

Giving quantum mechanics wings of 'force'

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Abstract

There have been no reports on the operators of force and the equations of wave mechanics containing force, as well as the representation of Newton's second law and the law of conservation of momentum using wave mechanics methods. It is necessary to explore the method of describing the action of force using wave mechanics. By carefully analyzing the composition, structure, and function of the Schrödinger equation (SC), it was found that it is a product of the organic combination of classical mechanical laws and wave functions. Starting from $F=ma$, SC can be derived. $F=ma$ can be precipitated from SC. The operators for physical quantities, such as mass, force, potential energy, etc., can be derived from SC. The wave equation with force has also been established. The law of conservation of momentum, Newton's second law, and Viry's theorem can also be expressed by the wave equation. According to SC, it can also be demonstrated the quantitative relationship between the wave and particle properties of moving particles. Through the experiment of "magnetic field and light interfering with electron diffraction", it can also be observed that moving particles undergo diffraction while complying with Newton's second law. The conclusion is that "quantum" and "classical" can be combined: quantum mechanics allows classical mechanics to be compatible with itself and can describe forces in the microscopic world.

1. Introduction

Having achieved the goal referred to in the title of this article, we can say the following sentence with great weight: "The wave equation that can calculate the force between electrons and nuclei in atoms" has appeared for the first time in human vision. Please listen to the author slowly.

Electrons in atoms and molecules cannot escape their attraction on their own. Numerous experiments have shown that in order for electrons to dissociate from atoms and ionize, energy must be provided to overcome the attraction of the nucleus (all processes that cause the cathode to emit an electron stream are processes that overcome the attraction of the nucleus electrons). Even if extranuclear electrons travel far away, they will return to the vicinity of the nucleus. The fact that hydrogen molecules are very stable cannot be explained from the perspective of dynamics and structure (the best explanation for this is that the system has reached mechanical equilibrium. The electron cloud diagram of hydrogen molecules is not a schematic diagram of its mechanical equilibrium structure, and cannot explain the balance between repulsive and attractive forces between nuclei). People use the concept of electron cloud repulsion derived from the concept of probability density. In fact, they use the electron's ability to "maintain its nucleophilic quirk and teleport" to illustrate the arrangement and movement of electrons outside the nucleus. For intermolecular interactions, it is acknowledged that van der Waals forces, dispersion forces, and induction forces exist. We don't talk about the effects of force inside atoms and molecules, but we must talk about the effects of force outside of atoms and molecules. This quantum theory is extremely uncoordinated (it should be noted that molecules also belong to the microscopic category). Furthermore, the relativistic effect of the energy and mass of the 1s electrons of all elements' atoms will increase with the increase of nuclear charge. This indicates that the more nuclear charges there are, the greater the attraction to 1s electrons. All of these reflect that the micro world cannot do without the influence of force. Since electrons in atoms and molecules cannot escape the attraction of electromagnetic forces, the major flaw of quantum mechanics is that it does not describe the concept of force and does not describe its effects. A considerable number of people are confused about the existing quantum mechanics.^[1-3] Perhaps after overcoming this major flaw, these people's desire to eliminate confusion can be fulfilled. It can be foreseen that overcoming this deficiency on the basis of ensuring that the existing mathematical system of quantum mechanics is not

changed can become the preferred research topic. The preliminary research results of choosing this topic in this article are: establishing a wave mechanics equation containing force; Established operators for classical physical quantities such as potential energy, mass, velocity, and force; The wave mechanics equations of "conservation of momentum law, Newton's second law, and Viry's theorem" have been derived (see sections 5, 6, and 9 for details). For the first time, the use of wave equations to calculate force desires in atoms has been achieved. Based on these achievements, a theoretical system for wave mechanics expression and operation of classical mechanical physical quantities and classical mechanical laws can be established.

The content of each chapter is arranged as follows.

This article focuses on the argument that "quantum mechanics can be combined with classical mechanics" and is divided into the following 10 chapters for discussion. 1. Introduction. 2. Export the quantitative relationship between the wave energy and particle energy of moving particles. 3. Prove the implicit Viry theorem in the Schrödinger equation. 4. Derive $F=ma$ from the Schrödinger equation of the hydrogen atom, and derive the Schrödinger equation from $F=ma$. five Export the wave equation containing force. 6. Introduce the operator of force, Newton's second law expressed by wave mechanics, and the law of conservation of momentum. 7. Introduce the experimental results of the anti-interference ability of electron diffraction. 8. It is predicted that the Schrödinger equation, which can describe macroscopic systems, can be established (as verified by references ^[4-8]), so that quantum mechanics and classical mechanics can be used together (as verified by references ^[9-12]). The problem of atomic stability caused by the use of classical mechanics will be solved by the next level of material structure theory ^[13-15]. 9. Derive the correct Schrödinger equation based on the Wigner/Stone theorem. 10. Conclusion. It is interesting that Section 6 introduces new mathematical knowledge about the operation rules of operators themselves.

Due to classical mechanics being a theory that primarily considers the effects of forces. Therefore, proving the compatibility between "quantum" and "classical" (the two can be used in combination) is proving the non repulsive effect of quantum mechanics. To give quantum mechanics wings of force, we will start by proving quantum and classical compatibility (the two can be used together). At the stage of establishing a wave mechanics representation method for classical mechanics laws, This strengthens the conclusion that quantum and classical can be compatible (completing the theoretical proof work). We have theoretically proven that 'the action of forces described by wave mechanics is permissible' and 'classical mechanics and quantum mechanics can be combined for use'. As for whether it can be achieved technically, it is answered with examples by references ^[9-12]. For describing the effects of forces in microscopic realms, as long as it is theoretically possible and technically feasible, 'old ideas do not allow' becomes less important.

2. Export the quantitative relationship between the energy described by the wave pattern of moving particles and the energy described by the particle pattern

This section explores the relationship between the wave energy of de Broglie waves, the wave energy of wave functions, and the kinetic energy of moving particles. In the process of establishing his famous equation, Schrödinger initially chose the energy of the de Broglie wave as the relativistic energy $E=\sqrt{m^2c^4 + p^2c^2} = \gamma mc^2$. However, it was not successful (no calculation results consistent with Bohr's planetary model were obtained). Later, Schrödinger changed the energy of de Broglie waves to the kinetic energy of moving particles, and in the wave function of the Schrödinger equation, he used the energy form of $E=hv$. He succeeded this time. However, there is a contradiction: $E=hv$ is the total energy of the wave in the wave function, which should correspond to the energy represented by the gamma mc^2 of the moving particle, rather than the kinetic energy of the particle. This is Schrödinger's subjective choice. Now, we are accommodating Schrödinger's choice and seeking the relationship between $T=\frac{1}{2}mv^2$ and $E=hv$. The idea is that we first assume $\frac{1}{2}mv^2 = khv$. Then, based on the fully accepted Schrödinger choice, we find the value of k (*i.e.*, we also need to find it in the correct Schrödinger equation). Attention! Since the Schrödinger method is effective, it indicates that his choice is reasonable. If

both the wave function and the de Broglie wave are regarded as "waves of medium like vibration" (*i.e.* waves whose wave energy does not include the internal energy m_0c^2 of the medium), the "contradiction" mentioned above is alleviated. However, in the future, we can no longer say that 'using waves to describe moving particles is a complete wave'.

The hydrogen atom model is a planetary model. Therefore, we start with the Schrödinger equation of the implicit virial theorem. The Schrödinger equation for a hydrogen atom is

$$-\frac{\hbar^2}{2m} \frac{\partial^2}{\partial x^2} \psi + V\psi = E\psi. \quad (1)$$

The wave function used by Schrödinger is

$$\psi = \psi_0 e^{-\frac{i}{\hbar}(Et - px)} = \psi_0 e^{-i2\pi(vt - x/\lambda)}. \quad (2)$$

Calculate the first term of Eq. (1) based on the two equivalent exponential functions on the left and right sides of the equal sign in Eq. (2). We can obtain $\frac{p^2}{2m} \psi = \frac{mv^2}{2} \psi = T\psi$ and $\frac{\hbar^2}{2m} \left(\frac{2\pi}{\lambda}\right)^2 \psi = \frac{(h\nu)^2}{2mv^2} \psi$, respectively. When using the exponential function on the left side of the equal sign in Eq. (2), we intentionally use classical mechanics laws. When using the exponential function on the right side of the equal sign, the relationship between $\lambda = h/mv$ and $v = \lambda\nu$ in the fluctuation law was employed. Since the equations $\frac{mv^2}{2} \psi$ and $\frac{(h\nu)^2}{2mv^2} \psi$ are derived from two completely equivalent wave function expressions and the same term in Eq. (1), the equation $\frac{mv^2}{2} = \frac{(h\nu)^2}{2mv^2}$ must hold, and the result is $(mv^2)^2 = (h\nu)^2$. If the square roots are all positive, then, we have

$$\left. \begin{array}{l} mv^2 = h\nu \\ T = \frac{1}{2} h\nu \end{array} \right\}. \quad (3)$$

This indicates that in the two recognized energy representations implied in the Schrödinger equation for hydrogen atoms, kinetic energy is only half of the energy value represented by the wave law. At the same time, it indicates that the wave of the wave function (the noumenon of the wave function) is not consistent with the de Broglie wave.

If the potential energy of a moving particle is zero, it is a free particle, and the Viry theorem no longer applies to it [one manifestation is that the sign of E in Eq. (1) has changed]. Eq. (1) becomes $-\frac{\hbar^2}{2m} \frac{\partial^2}{\partial x^2} \psi = E\psi$. Except for the internal energy mc^2 , the total energy of a moving particle is equal to its kinetic energy (considering energy conservation or the energy of the same particle, expressed by the wave law as $kh\nu$). The $kh\nu$ must be equal to $\frac{1}{2}mv^2$. So, we can obtain Eq.

(3). The E in $-\frac{\hbar^2}{2m} \frac{\partial^2}{\partial x^2} \psi = E\psi$ is $\frac{1}{2}h\nu$. If we use the partial derivative of the wave function over time $\frac{\partial}{\partial t} \psi$ to represent its operator, we need to make $f(i, \hbar) \frac{\partial}{\partial t} \psi = \frac{1}{2}h\nu\psi$. By solving this equation, we can obtain the relationship between $f(i, \hbar) = \frac{i\hbar}{2}$

and $\hat{E}_k = \hat{T} = \frac{i\hbar}{2} \frac{\partial}{\partial t}$. So, we have

$$-\frac{\hbar^2}{2m} \frac{\partial^2}{\partial x^2} \psi = \frac{i\hbar}{2} \frac{\partial}{\partial t} \psi. \quad (4)$$

This is the free particle wave equation (*i.e.*, the wave equation for the de Broglie wave of a one-dimensional free particle). It is also derived from the Schrödinger equation of hydrogen atoms and is suitable for describing free particles (*i.e.*, more suitable for de Broglie waves). To obtain partial derivatives in the free particle wave equation, Eq. (3) must be obtained [otherwise, one of Eq. (3) and (4) must not hold]. Section 8: Derive the correct Schrödinger equation using the unitary operator of Hilbert space — Eq. (1).

In Eq. (4), the propagation direction of the de Broglie wave is consistent with that of the wave function. It can reflect the qualitative and quantitative relationship between the wave and particle properties of moving particles from the perspective of energy. Eq. (4) can also reflect the relationship between de Broglie waves and wave functions. On the left side of its equal sign, the classical mechanical kinetic energy can be calculated, and on the right side of the equal sign, the wave energy of the wave function can be calculated (for particles in the same motion).

Eq. (3) originates from the Schrödinger equation (as long as the Schrödinger equation is not denied, it cannot be denied). It indicates that the kinetic energy of a moving particle is half of the value obtained by describing it with wave laws, that is, twice its kinetic energy (particle energy or classical mechanical energy) is equivalent to the energy obtained by describing it with wave laws (actually, it is equivalent to $\frac{1}{2}mv^2$ and $\frac{1}{2}h\nu$). From the perspective of energy, the quantitative relationship between the wave and particle properties of moving particles is fixed and unchanging. The principle of complementarity does not imply a complementary relationship between wave and particle properties (weak complementarity: the stronger one, the weaker the other). Strong "complementarity": the wave and particle properties of particles cannot be observed simultaneously. The equivalence of $\frac{1}{2}mv^2$ and $\frac{1}{2}h\nu$ can verify the phase velocity of de

Broglie waves:
$$v = \frac{E}{p} = \frac{h\nu}{p} = \frac{mv^2}{mv}$$

A true non dielectric wave (also a real wave), with an energy equal to $h\nu$ and a wavelength of $\lambda=h/p$, cannot be related to the width of the slit it passes through. This can be verified using photons. The energy of a photon before and after passing through a slit is almost the same (its wavelength is not determined by the slit width. If the slit width is appropriate and follows Huygens' principle, then the waves passing through the slit before and after are different. But this situation will never happen with matter wave). For the de Broglie wave of a particle with a moving electron of $\lambda=h/mv$, its wave energy is also $h\nu$ when it does not pass through a slit (independent of the slit width determined by λ and ν). The wavelength is determined by the velocity according to $\lambda=h/mv$, rather than being determined by the slit width according to $\lambda=dsin\theta$ (the letter "d" here refers to the seam width or aperture). It is evident that the waves (subjectively interpreted or understood) observed in electron diffraction experiments, determined by the wavelength $\lambda=dsin\theta$, do not ideally verify the de Broglie wave (at best, they provide only qualitative evidence).

Is de Broglie wave the essence of wave function? Eq. (3) states that if the wave equation in Eq. (2) is used to describe the de Broglie wave, the energy value of this wave is twice the true energy of the moving particle. This also indicates that Eq. (2) is an expression of artificially selected moving particles. Many people also say that 'wave functions are mathematical tools'. It is not the same wave as the de Broglie matter wave. The de Broglie waves in hydrogen atoms do not move in the same direction as the waves in the wave function: the de Broglie waves do not move along the X -axis, while the waves in the wave function move along the X -axis. The wave represented by Eq. (2) is a wave that travels in a straight line in one-dimensional space. The Schrödinger equation for hydrogen atoms describes electrons that are not free electrons but bound electrons, moving randomly in three-dimensional space instead of straight lines, and is not suitable for one-dimensional wave Eq. (2) to describe. This also indicates that the wave of the wave function in the Schrödinger equation of hydrogen atoms is not a de Broglie matter wave. Now, what should we do to describe the electrons in hydrogen atoms that move in three-dimensional space without going straight using a one-dimensional wave function suitable for straight lines? If the motion of electrons in hydrogen atoms is random, the problem is difficult to solve. If the motion of electrons in hydrogen atoms conforms to the planetary model, there is a way. However, there must be an assumption similar to spatiotemporal bending. Assuming that the extranuclear space of a hydrogen atom is curved, in Riemannian geometry, the electrons in the hydrogen atom travel in straight lines, achieving the same propagation direction of de Broglie waves and the wave of the wave functions. Only in this way can the electrons in the planetary model be described using one-dimensional wave function Eq. (2).

Previously, it seemed that some people believed that using spherical coordinates could solve the problem of the inconsistency between the de Broglie waves in hydrogen atoms and the waves represented by ψ . However, using spherical coordinates only masks the contradiction without resolving it. The reason is that changing x in ψ to r does not change the oneness of the propagation direction of the wave represented by ψ (the direction is always \vec{r}). And the equation of motion for electrons and their de Broglie waves in atoms is not always \vec{r} ! The direction of its quantity p is not always radial. In other words, using spherical coordinates does not change the original degrees of freedom of particle and wave motion. If the fluctuation is not a linear motion along the X -axis, but a random motion, then Eq. (2) does not hold (even if x is replaced with r in spherical coordinates, the situation remains the same).

As mentioned above, this section seems to demonstrate the "affinity relationship" between the Schrödinger equation for hydrogen atoms, which is highly practical, and the planetary model (as long as the planetary model is used, the contradiction of using the Schrödinger equation in hydrogen atoms is minimized).

3. Implicit Virial Theorem in Schrödinger Equation

In classical mechanics, the system that applies the Viry theorem must be the planetary model system. The Schrödinger equation is the fundamental equation of quantum mechanics. Proving that the Schrödinger equation is a product of the combination of the Viry theorem and wave functions, or that the Viry theorem can be derived from the Schrödinger equation, proves that the Schrödinger equation or quantum mechanics does not exclude planetary models and classical mechanics.

Comparing Eqs. (1) and (2) with $\frac{p^2}{2m}\psi = \frac{mv^2}{2}\psi = T\psi$, or replacing $\frac{p^2}{2m}\psi$ with the operator $\hat{p}^2 = -\hbar^2 \frac{\partial^2}{\partial x^2}$, the kinetic energy operator can be obtained as $\hat{T} = -\frac{\hbar^2}{2m} \frac{\partial^2}{\partial x^2}$. By substituting the kinetic energy operator into Eq. (1), we can obtain

$$T\psi + V\psi = E\psi. \quad (5)$$

Since T , V , and E in the above equation have already taken the form of operators and functions, Eq. (4) can be written as

$$T + V = E. \quad (6)$$

In classical mechanics, Eq. (6) is the relationship between the kinetic energy, potential energy, and total energy determined by the planetary model and the Viry's theorem.

The process of deriving Eq. (6) from Eq. (1) reflects in reverse that the Schrödinger equation is a product of the combination of classical mechanical laws (formulas) and wave functions. You should know that before the birth of wave mechanics, the Hamiltonian was a classical mechanical quantity, and the Schrödinger equation cannot be separated from the Hamiltonian operator.

In Section 8, we also derived the wave mechanics expression for the Viry theorem.

4. Derive $F=ma$ from the Schrödinger equation of hydrogen atom, and derive the Schrödinger equation from $F=ma$

The third section introduces the derivation of the Viry theorem from the Schrödinger Eq. (1) for hydrogen atoms. In the classic planetary model, $E = -T$ in Eq. (6). Both sides of this equation are divided by the orbital radius r in the planetary model, and considering $V/r = F$, we have

$$2T/r = F. \quad (7)$$

Substituting $T = mv^2/2$ into Eq. (7), and considering that the acceleration of an object in uniform circular motion is $a = v^2/r$, Eq. (6) becomes

$$ma = F. \quad (8)$$

The formula for kinetic energy in classical mechanics is $T = \frac{p^2}{2m}$. For an object in uniform circular motion, Eq. (8) can be

written as $F = mv^2/r$. Multiplying both sides of $F = mv^2/r$ by $\frac{1}{2}r$, we can obtain $\frac{1}{2}Fr = \frac{1}{2}mv^2 = T$. We can also write the

potential energy as $V=Fr$. Substituting $\frac{1}{2}mv^2=T$ and $V=Fr$ into Eq. (6), we can obtain $\frac{1}{2}mv^2+Fr=E$. For the gravitational force of electromagnetic force, Fr in the equation is $-Ze^2/r$ and $-GMm/r$., respectively. We feel that using the code V to represent potential energy is more intuitive and can represent different potential energies. Therefore, we write the classical mechanical formula $(1/2)mv^2+Fr=E$ as

$$\frac{p^2}{2m}+V=E. \quad (9)$$

If all terms of Eq. (9) are multiplied by ψ , we can obtain $\frac{1}{2}hv\psi+V\psi=E\psi$, or

$$\frac{p^2}{2m}\psi+V\psi=E\psi. \quad (10)$$

Take the form of Eq. (2) and let $f(\hbar, m)\frac{\partial^2}{\partial x^2}\psi=\frac{p^2}{2m}\psi = \frac{mv^2}{2}\psi = \frac{1}{2}hv\psi$, we can obtain $f(\hbar, m) = -\frac{\hbar^2}{2m}$. Substituting $\frac{p^2}{2m}\psi = -\frac{\hbar^2}{2m}\frac{\partial^2}{\partial x^2}\psi$ into Eq. (9), we can obtain Eq. (1). Considering $T=\frac{p^2}{2m}$, The process from Eq. (9) to Eq. (10), and then to Eq. (1) intuitively demonstrates the combination of classical mechanical laws and wave functions to form the Schrödinger equation.

5. Derive the wave equation containing force

We will first learn from Bohr and start by using the planetary model. Then transition to the Schrödinger method. In the planetary model of hydrogen atoms, the orbital angular momentum of electrons is $pvr=\hbar$. The orbital velocity of the first main layer electrons is $v=ac$. Dividing all terms of Eq. (1) by the radius r , and considering the electron orbital angular momentum formula and orbital velocity formula here, we can obtain

$$\frac{c\alpha\hbar}{2}\frac{\partial^2}{\partial x^2}\psi + \frac{E}{r}\psi = F\psi. \quad (11)$$

Here, α is the fine structure constant. The three-dimensional form of Eq. (11) is $\frac{c\alpha\hbar}{2}\nabla^2\psi+\frac{E}{r}\psi=F\psi$. It is applicable to the 1s electron of hydrogen atom [see Eq. (31) in Section 6 for the shape applicable to all planetary models]. Due to the energy eigenvalue of hydrogen atoms being $E=-\frac{Ze^2}{2r}$, the equation becomes $\frac{c\alpha\hbar}{2}\nabla^2\psi - \frac{Ze^2/2}{r^2}\psi=F\psi$ or $c\alpha\hbar\nabla^2\psi - \frac{Ze^2}{r^2}\psi = 2F\psi$. The establishment of Eq. (11) is like Bohr's successful use of old quantum theory to describe the hydrogen atom, which is a preliminary success in the effort to "give wings of force" to wave mechanics. It can intuitively demonstrate that wave mechanics itself does not exclude classical mechanics.

Eq. (11) is a wave equation that first appeared in human vision and can calculate the forces between electrons and nuclei in atoms. Readers can first perform a simple verification: choose Eq. (2) for the wave function, then select an arbitrary value of r , and calculate the size of F based on Eq. (11). If you have time, you can also solve the wave equation $c\alpha\hbar\nabla^2\psi - \frac{Ze^2}{r^2}\psi = 2F\psi$, just like solving the Schrödinger equation for hydrogen atoms, to calculate the quantized forces in hydrogen atoms. Most of the derivation results in this article are derived from the correct Schrödinger equation. Eq. (11) is actually a variation of the Schrödinger equation — Eq. (1). Its scope of application is almost identical to that of the Schrödinger equation. This can greatly enhance the meaning of Eq. (11). If Eq. (31) is written in the form of

$-\frac{m^2}{\hbar^2}\left[\frac{\partial^2}{\partial t^2}/\frac{\partial^3}{\partial x^3}\right]\psi - \frac{GMm}{r^2}\psi = F\psi$, gravity quantization can be achieved. However, currently, it has not been seen that this gravity quantization has any significant significance.

Eq. (11) contains a wave function and is very similar to the Schrödinger equation for hydrogen atoms. It is a wave equation containing force. It tells us that the wave equation does not exclude $F=ma$, and we can use both the wave equation and classical mechanics formulas to describe particles in the same motion. Its other uses are waiting for us to jointly develop. Its other uses are waiting for us to jointly develop. It's other uses are waiting for us to jointly develop. The Schrödinger equation for hydrogen atoms can also be derived using calculus from the planetary model and $T+V+E$ (see Section 4).

According to the Wigner/Stone theorem, the unitary operator $U(\alpha)$ in Hilbert space and the principle of energy conservation are used to derive the Schrödinger equation, which extends the applicability of the Schrödinger equation for hydrogen atoms to all atoms and molecules. This method of promoting applicability is applicable to wave mechanics equations with force (because for the Schrödinger equation of hydrogen atoms, if all terms in the energy conservation equation are divided by the distance r of the force, it becomes the equilibrium equation of force). In this way, the derivation of Eq. (11) makes quantum mechanics truly mechanics.

6. The operator of force (F), Newton's second law expressed by wave mechanics, and the law of conservation of momentum

As long as the work referred to in the title of this section is completed (establishing those equations), the work of representing important classical mechanical laws using wave mechanics methods is completed, and wave mechanics becomes truly "mechanics".

The operator of force is also a wave mechanics representation of force (a method of calculating force using wave mechanics). Considering that $F=V/r$, by dividing both sides of Eq. (8) by the interaction distance r , we can obtain

$$mv^2/r = F. \quad (12)$$

For the uniform circular motion of electrons, $pr=\hbar$. Considering $p=mv$, and $F=V/r$, we can obtain

$$p^3/m\hbar=F. \quad (13)$$

The operator of p^3 is

$$\hat{p}^3 = i\hbar^3 \frac{\partial^3}{\partial x^3}. \quad (14)$$

By replacing p^3 in Eq. (13) with the operator the operator represented by Eq. (14), we can obtain

$$\hat{F} = i \frac{\hbar^2}{m} \frac{\partial^3}{\partial x^3}. \quad (15)$$

Multiply both sides of $F=ma$ by ψ to obtain the relationship between $F\psi=ma\psi$. Replace F with the force operator shown in Eq. (15), and obtain the wave mechanics Eq. (16) for the final force. We can also directly write Eq. (16) based on Eq. (15).

$$i \frac{\hbar^2}{m} \frac{\partial^3}{\partial x^3} \psi = F\psi. \quad (16)$$

In a bound state equilibrium system, the force acting on electrons conforms to this equation.

Considering $mv^2=2T$, substituting $r = \frac{4\pi\epsilon_0\hbar^2}{mZe^2}$ into Eq. (12), we can obtain $\frac{TmZe^2}{2\pi\epsilon_0\hbar^2} = F$. By replacing the kinetic

energy T with the kinetic energy operator $\hat{T} = -\frac{\hbar^2}{2m} \frac{\partial^2}{\partial x^2}$, we can obtain

$$\hat{F} = -\frac{Ze^2}{4\pi\epsilon_0} \frac{\partial^2}{\partial x^2}. \quad (17)$$

Eqs. (17) and (15) are equivalent when $Z=1$, the operator of force and the wave equation containing force are completely new research results that were not available before.

The expression for the law of conservation of momentum is $m_1v_1=m_2v_2$, or $p_1=p_2$. Replace the momentum p with the operator $\hat{p}=-i\hbar \frac{\partial}{\partial x}$, resulting in $\hat{p}_1=-\hbar \frac{\partial}{\partial x_1}$ and $\hat{p}_2 = -i\hbar \frac{\partial}{\partial x_2}$. Multiplying both sides of this equation by both ψ_1 and

ψ_2 , result in $\frac{\partial}{\partial x_1} \psi_1 \times \frac{\partial}{\partial x_1} \psi_2 = \frac{\partial}{\partial x_2} \psi_1 \times \frac{\partial}{\partial x_2} \psi_2$ (the factor containing '-i' has been omitted). It can be proven that $\frac{\partial}{\partial x_1} \psi_2$ and $\frac{\partial}{\partial x_2} \psi_1$ are equal. Restoring the reduced factor $-i$, we can obtain

$$-i\hbar \frac{\partial}{\partial x_1} \psi_1 = -i\hbar \frac{\partial}{\partial x_2} \psi_2. \quad (18)$$

Here, $\psi_1 = A_1 e^{-\frac{i}{\hbar}(E_1 t - p_1 x_1)}$, $\psi_2 = A_2 e^{-\frac{i}{\hbar}(E_2 t - p_2 x_2)}$, $E_1 = \hbar v_1$, $E_2 = \hbar v_2$. Eq. (18) is the law of conservation of momentum expressed using wave mechanics methods. It indicates that wave mechanics allow the law of conservation of momentum to apply.

Calculate the first term in Eq. (1) and move some terms to become $\frac{p^2}{2m} \psi - E\psi = -V\psi$. Considering $E = -T$, we have

$$-\frac{p^2}{m} \psi = V\psi. \quad (19)$$

By replacing p^2 in Eq. (19) with an operator form, the potential energy operator $\hat{V} = \frac{\hbar^2}{m} \frac{\partial^2}{\partial x^2}$ can be obtained (note: potential energy V is a negative value).

$$\frac{p^2}{mr} \psi = F\psi = \frac{p}{2v} \frac{v^2}{r} \psi. \quad (20)$$

By substituting $a = v^2/r$ into Eq. (20), we can obtain $F\psi = \left[\frac{p}{2v} a\right] \psi$. By replacing the momentum p with the operator $\hat{p} = -i\hbar \frac{\partial}{\partial x}$ and using the relationship of $v = c\alpha$ for the ground state Bohr hydrogen atom, we can obtain

$$F\psi = a \left[-\frac{i\hbar}{2c\alpha} \frac{\partial}{\partial x} \right] \psi. \quad (21)$$

Eq. (19) is Newton's second law expressed using the wave mechanics method (applicable to Bohr's planetary model). According to the Schrödinger equation. It indicates that wave mechanics allows Newton's second law to apply under certain conditions.

Using $\lambda = h/mv = h/p$, $v = \lambda v$ and $a = v^2/r$, the first equation in Eq. (20) can be transformed into a $a \left[\frac{p^2}{2\hbar v} \right] \psi = F\psi$. Using

Eq. (3), $a \left[\frac{p^2}{2\hbar v} \right] \psi = F\psi$ can be transformed into a $a \left[\frac{p^2}{4T} \right] \psi = F\psi$. By replacing p^2 with the corresponding operator $\hat{p}^2 = -\hbar^2 \frac{\partial^2}{\partial x^2}$, we can obtain

$$a \left[-\frac{\hbar^2}{4T} \frac{\partial^2}{\partial x^2} \right] \psi = F\psi. \quad (22)$$

Eq. (22) is applicable to both macroscopic and microscopic planetary models, unlike Eq. (21) which is only applicable to ground state hydrogen atoms. From the derivation process of Eq. (22), it can be seen that the operator of the force with a wider range of applicability is $\hat{F} = -\frac{a\hbar^2}{4T} \frac{\partial^2}{\partial x^2}$.

From Eq. (22), it can be seen that the mass operator of a moving object is related to its kinetic energy

$$\hat{m} = -\frac{\hbar^2}{4T} \frac{\partial^2}{\partial x^2}. \quad (23)$$

This operator is applicable to moving objects in bound state systems. According to Eqs. (22) and (23), Eq. (12) can be transformed into a much more widely applicable form [See Eq. (30)].

$$a \left[-\frac{\hbar^2}{8T} \frac{\partial^2}{\partial x^2} \right] \psi + \frac{E}{r} \psi = F\psi. \quad (24)$$

However, the applicability of Eq. (24) is limited and only applies to planetary model systems where the Huang Weili law holds. According to $\hat{T} = -\frac{\hbar^2}{2m} \frac{\partial^2}{\partial x^2}$, $\hat{V} = \frac{\hbar^2}{m} \frac{\partial^2}{\partial x^2}$, $E = -T = -\frac{p^2}{2m}$, $\hat{E} = -\hat{T} = \frac{\hbar^2}{2m} \frac{\partial^2}{\partial x^2} = -i\frac{\hbar}{2} \frac{\partial}{\partial t}$ (the last equation can be found in Section 8 or Refs. 11-15), the wave mechanics expression of Viry's theorem can be obtained

$$-\frac{\hbar^2}{2m} \frac{\partial^2}{\partial x^2} \psi + \frac{\hbar^2}{m} \frac{\partial^2}{\partial x^2} \psi = -i\frac{\hbar}{2} \frac{\partial}{\partial t} \psi. \quad (25)$$

According to the momentum operator $\hat{p} = -i\hbar \frac{\partial}{\partial x}$, the velocity operator, velocity squared operator, and acceleration operator can be obtained.

$$\hat{v} = \hat{r} = -\frac{i\hbar}{m} \frac{\partial}{\partial x}, \quad (26)$$

$$\hat{v}^2 = -\frac{\hbar^2}{m^2} \frac{\partial^2}{\partial x^2}. \quad (27)$$

$$\hat{a} = \hat{v} = \frac{\partial}{\partial t} \left[-\frac{i\hbar}{m} \frac{\partial}{\partial x} \right]. \quad (28)$$

When using (28), be sure to use the relationship $p=mv$. Based on the derivative of the wave function of kinetic energy with respect to t , and considering $m=2T/v^2$, the quality operator is $\hat{m} = -i\hbar \frac{\partial}{\partial t} \div \left[-\frac{\hbar^2}{m^2} \frac{\partial^2}{\partial x^2} \right]$, that is

$$\hat{m} = i\frac{m^2}{\hbar} \left[\frac{\partial}{\partial t} / \frac{\partial^2}{\partial x^2} \right]. \quad (29)$$

This quality operator is universal, while Eq. (23) only applies to systems where the "Viry theorem applies". If the operator forms of various physical quantities are written, then classical physics formulas have corresponding operator expressions, which can be written as wave mechanics equations. For example, the operator formula for Newton's second law of $F=ma$ is $\hat{F}=\hat{m}\hat{a}$. According to the multiplication operation of $\hat{m}\hat{a}$, Eq. (30) can be obtained.

$$\hat{F} = m \left[\frac{\partial^2}{\partial t^2} / \frac{\partial}{\partial x} \right]. \quad (30)$$

Eq. (30) and the resulting $F\psi = m \left[\frac{\partial^2}{\partial t^2} / \frac{\partial}{\partial x} \right] \psi$ are only applicable to planetary models. Considering $F=mv^2/r$, Eqs. (27) and (30), the "wave mechanics method with force" applicable to all planetary models is

$$-\frac{m^2}{\hbar^2} \left[\frac{\partial^2}{\partial t^2} / \frac{\partial^3}{\partial x^3} \right] \psi + \frac{E}{r} \psi = F\psi. \quad (31)$$

Eq. (30) and the resulting $F\psi = m \left[\frac{\partial^2}{\partial t^2} / \frac{\partial}{\partial x} \right] \psi$ are only applicable to planetary models.

$$F\psi = -\frac{\partial f(p)}{\partial t} \left[i\hbar \frac{\partial}{\partial x} \right] \psi. \quad (32)$$

In the equation, $\partial f(p)/\partial t$ represents differentiating only the momentum p of the partial derivative result in parentheses (since mass is a constant, only the velocity v is differentiated). Equation (25) is the wave mechanics expression of Newton's second law and is universal and is universal. The wave mechanics representations of various classical mechanical concepts and laws can form a complete system. With such a system of mechanical equations, it can no longer be denied that classical mechanics can be combined with wave mechanics.

The above discussion has already covered the four operations of operators. Eq. (28) and $\hat{m}\hat{a}$ involve multiplication of "heavy partial derivatives" or/and operators, while Eq. (29) involves division of operators. The multiplication rule of

operators is reflected in Eq. (31) (belonging to the rule of multiple derivatives). This is different from the high-order partial derivative rule. Especially the heavy partial derivatives with different independent variables. This is different from the high-order partial derivative rule. Especially for the heavy partial derivatives with different independent variables. The division rule of operators is to take the derivatives of the numerator and denominator separately, and then divide them. The relationship between Eqs. (26) and (27) reflects the operation rule of the square of the operator. As for the square root of operators, the situation is quite complex. The rules are left to mathematicians to formulate. This section has constituted a true wave mechanics that does not distinguish between "quantum" and "classical".

7. Results of disturbed electron diffraction experiments

Experiment Name: Electron Diffraction Experiment under the Interference of Magnetic Field and Light.

Experimental objective: To observe the changes in electron diffraction phenomena under the interference of visible light and magnetic field. So as to search for the characteristics and laws of motion electrons

Experimental instruments and tools: electron diffractometer, permanent magnet, flashlight

Experimental steps: Turn on the power switch of the instrument to start working. Adjust to the optimal diffraction effect state. Scenario A: use a high-strength permanent magnet to move at the electron beam exit end and interfere with diffraction, observe the changes in the diffraction pattern.

Experimental phenomenon description: Scenario A. Use a high-strength permanent magnet to move at the electron beam exit end and interfere with diffraction, observe the changes in the diffraction pattern. Scenario B. Visible light has no visible effect on the electron diffraction pattern (See Fig. 1).

Inference of experimental phenomena: In Joseph John Thomson's cathode ray deflection experiment, the electron beam underwent a deflection that conforms to the $F=ma$ law. In the experiment of this article, the diffraction pattern moving in a magnetic field indicates that the electron beam is also undergoing a deflection that conforms to the $F=ma$ law (that is, the same force bias as in Fig. 2 also occurred in the experiment of this article). The experiment in this article is equivalent to installing a slit in a cathode ray tube. The diffraction pattern does not disappear, indicating that the quantum decoherence process has not occurred, and the electrons in the electron beam are still in the microscopic world as holders of quantum properties. Electrons move longitudinally under force, but diffraction still occurs. This indicates that particles with wave particle duality can exhibit both particle and wave properties simultaneously.

Experimental conclusion or explanation: The quantum superposition and quantum superposition collapse process, quantum decoherence process, Bohr complementary relationship between wave and particle properties of moving particles, etc. do not seem to exist. This conclusion and explanation do not deny the main framework of the mathematical form of quantum mechanics. We can observe both particle characteristics that conform to $F=ma$ and wave characteristics that conform to diffraction laws (which are exhibited by moving particles in simple and stable diffraction experiments without ambiguity).

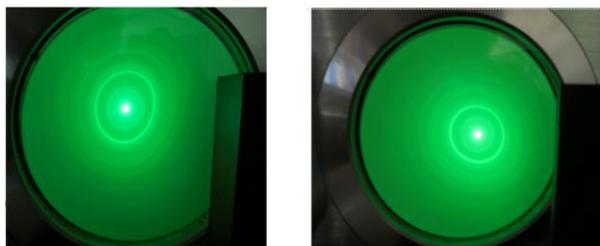


Fig. 1. The result of using magnetic field to interfere with electron diffraction. The electron beam moves laterally along the direction of force, causing diffraction fringes to deform and move as a whole, but not disappear. During the diffraction process,

electron rays can exhibit both particle characteristics and wave law simultaneously.

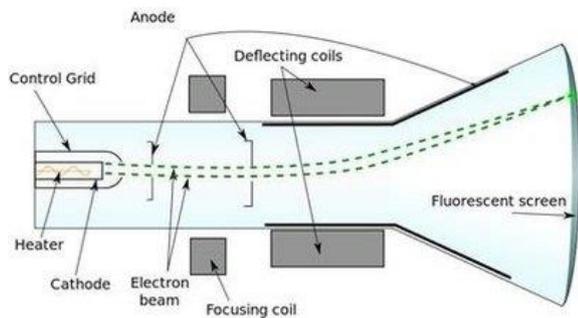


Fig. 2. Schematic diagram of Thomson cathode ray deflection experiment principle. Image source:

https://p0.ssl.qhimgs1.com/sdr/400_/t0136f39cb9fcded8d0.jpg

Conditional readers can redo the experiment of interfering with electron diffraction by themselves and replace visible light with X -ray as the interference source.

7. Prophecy and application examples cited in references

We believe in the principle for the corresponding relationship between mathematics permission and physical reality'. Its strong form is that "permission is existence". Its weak form is that mathematics permissional thing (*i.e.*, the mathematics allowable authority) has a high probability of being a physical reality. The principle of 'permission is existence'. This is the principle of the relationship between physics and mathematics, also known as the principle of permission beng existence. allowable. Its content is that as long as a physics equation is successfully applied in a certain range or field, the composition, structure, and function of the equation (*i.e.*, the content allowed to be described by the equation) will have corresponding physical reality (manifestations or existence) in that range or field. It must meet two key conditions: the first is that the application of the equation has been very successful; Secondly, within the field where the equation has been successfully applied. Therefore, this principle is not applicable to theories such as string theory where mathematics is before physical unknown. This principle is about exploring reality from equations. A typical example is that the Schrödinger equation, which has been very successful in applications, allows the mass m in it to take on a large value, so that it can be a physical quantity of macroscopic objects. And macroscopic objects allow classical mechanics to apply. In this way, the Schrödinger equation itself allows classical mechanics to apply. According to the principle of permission existence, it is highly likely that classical mechanics is applicable to systems (not limited to microscopic systems) that can be successfully described by the Schrödinger equation. The belief that quantum mechanics rejects classical mechanics is based on old ideas rather than logic.

Principle of authenticity of permissions is the principle of interpreting mathematics through physics. It is the method by which mathematical permissions is implemented in physics. Belonging to the category of the relationship between physics and mathematics.

The application of the Schrödinger equation for hydrogen atoms has been very successful. The two expressions for the energy of the same moving particle ($\frac{1}{2}mv^2$ and $\frac{1}{2}h\nu$) are equivalent and originate from the Schrödinger equation (*i.e.*, it is allowed by the Schrödinger equation). Based on the export process of Eq. (3), the principle of permission existence, and the theoretical analysis above, we can predict that "the diffraction pattern of moving particles, which is considered to

be the manifestation of waves, and the classical particle properties can be presented simultaneously" (for convenience, it is referred to as prediction 1). If combined with the content of sections 3-4, this prophecy can be further concretized.

Sections 3 and 4 introduce the derivation of the Schrödinger equation from $F=ma$, and/or conversely, the derivation of classical mechanical laws from the Schrödinger equation. This can more intuitively reflect that the Schrödinger equation is a product of the combination of classical mechanical laws (formulas) and wave functions. This proves that the Schrödinger equation allows for the coexistence of classical mechanical laws and wave mechanics. According to the principle of 'permission is existence', prophecy 1 can be more specifically stated as Prophecy 2: Wave mechanics cannot exclude $F=ma$ based on mathematical logic; Moving particles can exhibit diffraction patterns while acting at " $F=ma$ ". We will verify this prediction using disturbed electron diffraction experiments (see Section 7). The prophecy 1 and 2 have also been verified through many calculation examples. [4-7] Because Refs. 4-7 provide evidence of the application of prophecy 3.

Reference 8-10 lists a hypothesis. The assumption is that electrons are composed of fundamentally centimeter polarized photons, and this wave propagation around the nucleus does not belong to the category of charge acceleration and does not emit electromagnetic waves outward. Using it to solve the main contradiction of Bohr's atomic model can avoid the use of unreality concepts and methods. At present, we can only verify this hypothesis by using it to calculate the electron spin angular momentum. The experimental basis for this hypothesis is that high-energy photons can decay into electrons and anti electrons.

For the same reason, we can also predict that for particles describing the same motion, we can combine quantum mechanics with classical mechanics for use (Prediction 3).

The prediction made in this article based on the previous analysis is that the Schrödinger equation, which can describe macroscopic systems containing gravitational potential energy, can be established; Classical mechanics and quantum mechanics can be combined to describe particles in the same motion. Refs. 11-15 introduce the Schrödinger equation, which contains gravitational potential energy and can describe macroscopic systems, and verify prediction 4.

Sections 5 and 6 introduced the process of deriving the wave equation with force from the Schrödinger equation, indicating that the Schrödinger equation allows $F=ma$ to be applicable. Because they derive wave equations containing force (This is strong support for the various prophecies in this article). The preliminary significance of Eqs. (10), (14), and (16) also lies in this. The operator of force and the wave equation containing force are both new things. They use clear logical methods to demonstrate that the quantum mechanical concept of rejecting $F=ma$ needs improvement, and strengthening the reasons for all the prophecies in this article.

9. Derive the correct Schrödinger equation according to the Wigner/Stone theorem

The complete version of the Schrödinger equation (one-dimensional form) introduced in existing official textbooks is

$$i\hbar \frac{\partial}{\partial t} \psi = -\frac{\hbar^2}{2m} \frac{\partial^2}{\partial x^2} \psi + V\psi. \quad (33)$$

Firstly, we can rely solely on intuition to suspect that Eq. (33) is inconsistent with Eq. (1). Because E in Eq. (1) is a negative value, while the first term in Eq. (33) is a positive value. Upon closer examination, on the right-hand side of Eq. (33), the

Hamiltonian operator $[-\frac{\hbar^2}{2m} \frac{\partial^2}{\partial x^2} + V]\psi$ acts on the wave function, resulting in the energy eigenvalue of the described

particle. Upon closer examination, on the right-hand side of Eq. (33), the Hamiltonian operator $[-\frac{\hbar^2}{2m} \frac{\partial^2}{\partial x^2} + V]\psi$ acts on

the wave function, resulting in the energy eigenvalue of the described particle. The widely recognized Hamiltonian is $\hat{H} =$

$\frac{\hat{p}^2}{2m}$. From it, $-\frac{1}{2}mv^2$ can be obtained. Changing the steady-state Schrödinger equation of a particle to a non-stationary

Schrödinger equation will not change the Hamiltonian. The energy E calculated based on the unitary operator $U(\alpha)$ in Hilbert space corresponding to the symmetry transformation must be $-\frac{1}{2}mv^2$. Under this premise, we assume that $f(\hbar, m)\frac{\partial}{\partial t}\psi = -\frac{1}{2}mv^2$. According to Eq. (3), $f(\hbar, m)\frac{\partial}{\partial t}\psi = -\frac{1}{2}h\nu$. The solution is $f(\hbar, m) = -i\hbar/2$. Therefore, by changing equation (1) to the non-stationary Schrödinger equation, the result must be $-\frac{i\hbar}{2m}\frac{\partial}{\partial t}\psi = -\frac{\hbar^2}{2m}\frac{\partial^2}{\partial x^2}\psi$. The successful application of the Schrödinger equation for hydrogen atoms shows that Eq. (1) is correct, and this energy eigenvalue (also the total energy of electrons in hydrogen atoms) is a negative value with a magnitude of $E = -T$. The calculation result of $i\hbar\frac{\partial}{\partial t}\psi$ in Eq. (33) is a positive value with a magnitude of $h\nu = \frac{\hbar^2}{m} = 2T$. Its physical meaning is the wave energy of the wave of the wave function (the noumenon of the wave function), rather than the energy eigenvalue obtained by the Hamiltonian operator acting on the wave function. In short, the energy carriers of $E = -T = -\frac{1}{2}mv^2$ and $E_{wave} = h\nu$ are different and cannot be made equal. By utilizing the relationship between wave energy and particle energy in Eq. (3) and substituting Eq. (2) into Eq. (33), we can obtain $i\hbar\frac{\partial}{\partial t}\psi = -\frac{\hbar^2}{m}\frac{\partial^2}{\partial x^2}\psi$. Considering Eqs. (10) and (1), $E = -T$, and the kinetic energy operator $\hat{T} = -\frac{\hbar^2}{2m}\frac{\partial^2}{\partial x^2}$, and the Viry theorem, it can be concluded that $E\psi = \frac{\hbar^2}{2m}\frac{\partial^2}{\partial x^2}\psi = -i\frac{\hbar}{2}\frac{\partial}{\partial t}\psi$. It can be seen that the correct one-dimensional stationary Schrödinger equation should be Eq. (25). Eq. (25) is consistent with Eq. (1). Later on, we will use advanced mathematical methods to derive the Schrödinger equation. Eq. (25) is also the Schrödinger Tu equation that we derived before this. [13]

Another intuitive and simple method is to compare the similarities and differences of the relationship between 'Eqs. (33) and (1)' and Viry's theorem. The Viry theorem of $E = T + V$ cannot be derived from Eq. (33) by using the relationships of $T = \frac{p^2}{2m}$ and $E = -T$, while from Eq. (1) can. Only one of Eqs. (33) and (1) is correct. Eq. (1) has been proven by countless examples and cannot be wrong. So, what must be wrong is Eq. (33). No one had noticed this error before. The reason is that when applying the Schrödinger equation, we use the correct Eq. (1), while when learning the Schrödinger equation, we use Eq. (33). We unconsciously employed the technique of 'swapping concepts'. Next, we will use group theory and the unitary operator on Hilbert space to derive the Schrödinger equation. So as to identify the problems that existed in the previous derivation process.

The simplest method is to start from Eq. (4) and reverse derive Eq. (1), resulting in Eq. (25) instead of Eq. (33). The Wigner/Stone theorem states that symmetry operations in quantum systems are induced by a unitary or anti unitary operator. Based on it, we can derive the energy operator from the unitary operator of Hilbert space. The unitary operator on Hilbert space corresponding to a symmetric transformation is $U(\alpha)$. If this transformation is continuously dependent on the parameter α , it can be written in exponential form:

$$U(\alpha) = e^{-\frac{i}{\hbar}\alpha\hat{E}}. \quad (34)$$

Assuming a state $\psi(0)$ evolves over time t at $t=0$ to:

$$|\psi(t)\rangle = U(t)|\psi(0)\rangle. \quad (35)$$

By taking its derivative, we can obtain

$$\frac{d}{dt}|\psi(t)\rangle = -i\frac{\alpha}{\hbar}\hat{E}e^{-i\frac{\alpha}{\hbar}t\hat{E}}|\psi(0)\rangle = -i\frac{\alpha}{\hbar}\hat{E}|\psi(t)\rangle. \quad (36)$$

$$\frac{i\hbar}{\alpha}\frac{d}{dt}|\psi(t)\rangle = \hat{E}|\psi(t)\rangle. \quad (37)$$

So, the operator of E is

$$\hat{E} = \frac{i\hbar}{\alpha} \frac{d}{dt}. \quad (38)$$

The α in Eqs (36) - (38) cannot be roughly taken as 1, but should be obtained through experiments or other reliable methods. If α is set to 1, the result obtained is $\hat{E} = i\hbar \frac{d}{dt}$ (the energy calculated based on $\hbar \frac{d}{dt} \psi$ is $h\nu$). The relationship obtained based on the experimentally confirmed Schrödinger Eq. (1) for hydrogen atoms is

$$E\psi = -\frac{\hbar^2}{2m} \frac{\partial^2}{\partial x^2} \psi = -i \frac{\hbar}{2} \frac{\partial}{\partial t} \psi. \quad (39)$$

The export of Eq. (39) validates Eq. (4). The energy calculated based on $-i \frac{\hbar}{2} \frac{\partial}{\partial t} \psi$ is $-\frac{1}{2}h\nu$, and also is $-\frac{1}{2}mv^2$. It is not difficult to see that if Eq. (39) is chosen, it is equivalent to selecting a value of -2 for α . Taking the hydrogen atom as an example, both theoretical and experimental methods can confirm that the energy obtained by the Hamiltonian operator in Eq. (1) acting on the wave function ($\hat{H}\psi$) is $-\frac{1}{2}mv^2$. This indicates that only selecting α as -2 is correct.

Thus, in Eqs. (36) to (38), α is -2 . This is what the Schrödinger equation, which has been widely and successfully applied, tells us, rather than making subjective and hasty choices. Since group theory and physics tell us that 'time shift symmetry ensures the conservation of energy, and this operator is a generator, it must be a self adjoint operator', it is naturally interpreted as an energy operator. This is just a qualitative judgment. We must have accurate quantitative judgments. Otherwise, it carries serious subjective factors. In fact, quantitatively, the difference between the energy value obtained by this operator acting on the wave function and the energy value obtained by the Hamiltonian operator acting on the wave function is α times. In other words, the Schrödinger equation uses both de Broglie waves and the wave of the wave functions. However, they are not consistent. This determines that there are two possible expressions for the energy on both sides of the Schrödinger equation (*i.e.*, there are two types of energy carriers in the equation). One is the particle energy determined by the Hamiltonian and allowed by Viry's law. Another way is to describe the energy of moving particles (or the energy of the wave of the wave function) using the wave law. When $i\hbar \frac{d}{dt}$ acts on the wave function in Eq. (2), the energy obtained is the "wave of the wave function" $h\nu$. Who can be certain that it is the energy of the de Broglie wave of a moving particle? We first determine the energy form of the Hamiltonian operator acting on the wave function as the particle characteristic energy of the moving particles (*i.e.*, the energy eigenvalue of the system expressed as the particle characteristic). In this way, there are two options for the energy attribute on the other side of the equal sign. If the constant α is set to 1, the energy expressed by the fluctuation law is chosen (and the energy carrier is the wave of the wave function). If the constant is chosen as -2 , it chooses the exact same energy expression as the Hamiltonian operator acting on the wave function side (the energy carrier is a moving particle, whose value is the negative value of kinetic energy). In view of this, only when the latter energy attribute (or energy expression, or energy carrier) is selected, can there be a relationship of $\hat{E}\psi = \hat{H}\psi$. In this way, as long as the Hamiltonian operator is written out, the correct Schrödinger Eq. (25) can be obtained.

As mentioned above, previous errors in deriving the Schrödinger equation were based on a physical understanding of the mathematical results. Secondly, the difference between the energy carrier of the Hamiltonian and the carrier (or property) of the energy derived mathematically (*i.e.*, the energy calculated using $i\hbar \frac{d}{dt} \psi$) was not carefully distinguished. At the end of the day, they still haven't grasped the relationship between mathematical permission and physical reality (which involves too many subjective factors in determining this relationship).

10. Conclusion:

Quantum mechanics and classical mechanics are compatible and can be combined. This combination will inevitably form classical wave mechanics. The mathematical foundation of classical wave mechanics is the original mathematical foundation of quantum mechanics plus the series of equations and operators in Section 9.

The composition and structure of the Schrödinger equation determine that it is the product of organic combination of wave functions and classical mechanics. In pure mathematical logic (or principle), it can be used to describe both macroscopic and microscopic objects. The derivation of wave equations containing force and wave functions further brings wave mechanics closer to classical mechanics, which focuses on describing the action of force. The overall conclusion, determined by theoretical analysis and computational examples, is that quantum mechanics and classical mechanics can definitely be combined and used together, which has been theoretically licensed and technically achieved.

References

- [1] Sean Carroll. Why even physicists still don't understand quantum theory 100 years on. *Nature*. 638, 31-34 (2025). doi: <https://doi.org/10.1038/d41586-025-00296-9>
- [2] Lee Billings. Quantum Physics Is on the Wrong Track, Says Breakthrough Prize Winner Gerard 't Hooft. Breakthrough Prize Winner Gerard 't Hooft Says Quantum Mechanics Is 'Nonsense'. *Scientific American*. 34(2), 104 (2025). doi: [10.1038/scientificamerican062025-3ndxLHOdGJV2u6twkhWFzi](https://doi.org/10.1038/scientificamerican062025-3ndxLHOdGJV2u6twkhWFzi)
<https://www.scientificamerican.com/article/breakthrough-prize-winner-gerard-t-hooft-says-quantum-mechanics-is-nonsense/>
- [3] Gibney, E. Physicists disagree wildly on what quantum mechanics says about reality, Nature survey shows. *Nature*. 643, 1175-1179 (2025). <https://doi.org/10.1038/d41586-025-02342-y>
- [4] Runsheng Tu. Research Progress on the Schrödinger Equation that Can Describe the Earth's Revolution and its Applications, *London Journal of Research in Science: Natural & Formal*. 25(1) , 17-28 (2025). https://journalspress.com/LJRS_Volume25/Research-Progress-on-the-Schrodinger-Equation-that-Can-Describe-the-Earths-Revolution-and-its-Applications.pdf
- [5] Runsheng Tu. Derive Schrödinger equation from $F=ma$. Vixra, <https://vixra.org/pdf/2509.0034v2.pdf>
- [11] Tu, R. Establishing the Schrödinger Equation for Macroscopic Objects and Changing Human Scientific Concepts. *Adv Theo Comp Phy*, 7(4), 01-03 (2024). <https://dx.doi.org/10.33140/ATCP.07.04.18>
- [6] Tu, R. Research Progress on the Schrödinger Equation of Gravitational Potential Energy. *Adv Theo Comp Phy*, 8(1), 01-07 (2025). <https://dx.doi.org/10.33140/ATCP.08.01.01>
- [7] Tu, R. Schrödinger-Tu Equation: A Bridge Between Classical Mechanics and Quantum Mechanics. *Int J Quantum Technol*, 1(1), 01-09 (2025). <https://www.primeopenaccess.com/scholarly-articles/schrodingertu-equation-a-bridge-between-classical-mechanics-and-quantum-mechanics.pdf>
- [8] Runsheng Tu. Research Progress on the Schrödinger Equation that Can Describe the Earth's Revolution and its Applications, *London Journal of Research in Science: Natural & Formal*. 25(1) , 17-28 (2025). https://journalspress.com/LJRS_Volume25/Research-Progress-on-the-Schrodinger-Equation-that-Can-Describe-the-Earths-Revolution-and-its-Applications.pdf
- [9] Tu, R. Quantum Mechanics and Classical Mechanics Can Be Used Together. *Adv Theo Comp Phy*, 8(4), 01-07 (2025).
- [10] Tu, R. A New Theoretical System Combining Classical Mechanics and Quantum Mechanics. *Adv Theo Comp Phy*, 8(2), 01-06 (2025). AGR: <https://doi.org/10.33140/ATCP.08.02.01>
- [11] Tu, R. Some Successful Applications for Local-Realism Quantum Mechanics: Nature of Covalent-Bond Revealed and Quantitative Analysis of Mechanical Equilibrium for Several Molecules. *Journal of Modern Physics*. 5(6), 309-318 (2014). DOI: [10.4236/jmp.2014.56041](https://doi.org/10.4236/jmp.2014.56041)

- [12] Runsheng Tu. The principle and application of experimental method for measuring the interaction energy between electrons in atom. *International Journal of Scientific Reports*. 2(8), 187–200 (2016). DOI: [10.18203/issn.2454-2156.intjsci20162808](https://doi.org/10.18203/issn.2454-2156.intjsci20162808)
- [13] Tu, R. A Wave-Based Model of Electron Spin: Bridging Classical and Quantum Perspectives on Magnetic Moment. *Adv Theo Comp Phy*, 7(4), 01-10 (2024). DOI: <https://dx.doi.org/10.33140/ATCP.07.04.11>
- [14] Tu, R. A Review of Research Achievements and Their Applications on the Essence of Electron Spin. *Adv Theo Comp Phy*, 7(4), 01-19(2024). DOI: <https://dx.doi.org/10.33140/ATCP.07.04.10>
- [15] Tu, Runsheng. Solving the problem of source of electron spin magneticmoment. *Physical Science International Journal*. 28(6): 105-110 (2024). DOI: <https://doi.org/10.9734/psij/2024/v28i6862>