides a new explanation for the electronic pattern of the Davisson–Gemma experiment, as shown in Fig. 14, Fig. 15 and Fig. 16. The atoms in the metal crystals are arranged regularly, and an electric field is generated in the surrounding space of the 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 a crystal atom interacts with the electric field of the electron, which is reflected by the crystal surface or enters the crystal. After many interactions, a small number of electrons have difficulty penetrating through the thin crystal and redistribute in the back space, carrying the characteristic information of the 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.

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

The microscopic mechanism of the Davisson–Gemma experiment is that when the electron beam hits the crystal surface, the surface atoms first block most of the electrons, which are reflected by the surface atoms and spread back. It carries the characteristic information of the crystal surface, and the pattern of the crystal surface can be determined by collection and processing. This is the principle of a reflective electron microscope. Other electrons pass through the gap between atoms on the surface of the crystal and enter the second layer of atoms, and most of them are reflected by atoms. Only a few electrons can pass through the gap between atoms and enter the following layers of atoms. Finally, only a few electrons can penetrate all the atomic layers of the crystal and finally reach the screen, exciting visible light and forming patterns. This is the principle of transmission electron microscopy, 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. In contrast, the thinner the crystal is, 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. A stable electron beam is injected into a crystal with regularly arranged atoms so that the electron distribution is stable and a stable pattern is formed.

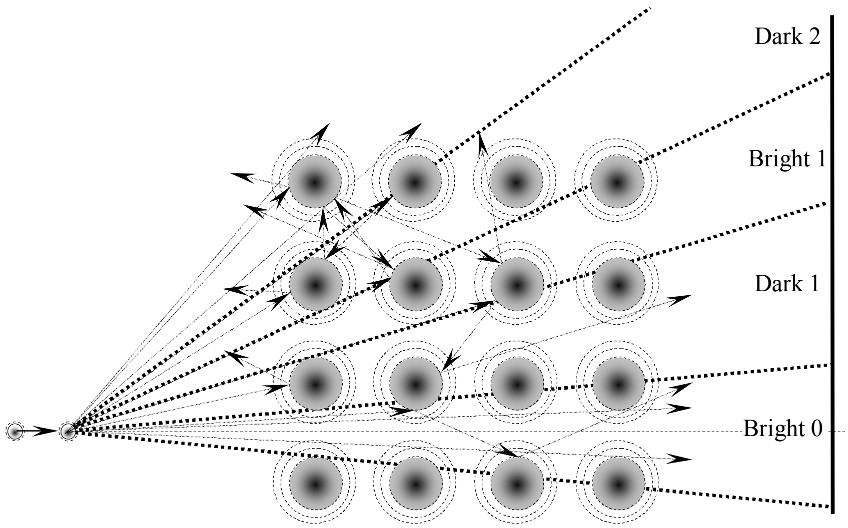



**Fig. 14.** Microscopic mechanism of the Davisson–Gemma experiment.

When there is an angle between the electron at the edge of the 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 beams passing through single crystals, quasicrystals, polycrystals and amorphous materials are different. The patterns passing through single crystals and quasicrystals are sharp and clear, which can indicate the arrangement of the crystals. The patterns passing through a single crystal are clearly arranged in a series of circular rings, whereas those passing through polycrystalline rings are relatively clear single circular rings, whereas those passing through quasicrystals are relatively vague single circular rings, and those passing through amorphous rings are very vague single circular rings.

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 charged differently and are affected by the electric field outside the nucleus of matter.

As shown in Fig. 15 and Fig. 16, the analysis of the two patterns reveals that the bright stripes in the dark region and the dark regions are wider than those in the bright region are because the atoms in the first layer on the surface of the crystal have a more obvious shielding effect on electrons, and the atoms in the latter layers continue to shield them. At the center of the electron beam, the incident angle of the electrons is small, and the more difficult it is to block them by the atoms of the crystal, the fewer dark stripes there are, such as the bright **0** region and the bright **1** region in Fig. 15. There are also scattered electrons in dark areas, such as the dark **1** area in Fig. 15. At the edge of the electron beam, the electron incident angle is large, and it is easily blocked by the atoms of the 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 the 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.

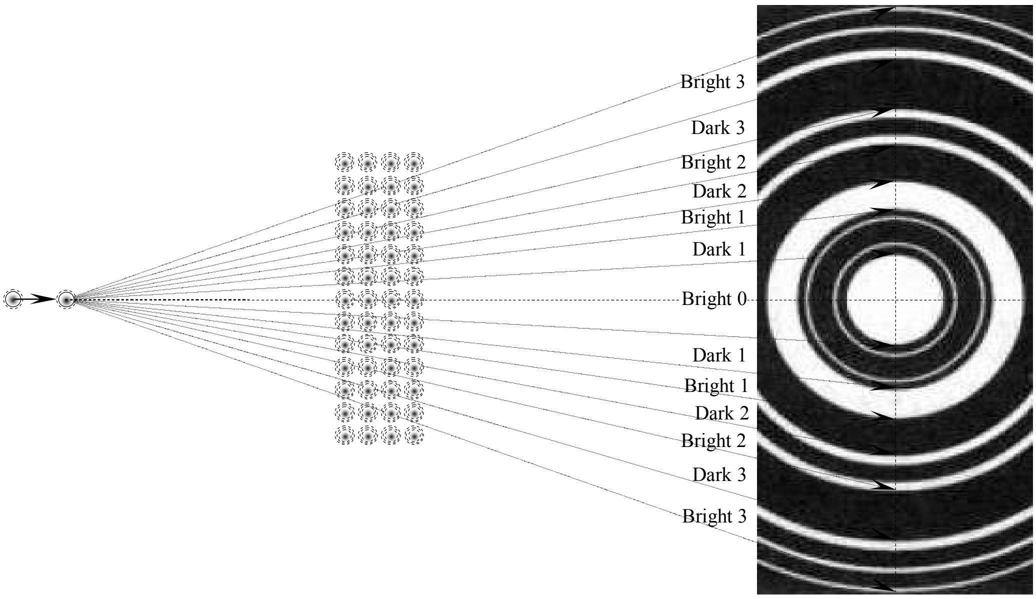



**Fig. 15.** Pattern analysis of Davisson–Gemei experiment 1

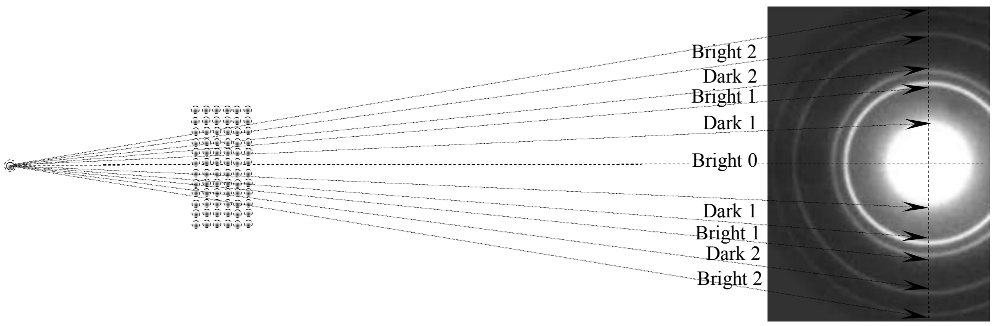


**Fig. 16.** Pattern analysis of Davisson–Gemei experiment 2

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

Mr. Zeng Jiqing of South China Botanical Garden, Chinese Academy of Sciences, has a similar view[12].

### 12.3. A New Explanation of the Principle of Electron Microscopy

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

To make the electron microscope image clear and sharp, it is necessary to increase the accelerating voltage and electron velocity, thus increasing the electron momentum and reducing the influence of the electric field of the observed substance on the electrons. The thinner the electron beam is, the more concentrated the electrons are, the stronger the penetration ability of the 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 an ordinary light source are strong evidence that light is a wave rather than a particle. Similarly, the Davisson–Gemma experiment provides strong evidence that electrons are particles rather than waves.

Regardless of whether the light passes through a single slit, a double slit, a multislit or a grating, the pattern generated is a diffraction or interference phenomenon of light waves. Regardless of whether electrons pass through a single crystal, polycrystal, quasicrystal or amorphous or through a single slit, double slit or multislit, the pattern generated is not a diffraction or interference phenomenon but rather a 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 "multiworld" 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. This 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 yield a different uncertain relationship. In the new atomic model of Fig. 3 ~ Fig. 6, the center position of the 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 the position is within half a wavelength, that is, $\Delta x \leq \lambda / 2$. From ***p=h/λ***, the "uncertain" range $\Delta p = h / \lambda \leq h/(2\Delta x)$ of momentum is obtained. The "uncertainty relation" of position and momentum is obtained:

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

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

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

Similarly, the "uncertainty" range of electron time in the wave packet is within half a period, that is, $\Delta t \leq T/2 = 1/2\nu$, and the "uncertainty" range $\Delta E = h\nu \leq h/(2\Delta t)$ of energy is obtained from ***E=hν***. The "uncertain relationship" between energy and time is obtained:

$$\Delta t \Delta E \leq \frac{h}{2} \tag{100}$$

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

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

## 14. Discussion on Other Issues

### 14.1. The essence of new quantum mechanics

**The** above discussion **shows that the essence of new quantum mechanics is** the **Compton wavelength (*mvλ=h*), standing wave condition and quantization principle.**

From the above discussion, as long as the cause of **the** fluctuation is clearly defined, its essence is only **the Compton** wavelength relation **in** Eq. (7), its standing wave condition **in** Eq. (10) and **the** quantization general rule **in** Eq. (11). As long as the cause of **the** fluctuation is clearly defined, two expressions **related to** Eq. (8) and Eq. (9) can be derived by using **the Compton** wavelength relation **in** Eq. (7). In fact, the mystery of quantum mechanics lies in Eq. (7), which shows that any substance has **fluctuations** and **that** its wavelength is restricted by the quality of **the** substance. When the mass of microscopic matter is small, its wavelength is long, and its fluctuation is obvious. When the mass of macromatter 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.

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

$$n\frac{\lambda}{2} = l \tag{10}$$

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

When hydrogen-like atoms **are solved**, the nucleus is regarded as fixed, and it can be easily solved by **the** standing wave condition **shown in** 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 be solved **only** by Sommerfeld's general principle of quantization **(**Eq. (11)**)** so that the fine structure of **the** hydrogen atomic energy level spectrum can be solved. Any other complex system can be solved via Sommerfeld's general principle of quantization without **the use of** 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 **does not** know what it is, what it means and what it is fluctuating. **Since** the beginning, many embarrassing problems **have been identified** in this theory, **and** the future road **has** not **been** smooth.

The significance and explanation of **the** wave function is **highly difficult** in this theory. Later, according to the diffraction pattern of electrons, the stripes of **the** pattern were the "probability distribution" of "particles" hitting the screen, the wave function was not a real wave but **rather** a "probability wave" or "probability amplitude", and the square of **the** wave function represented the "probability density of finding particles" [13], 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 **the** 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 **that** describes the **relationships among** wave parameters. It is only the solution of **the** wave equation and cannot represent the matter itself. Eq. (16) clearly **shows** that the generalized field (field state matter) **clearly** fluctuates, not the particle, not the probability density, and the wave function reflects the distribution and change **in the** real generalized field (field state matter) in space, not the illusory probability density.

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

### 14.3. The Schrodinger equation is not a wave equation.

**The** Schrodinger equation is constructed by a plane wave function combined with **an** energy relationship. **Without the form and characteristics of the above wave equation, the Schrodinger equation is not a wave equation, and its solution cannot represent waves, so it does not have the meaning of a 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 microworld, and the imaginary part also has 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 the 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 Sommerfeld's general principle of quantization is used to solve it.

### 14.4. Basic assumptions of the quantum mechanics theory of Copenhagen School

There are five **basic assumptions** in the quantum mechanics theory of **Copenhagen School**[14]: (1) **the** wave function assumption, (2) **the** mechanical quantity operator assumption, (3) **the** eigenvalue probability and average value assumption (including probability explanation), (4) **the** Schrodinger equation, and (5) **the** 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. **The volatility** hypothesis, quantization principle, **Einstein–de** Broglie relation, Bohr quantum hypothesis, electron spin, etc., were first **proposed** in the form of **hypotheses**.

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 provide a reasonable explanation for these assumptions**. **However,** they are still only based on a **single** 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 **do not** understand it and **cannot** determine it **does**

**not** mean that it is not true. How can you say that "uncertainty is an inherent attribute of itself"?

The wave function of **the** basic theory of quantum mechanics is solved **via an** 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 **a** probability? The law of an equation is deterministic. How can the result of **the** solution be said to be uncertain?

Physics studies the objective material world, and its task is to **determine** the most essential truth of **the** 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 **that is** guided by dialectical materialism philosophy, **is** based on logical reasoning, and **is** calculated by mathematics as a tool. It must be reasonable and self-consistent to explain the results combined with scientific practice, 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 **cannot** produce real results.

It seems that the quantum mechanics theory of **Copenhagen School** has not grasped a reliable "physical model". **Initially**, a physical model**,** light (electromagnetic wave), **was used;** 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 **work**, there is only **one physical model: the generalized field forms a 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 the Photoelectric Effect

The photoelectric phenomenon was discovered by Hertz in 1887 and is **now** widely accepted as an explanation by Einstein. **The photoelectric** effect is the effect **in which** the metal surface emits electrons under the action of optical radiation, and the phenomenon of **photoelectrification** is collectively called **the photoelectric effect**. When light strikes a metal, electrons escape from the metal. Experiments **have shown** 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 **or** how long the irradiation time is, no electrons are generated. The energy of electrons is related **only** to the frequency of light but has nothing to do with the intensity of light. The higher the frequency of light **is**, the greater the energy of **the** electrons. The intensity of light only affects the number of electrons. As the intensity increases, the number of electrons increases. These laws of **the** 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 **refers to** emitted **electron** photoelectrons. He **suggested** 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 **type** of particle is called **a** 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 **the** 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:

$$\frac{1}{2}mv^2 = h\nu - W_0 \tag{101}$$

**where** ***m*** is the mass of **the** electron, ***υ*** is the velocity of **the** electron leaving the metal surface, and $W_0$ is the work that the electron needs to do to leave the metal surface, which is called the work of leaving. If the energy ***hv*** 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 **affects only** the number of light waves. There are more photons and more photoelectrons. In this way, the photoelectric effect**, which cannot** be explained by classical theory**,** is explained. Einstein won the Nobel Prize in physics for his explanation of **the** photoelectric effect.

However, Einstein's explanation of **the** 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 **the** metal. According to the law of conservation of momentum, when part of **the** energy of photons is transferred to electrons, the energy of photons is reduced and **bounces** back, and electrons are punched into the metal without leaving the metal. The frequency of bounced photons decreases **with decreasing** energy. Thus, **Einstein's explanation of the photoelectric effect is wrong.**

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

Now**,** the photoelectric effect can be well explained by the new quantum mechanics theory. **An** analysis of **the** essence of light in new quantum mechanics **reveals** that light is **an** electromagnetic wave, not material particles, and **that** one part of **the** energy carried by light **waves** 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, **overcoming** the **bonding** of atoms**, leaving** the metal surface, and **entering** the free space to become free electrons. The free electrons continue to spread in the state of motion when they are detached, and the kinetic energy is mv2/2, which is the essence of **the** photoelectric effect. The work that needs to be done to **eliminate atom constraints** on electrons is called the work of **eliminating the** metal surface, and the energy relation still satisfies the above formula **for the photoelectric effect equation**.

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

**14.6. There is no "wave–particle duality".**

First, 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.

**Waves are** a manifestation of physical quantity. When a physical system is disturbed, the disturbance can form a wave when it propagates in space. **A** wave is the periodic dynamic distribution of **the** 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 **the** medium. **A mechanical** wave is the dynamic distribution of **a** whole solid **substance** particle medium **that is** disturbed in space, and **an** electromagnetic wave is the dynamic distribution of **an** electromagnetic field **that is** disturbed in space.

**The physical** quantities **used to describe** waves include wavelength, frequency, phase, wave velocity, and **amplitude**.

The characteristics of waves **include** 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 **is** not accelerated or decelerated. Without the process of acceleration or deceleration, the direction of wave propagation **does** not **change**. When the wave source vibrates, it immediately fluctuates and propagates at a constant wave velocity.

Relative to the medium, the motion of **the** wave source does not affect the propagation velocity **or** direction of **the** 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 wave **properties** determine the unique behavior of **waves**, which is also obviously different from the properties of solid substances.

Waves need a medium in the process of propagation. **The matter** is the medium for wave propagation, while solid substances **propagate** mechanical waves, and **the** electric

**field matter propagates** electromagnetic waves.

**Waves are a form of movement and change in matter, not matter.**

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

Planck first **proposed** the concept of "**energy quantization**". When **a** black body radiates and absorbs electromagnetic waves, it radiates and absorbs electromagnetic wave energy one by one. The concept of **a** "quantum" is very clear. When Einstein explained the photoelectric effect, he extended the radiation energy of **a** blackbody to the energy of light and regarded the energy of light as light particles, which **were** called photons for short, and thought that such photons were matter particles. It is known that light is **an** electromagnetic wave, and Einstein thinks that light is still **a** 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 **proposed** the concept of **a** matter wave. Therefore, both light and matter **are considered to** have the dual nature of **fluctuations and particles**, which is called the "**wave–particle** duality" of light and matter.

**Waves** and **particles** are completely different concepts, and their concepts and essence are very different. They have no similarity, are completely incompatible and have no intersection. **The fluctuation** and particle nature cannot be used to describe the properties of **the** 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. **Even if a wave has a shorter wavelength, it** is still a wave **that is still moving or changing in the** medium, and it **cannot** become a substance, let alone a substance particle. **When any** substance **is** used as a medium of fluctuation, **it** is only a medium of fluctuation and cannot be **a** form of fluctuation itself. The concept of "**wave–particle** duality" is unimaginable and incomprehensible.

**An** experiment **on the** photoelectric effect and Einstein's explanation of **the** photoelectric effect **cannot** say that bright light has particle **properties**, let alone "**wave–particle** duality". His explanation is wrong. The **Davisson–Gemma** experiment, as well as other related experiments, **cannot** show that the solid substances **are volatile**.

### 14.7. Compton Effect

When **Compton** studied X-ray scattering through solid substances in 1923, X-rays with longer **wavelengths** in the scattered light **were found**, and the **increase in** 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 **the** energy of an X-ray wave**. The** scattered energy of X-ray waves decreases, the frequency decreases**,** and the wavelength becomes longer. **Moreover**, when X-ray waves exchange energy with electrons, they obey the law of conservation of energy so that the **increase in** wavelength changes with different scattering angles, and **the** wavelength is λ=h/mc. This is the essence of Eq. (3)**, where** $m\upsilon\lambda=h$.

### 14.8. Barrier penetration

A particle with low energy cannot pass through a barrier with higher energy than it **does** 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 **the** wave function, the barrier can hinder or shield **only** the corresponding generalized field (that is, field state matter) that forms this barrier and has no effect on other generalized fields. **The** generalized field can only produce energy and force with the corresponding generalized quantity.

**According to** the previous analysis of **the** electric field between two charge amounts and the collision between two balls, **the field matters that runs through the high barrier, not the solid substance particles**, and the **field** matters has superposition and can cross the barrier. However, there is no case **in which** the particles of solid substances can penetrate the barrier and move to another area of **the** 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**, extranuclear electrons **that** appear with a certain probability in space limited by **the** energy level.

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

Make an image metaphor: **The orbit description is similar to ordinary video, the electron cloud description is similar to photography, and the electric field standing wave packet description is similar to 3D video**. There are no orbits outside the nucleus, **the** 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 **a** structure, size, volume and shape, and the transition of electrons between energy levels is also a process **that** takes time, **is** omnibearing and **is** detailed.

### 14.10. Normalize

In the quantum mechanics theory of **Copenhagen School**, there are complex numbers in **the** 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 **the** Schrodinger equation, even **when** the velocity, frequency and wavelength of **the** standing wave **cannot** 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 **much** of the most critical information. If the dimensions of **the** wave function are the strength of **the** generalized field and the amplitude of **the** wave function, these two pieces of information are the most critical physical quantities, which precisely reflect the physical significance of **the** 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 **the** Copenhagen School, Einstein **did not** 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 **did not** find hidden variables, and **the** EPR paradox and **Bell** inequality were **proposed on the basis of** this problem. **The** Bell inequality describes this locality relation, **indicating** that if **the Bell** inequality holds, there will be incompleteness of locality, and vice versa. **This** means that quantum mechanics violates the localization principle or counterfactual accuracy and that some quantum effects seem to be able to travel at superluminal **velocities**. Experiments prove that **Bell** inequality is not established, which of course denies the necessity of **the** existence of "hidden variables", but it is not certain that the quantum mechanics theory of **Copenhagen School** is complete. **The** concepts of "probability, uncertainty, superposition of states, electron **clouds, etc.**" in quantum mechanics and "quantum entanglement, wave function collapse, quantum fluctuation**, etc.)** do not exist. **This is because we do not 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 **indicates** that **field matter is fluctuating and that field matter is a 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 **velocities, positions, wavelengths and amplitudes are** 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, a certain field substance of things exerts a force on the sensors, the sensors change, and finally**,** people feel the situation of things. **Typically, a** change **in a** sensor is converted into **an** optical signal, which makes people see and feel the existence and situation of things.

People cannot directly measure and observe the situation of the micromaterial world but can only do so indirectly with the help of the sensors of the instrument. After in-depth research in [9], the author suggested that all the noncontact observation results reported by using light waves (or other waves) as messengers are not true, and the observation results need to be corrected by the inverse transformation in this paper to obtain real results.

### 14.13 Planck scale

Planck mass: The Planck mass is the dividing point between the macroscale and microscale. When the mass of matter is greater than the Planck mass, its behavior is certain, as it shows macroscopic material characteristics. When the mass of matter is less than the Planck mass, its behavior is uncertain and shows microscopic quantum characteristics. This characteristic appears to be the result of the gravitational field effect.

$$m_p = \sqrt{\frac{\hbar c}{G}} = 2.17651(13)\times 10^{-8}\, kg$$

Planck length: meaningful minimum measurable length.

$$l_p = \sqrt{\frac{\hbar G}{c^3}} = 1.616224(12)\times 10^{-35}\, m$$

Planck time: the smallest interval between time quanta, and there is no shorter time.

$$t_p = \sqrt{\frac{\hbar G}{c^5}} = 5.39116(13)\times 10^{-44}\, s$$

At present, the physical meaning of the Planck scale [15] is not known.

The author of this paper believes that the Planck scale is only three scales pieced together by dimensional analysis, which has no physical significance and cannot be overinterpreted.

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## Postscript

In this work, the author studied physics at Guizhou University in 1987 and studied the Quantum Mechanics Course (1979 edition) written by Zhou Shixun when he was in the fourth year of college in autumn 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 could not understand many questions. I asked Mr. Yang Bangjun, who said that this is a new theory. Unlike classical theory, many problems have not been solved, which is highly controversial. I saw Zhou Shixun write in the conclusion at the end of the 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. With respect to 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 quantization hypothesis. For decades, 25 top physicists in the world have participated in the creation of quantum mechanics, among which 12 physicists won the Nobel Prize in Physics, and many physicists later won the Nobel Prize in Physics.

I started thinking from light, and light is an 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, was invited to participate in an academic seminar on the centenary of De Broglie's birth and the history of quantum physics sponsored by the China Academy of Sciences, and distributed it to the participants.

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

The abridged English version of the field meaning of the wave function has been published on the preprint website of Nature [16].

The author always believes that the objective material world is as follows:

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 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 relationships between the parts form a causal relationship according to the time sequence of occurrence.

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

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 the 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 the 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 the objective material world can it be a correct theory.

People have an incorrect understanding of the 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 the objective material world are expressed in complex forms, and people can feel and see them.

People think, analyze and judge the perceived information, identify and sort out laws, constantly improve and sublimate, and obtain laws close to the truth of the 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, 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 simpler 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 large formulas are often wrong.

8. From simplicity to complexity, the objective material world has developed and changed 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 repeatedly stressed that scientific theory should conform to common sense, rationality and objective facts and adhere to scientific unity and consistency, which has a great guiding role in scientific research. Basic facts and basic logic are the basis of the objective existence and laws of the 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 the theory is tested, and finally, the correctness of the theory is tested via experiments.

10. Scientific theory: In the process of understanding the objective material world, people have summarized several methods, including prophetic, philosophical and scientific methods. The effective method is scientific and 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 an identity; that is, it is formed by the combination or evolution of basic substances, and the physical laws are universal. Their combination has laws and logic, and determining their laws is the purpose of theoretical physics research. This requires logic. Mathematics is an advanced form of logic that 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 laws, and this law is the truth of matter. The 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 always exist, 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 an 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 are used to study people's thinking activities in their minds. Mathematics is more rigorous logic, and quantitative relationships are more accurate logic. The relationships among substances are expressed in mathematical language, laws are concluded by reasoning and checked via 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 use only logical thinking, we can obtain only a rough understanding, but we cannot obtain accurate laws, and even more are unconstrained nonsense. In particular, many enthusiasts do not have the ability to describe mathematics, think about irrelevant things and waste energy and time.

These are just basic experimental phenomena, not rules. Without rules, we do not know why this is the case, and without rules, we do not 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 do not know its law, you will not understand that lightning, friction electrification, power generation and battery electricity are the same thing, let alone that electricity and magnetism are related, and you cannot 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. The method involves dialectical materialism and the 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 commonality of these properties is the law that 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 is the reason for material existence and movement and is not chaotic or unpredictable. This reason is logical. From this point of view, logic is both basic and simple, and the more basic and simple the law is, the more universal it is, and the complex is composed of simple ones. Logic is a 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 the objective world, but it does not necessarily represent the essence of the objective world.

However, experimental testing is not a basic and simple method but rather a simulation method. Owing 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 strengths of the whole country. It is difficult for others to reproduce them and perform repeated tests. Often, a monopoly of the right to speak is formed; he says what he says, others cannot repeat the test from the experimental method and cannot be questioned. There are too many such examples, such as colliders, astronomical interferometers and Mozi satellites.

People do not 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. However, 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 the microscopic material world. In the quantum mechanics theory of the Copenhagen school, people's research on the microworld is the "observation effect" when "people" look at the world. If you cannot see the details and process of the micromaterial world, you cannot see the real microworld, not the truth of the microworld. What the theory describes is not the "real" movement law of the micromaterial 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 being "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 does not exist without looking at the moon".

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

People live in the macro world, are familiar with the macro world, and are unfamiliar with the micro world; thus, they are full of mysteries about the micro world, are 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 microlevel, high-speed and low-speed, let alone follow several incompatible laws but rather unified laws. If several incompatible theories are treated differently, it must be wrong.

In reference [3], the author not only analyzes the mistakes in the theory of relativity but also establishes a new relationship between time and space and analyzes the relationships among matter, space, time and motion.

The author suggested that these basic root concepts, such as matter (mass), space (length), time and charge (electric quantity), have independent meanings and that there is no essential connection between them, but they are independent of each other. Other subordinate concepts are defined by the combination of these root concepts.

No one can accurately describe them in any language or vocabulary; that is, they cannot be defined. We can only illustrate their meanings with examples. This is called explaining concepts and allowing everyone to understand their meaning. This is the only way to do it. We cannot give them an accurate definition.

These viewpoints include the following: the universe is nothingness, the world does not exist, quantum fluctuations, matter fluctuating out of nothingness, mass–energy conversion (energy is converted into the mass of matter, and mass is converted into energy), multidimensional space and multidimensional universe, time does not exist, the speed of light is constant (in any reference system), mass increases with speed, length decreases with speed, time slows down with speed, singularity, BIGBANG, black hole, and white.

In reference [3], the author noted the following:

Mass is the number of substances contained in an object, which is an intrinsic property of an object. It does not need to be externally endowed with mass, and its number has nothing to do with whether the object is moving or not; it has nothing to do with whether the object is attracted or not and has nothing to do with all the states and forms of the object. When an object is moving and changing, as long as the substance contained in the object is not transferred, its total amount is constant, which is the law of immortality of the substance and conservation of mass.

Newton reported that there is universal gravitation between any matter and that the gravity of other objects is directly proportional to the mass of the object, that is, all. However, this does not mean that mass can be characterized by gravity; that is, "gravitational mass" is meaningless.

Inertia is not represented by symbols, inertia does not specify physical quantities that can participate in calculation, and Newton's law of inertia does not have a mathematical expression but uses mass to measure the size of inertia. If m is used to represent the inertia of an object and m is used to represent the mass of an object, then $M=km$, and the ratio $k=1$ is considered.

Inertia is related only to mass and has nothing to do with all other factors. Inertia is not mass, inertia is not a force, and inertia is only the motion characteristics of objects when they move. Inertia cannot be equated with gravity, and inertia cannot be attributed to the interaction between objects. That is, "inertial mass" is meaningless.

Therefore, "inertial mass" and "gravitational mass" should be eliminated, and only the concept of "mass" should be retained.

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