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Research Article

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A Wave-Based Model of Electron Spin: Bridging Classical and Quantum Perspectives on Magnetic Moment

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Abstract

Existing theories of material structure and quantum field theory cannot describe the specific sources of fundamental particles. In quantum field theory, the generation of particles is the instantaneous transformation of the field, rather than the true creation of particles. It is necessary to explore the composition (or source) of the next level of elementary particles or fields. The material structure theory of "all fundamental particles mainly originate from photons" has great advantages in combining logic and fact. By utilizing this new theory of material structure, quantum theory, Bohr theory, and classical electromagnetic theory can be mixed to describe the same particle. Both this new theory of material structure and its application examples demonstrate that there is no longer a gap between the micro world and the macro world in calculating the spin angular momentum of basic particles, atomic ionization energy, and molecular dissociation energy.

Keywords: Theory of Material Structure of Wave Elements, Light-Knot Electronic Structure Model, Electron Spin Magnetic Moment Operator, Quantum Mechanics, Compatibility Between Quantum Mechanics and Classical Electromagnetic

1. Introduction

Some people are dissatisfied with the existing theory of quantum mechanics [1,2]. However, they did not establish a completely new theory of quantum mechanics. What is the essence of electron spin? No one has ever built a model. Only the author of this article established an electron spin model and achieved complete success in its application.

Prior to the author's research work, only Bohr's model of the hydrogen atom believed that the electron outside the nucleus was drawing a circle in the form of a dot, rather than assuming that the electron was a circular ring. That is to say, the idea that the structure of electrons is a ring surrounded by waves was first proposed by the author of this article [3-6]. In addition, the work of using classical planetary models to calculate energy eigenvalues in atomic structures was only done by Bohr for hydrogen atoms. However, the combination of classical mechanics methods that follow planetary motion with quantum mechanics methods is also the first of its kind in this article. This article is a review of the methods and significance of the author's past work.

This article suggests a new structure of particle physics that proposes compositional details of elements such as photons and electrons that are not completely described in currently accepted theories of atomic matter. The theory it presents is called a "light-knot structure" of atomic particle composition, proposing that all fundamental particles on the quantum scale originate from photons. Planar polarized light is modeled as decomposed into left-hand and right-hand polarized light, whose interaction constitutes the behavior of photons and electrons. The article begins with a description of the particle model that is proposed, and continues to describe many facets of this model relating to quantum physics as it is currently understood. In doing so it gives renewed support to Bohr's planetary model of atomic behavior. The article concludes with a review of 10 features of quantum modeling that are resolved by the light-knot proposal.

As mentioned above, the work done by the author of this article and its effectiveness and significance are as follows: (1) The research presented in this article delves into the fundamental questions and challenges of modern physics, specifically addressing the limitations of existing theories in describing the sources of fundamental particles. The innovative theory proposed, suggesting that "all fundamental particles mainly originate from photons," represents a significant leap forward in bridging gaps between classical and quantum physics. (2) The theoretical advancements outlined in the study are noteworthy. The proposed models and calculations, such as those for the electron radius, electron spin angular momentum, and the electron spin magnetic moment using classical mechanics, demonstrate a profound understanding of both classical and quantum mechanics. (3) One of the standout contributions of this work is the innovative description of high-energy photon decay into electron-antielectron pairs. By presenting a model where photons transform into discrete localized particles through circular propagation, the author provides a

compelling explanation that aligns with observed phenomena while challenging the traditional interpretations of quantum field theory. (4) The author's ability to establish a theoretical basis for the compatibility between classical and quantum mechanical methods marks a significant milestone in the field. (5) In summary, the author's work is a testament to the power of combining logical reasoning with empirical data to challenge established theories and push the boundaries of scientific knowledge.

The theme of this article is A Wave-Based Model of Electron Spin: Bridging Classical and Quantum Perspectives on Magnetic Moment.

2. Research Progress in Material Structure Theory and its Applications

For the material structure (especially the basic particle structure), there is still a considerable amount that has not been explained clearly (the internal structure and motion of common electrons, as well as the specific motion of electrons outside the nucleus, are still unclear to humans). Some people are very satisfied with what has already been explained, while others are very dissatisfied. For example, many people are dissatisfied with the explanatory system of quantum mechanics [1-3]. Because that violates local realism and determinism. And this explanatory system has a significant impact (including adverse effects) on the mathematical formal system and applications of quantum mechanics. In chemistry, the quantitative application results of quantum mechanics are not very accurate. However, conservative people believe that quantitative calculations in quantum chemistry are accurate and successful. Radical people believe that the so-called "accuracy and success" of quantum chemistry calculations are obtained through semi empirical calculation programs that are constantly compared with experimental results (although non semi empirical methods have emerged, they do not have much advantage compared to semi empirical methods). Accurately calculating a very simple hydrogen molecule by hand using quantum mechanics cannot be achieved, and computer programs are needed. However, computer programs for calculating hydrogen molecules are not solely based on logic, but are mainly written based on experience and constantly compared and modified with known experimental values. The different computer programs sold by different companies for hydrogen molecules indicate that those programs were not written based on the structure and motion of electrons in hydrogen molecules. If one does not know the experimental values related to hydrogen molecules, it is impossible to write a calculation program for hydrogen molecules. The quantum mechanical calculations of electron spin angular momentum and spin magnetic moment are consistent with experimental facts. Satisfied people believe that this fact is rigorously calculated, indicating that quantum mechanics is successful and practical. Dissatisfied people believe that we do not know the specific ways in which electrons spin and orbit, yet we calculate the values of physical quantities related to spin or orbit motion. Even for the calculation of the simplest molecule - hydrogen molecule, the situation is the same: without knowing the specific structure of hydrogen molecule and the specific motion state and mode of electrons outside the nucleus, the energy eigenvalue of hydrogen molecule (and other physical quantities related to the structure of hydrogen molecule and the motion mode of electrons inside it) is calculated. It makes people feel that the calculation results are pieced together, opportunistic, or it seems that there is help from God. It is inevitable that people will feel that the theory of quantum mechanics computing is a rootless and rootless skyscraper. It's also difficult not to experience the negative feelings mentioned above.

What is the internal structure of electronics? What is the motion of extranuclear electrons? What is the way electrons spin? These cannot be clearly explained through theories related to quantum mechanics or material structure theory (it is unknown what the electron spin magnetic moment specifically comes from). Physicists do not know the specific motion and detailed internal structure of particles, but they have calculated the values of some physical quantities related to the structure and motion of particles. If someone draws the conclusion based on this that we do not need to know the specific internal structure of the described object, nor do we need to explore this internal result (vehemently denying others' exploration work in this regard), then they are deceiving themselves. In physics, there are things that one wants to know but cannot, which is a manifestation of the inadequacy of physics theory (It has been said that there is no unquestionable theory. This determines that it is impossible not to have new ideas, new theories, new ideas and assumptions about "the new structure, nature and state of things" that are different from the existing orthodox theories). Since there are shortcomings in physics theory and there are dark clouds above it, how can we be completely satisfied? 'Very satisfied with the existing physics theory' seems to indicate that people's demands are too low.

The author of this article belongs to a group of people who are dissatisfied with existing physics theories. Therefore, long-term exploration of the composition and structure of electrons, intrinsic motion modes (especially the specific way electrons spin), and the motion modes of electrons outside the nucleus. Many people have also done or are currently doing these exploratory works. The situation I understand is that the vast majority of people have not broken free from the constraints of point particle structures (including small ball particle structures). Therefore, none of them were successful. I want to try to establish a new concept of material structure (specifically the concept of wave element material structure) in order to dispel the dark clouds over physics.

After long-term efforts, I proposed the wave element particle structure hypothesis (formerly known as the light-knot electronic structure model, breaking free from the constraints of old material structure concepts). This particle structure theory can at least clarify the specific ways of electron spin and the motion of electrons outside the nucleus, and accurately quantify the electron spin angular momentum and spin magnetic moment. Integrating the wave element particle structure model into the mathematical formal system of quantum mechanics can enable existing quantum mechanics to enter at least partially into the realm of local realism. Local realism quantum mechanics has indeed been established [4]. Fortunately, the preliminary

applications of wave element particle structure theory and local realism quantum mechanics methods have been quite successful. In any case, the research work introduced in this paper belongs to the iterative creative work of basic theory. In the field of physics, there has been no research work of this type for over a hundred years. The research work introduced in this article is at least worth discussing and exchanging.

I was told that quantum field theory has explained the phenomenon that high-energy photons decay into electron-antielectron pairs. Your explanation that is inconsistent with this is nonsense (that is, wrong). My reply is that even if there are many theories to explain the same phenomenon, it is king to judge whether the new explanation is more practical (not to see who has the greatest influence). I am sure that the explanation of quantum field theory has no advantage in solving the specific form of electron self-magnetization and explaining the source of electron spin magnetic moment (at least my explanation has obvious advantage in this respect-it can solve the specific source of electron spin magnetic moment). Some people claim to have discovered that the process of photon decay involves two high-energy photons. However, they did not prove that "a single high-energy photon must not decay when passing through a heavy nucleus". His discovery cannot prove that "I choose a single high-energy photon to decay into an electron anti electron pair" is wrong.

In principle, what has been introduced in references will not be repeated [1,4-6]. However, over time, the author's level of understanding has improved. I have found some issues with the previous description and it must be corrected (mainly due to insufficient details, poor systematization and organization in some aspects). For example, in the past, there was some confusion when the description of free electrons and the description of de Broglie waves for electrons were mixed together. This time the author separated these two situations. The author's understanding of the present situation and development of physics has been improved, which is reflected in the introduction of this work achievement. The author proposed the specific ways and processes of electron spin, and calculated a) › values of some physical quantities of electrons based on it. This obviously eliminates the suspicion of speculation caused by "the existing quantum mechanics does not know the specific form of the intrinsic motion of electrons and the motion mode of electrons outside the nucleus, but calculates the values of some physical quantities related to the motion of electrons". Based on the basic premise, the electron spin angular momentum operator, Dirac equation, and Schrödinger equation were derived (i.e., a b) w quantum mechanics theoretical system compatible with the existing quantum mechanics system was established), a new method of quantum mechanics was established, and quantum mechanics calculations were carried out. This indicates that the author's work can be integrated into the existing quantum mechanics system and improve the theoretical framework of c) antum mechanics.

In short, this article aims to tell everyone what the author has done? How was it done? What was the result? And comment on the effectiveness of the method, guiding everyone to understand the significance of the research work done by the author. Tell everyone about the assumptions made by the author and verify the effectiveness of the basic assumptions. I hope readers also d) y attention to checking the utility of the basic assumptions rather than focusing on whether the basic assumptions conform to existing theories. Because since it is a hypothesis, there is e) mething inside that even the author is not fully aware of. Otherwise, if the author knows everything, there is no need to make assumptions. Just like the Goldbach Conjecture, if Goldbach himself could explain it clearly, there would be no need to throw out a conjecture for others to prove. If some readers always want to find out why Goldbach put forward that conjecture and criticize (or question) that its conjecture is unreasonable (unfounded) instead of proving it, isn't that a waste of money? Hypotheses in physics are conjectures, and conjectures are hypotheses, just like conjectures or hypotheses in mathematics. Moreover, when dealing with all new theories and viewpoints, existing orthodox theories and viewpoints (i.e., old theories, old viewpoints, and old ideological concepts) should be used as the standard for judgment. So how can new theories and viewpoints emerge, and how can technology progress? The result of this way of evaluating research results is definitely that “scientific research can only spin around within the old theoretical framework”. I want to repeat the important content: please focus on checking the "effectiveness of the theoretical system constructed by the author according to the hypothesis" [that is, focus on checking whether the new theory and method can solve the problems that the old theory can't solve, and whether the calculation results are consistent with the experimental results (including the consistency of quantitative results and qualitative explanations)].

This article suggests a new structure of particle physics that proposes compositional details of elements such as photons and electrons that are not completely described in currently accepted theories of atomic matter. The theory it presents is called a "light-knot structure" of atomic particle composition, proposing that all fundamental particles on the quantum scale originate from photons. Planar polarized light is modeled as decomposed into left-hand and right-hand polarized light, whose interaction constitutes the behavior of photons and electrons. The article begins with a description of the particle model that is proposed, and continues to describe many facets of this model relating to quantum physics as it is currently understood. In doing so it gives renewed support to Bohr's planetary model of atomic behavior. The article concludes with a review of eleven features of quantum modeling that are resolved by the light-knot proposal.

3. The Basic Premise of the Electronic Structure Theory of Wave Elements

Scholars engaged in particle physics research know that high-energy photons can decay into electron anti electron pairs. How to explain this process? The statement of quantum field theory is that "the light field undergoes a process similar to jumping, which turns the light field into an electrostatic field of electrons". Due to the unknown nature of the jumping process, quantum field theory has not yet clarified how photons become electrons, nor has it elucidated the internal structure of electrons, nor

dispelled the dark clouds over physics. Today, many people believe that complexity is the right thing to do. However, "simple, correct and efficient" things have concise beauty and are pursued by nature and human beings. "Get the maximum functional utility in a concise way" is also the principle followed by the development (natural evolution and renewal) of things in nature. If we describe the process of photon decay into electrons in the simplest way, that is, photons traveling in a straight-line travel along a small circle instead, and discrete waves can become things that look like particles. This structure is like a Ferris wheel in operation that ignores the spokes. However, the model mentioned in this paper is not that objects with static mass are being transported, but that wave energy is rotating, or that the mass equivalent to wave energy is rotating. Therefore, it can be assumed that a high-energy photon first decomposes into left-handed circularly polarized photons and right-handed circularly polarized photons, and then the left and right circularly polarized photons are connected end-to-end and propagate along a small circle to form electrons and anti-electrons. For convenience, we refer to it as basic assumption 1. Simply put, this is the light-knot hypothesis and also the optical knot electronic structure model. It is not difficult to observe that such a free electron entity is circular (It is a circular phase trajectory — Phase trajectory ring), and for convenience, this ring can be referred to as an electronic ring. The composite circularly polarized light synthesized by two plane polarized photons can be further decomposed into two plane polarized light. Basic circularly polarized light is non-synthetic circularly polarized light that can no longer be decomposed.

We establish a new concept here — 'line of mass'. It is the line connecting the center of mass of the transverse column of a long object. Cut a long object horizontally into infinite segments, each segment having a centroid. Then connect these centroids into smooth curves in sequence. This line segment is the “mass line” of this long object. Although the electronic structure of the Ferris wheel mentioned above is three-dimensional, the mass line of the Ferris theory that ignores the spokes is a two-dimensional circle. In this case, the spin of electrons is similar to the rotation of the mass line of a Ferris wheel, which can be described using the SU (2) group.

Basic assumption 2: The electron ring surrounded by circularly polarized photons can expand its radius (including transition processes) in a quantized form in the central force field, following the rule of $r_d=274n^2\ r_0$, (n=1,2,3, ···). When Z = 1 (the number of nuclear charges sensed by electrons is 1), $r_0 = \lambda/2\pi = \hbar/2mc$. The physical quantity with subscript d is the physical quantity of wave particle duality particles described by de Broglie waves. If the bound state particle happens to be an electron, then, r_0 is r_e., and m_d is m_e. When it is indicated that the described particle is an electron, the subscript in m_e can be omitted. Basic assumption 3 is about the assumption that two electrons with opposite spin pairs coincide. In atoms and molecules, electron pairing refers to the complete coincidence of two electrons with opposite spin. That is to say, electrons in the potential field are equivalent to falling into the potential field, thus changing their motion and energy. Under the basic assumption of this article, the mass line of a free electron is the phase trajectory of the wave that makes up the electron.

The light-knot electronic structure model indicates that photons (i.e., electromagnetic waves) are one of the components or sources of fundamental particles at the next level. Adhering to the principle that entities without static mass are more fundamental than entities with static mass, we assume based on experimental facts that neutrinos are also a component of fundamental particles. In this way, the next level of origin for the composition of elementary particles is photons and neutrinos. The corresponding material structure theory is also known as the theory of wave elements material structure.

When communicating with friends, I found that many people find it difficult to understand the concept of “high energy photons split in half” included in "high-energy photons first decompose into left and right circularly polarized photons during decay, and then circularly polarized light curls". Today I will elaborate on it in detail. We assume the existence of basic left-handed and right-handed circularly polarized photons. In this way, the left and right circularly polarized light lines with the same frequency and phase overlap, which can certainly form a basic plane polarized light line. The inverse process of this combination process is that a basic plane polarized light is decomposed into a left-handed circularly polarized light and a right-handed circularly oscillating light. Wherein each basic plane polaron is decomposed into a left-handed circular polaron and a right-handed circular polaron.

4. Using A Photo Junction Electronic Structure Model to Solve the Problem of the Source of Electron Spin Magnetic Moment

The wave equation frequently used in quantum mechanics is

$$\psi(x,t) = Ae^{-i2\pi(\nu t - x/\lambda)}. \quad (1)$$

The plane wave solution of the electromagnetic wave equation is similar to it. In the formula, $p = 2mc = h/\lambda$, $E = h\nu = 2mc^2$, $c = \lambda\nu$ (This is the commonly used first set of data). According to basic assumption 1 (model of photonic electronic structure), it can be inferred that the energy, momentum, and maximum amplitude of photons in circularly polarized light are only half of those in plane polarized light before decomposition. But the frequency, wavelength, and propagation speed of the two are equal. Equation (1) is equivalent to $(x,t) = Ae^{-i(Et-xp)/\hbar}$. If it is the basic circularly polarized light decomposed from plane polarized light, during the decomposition process, the frequency and wavelength remain unchanged, but the maximum amplitude is reduced by half. If the wave function of this wave is represented by the functions of ν and λ, the form is still the same as equation (1). Quantitatively, A, E, and p are only half of equation (1). Use the second set of data to distinguish when using. The second set of data is $p = mc = h/2\lambda$, $E = h\nu/2 = mc^2$, $c = \lambda\nu$, $\lambda = 2\pi r$. If describing de Broglie waves, the wave function used is different from the form mentioned above.

$$\psi_d(x,t) = A_d e^{-i(E_d t - xp_d)/\hbar}. \quad (2)$$

Here, $p_d=m\upsilon_d=h/\lambda_d$, $E_d=h\nu_d=\left(\frac{1}{2}\right)m\upsilon_d^2$, $\upsilon_d=\lambda_d\nu_d=\alpha c$, $\lambda_d=2\pi r_d$, (This is the third set of data). In this case, E_d no longer contains

stationary mass but only kinetic energy E_k or T. Eauation (2) and basic assumption 1 tell us the specific form of spin of free electrons — Basic circularly polarized photons propagate along a small circle — The circular motion of momentum and energy (mass equivalent to energy).

According to assumptions (1) and (2), it can be inferred that when a circularly polarized photon propagates end-to-end along a small circle with a radius of r, there is a relationship of $\lambda = 2\pi r$ (using the second set of data). The spin angular momentum of a free electron is the intrinsic angular momentum of the electron's motion, expressed as $\vec{L} = \vec{r} \times \vec{p}$ (via the classical electrodynamics equation). Substituting $\lambda = 2\pi r$, $p = mc$, $\hbar = h/2\pi$ into this classical angular momentum expression yields

$$\left|\vec{L}\right| = \hbar/2. \qquad (3)$$

The method for determining the sign of spin angular momentum in a horizontal circular plane is as follows: when the fundamental circularly polarized photon propagates clockwise, it is defined as negative, and counterclockwise, it is defined as positive, and the direction perpendicular to the circular plane and above is defined as the positive Z-axis direction. In this case, flipping the circle (or electronic ring) 180 ° allows the electron spin angular momentum to transition between positive and negative values: $L = +\hbar/2$ and $L = -\hbar/2$. The electron spin angular momentum can be combined and written as $L = \pm \hbar/2$. According to classical electrodynamics, if the electron spin angular momentum takes a negative value, the relationship between the electron spin magnetic moment and the electron spin angular momentum is

$$\mu = -\frac{e}{2mc}L = \frac{e}{4mc}\hbar. \qquad (4)$$

We have elucidated the source of electron spin magnetic moment (i.e. clarified the specific way of electron spin). Knowing the specific way of electron spin motion (which is also its intrinsic motion and structure). Below, we derive the electron spin angular momentum operator and electron spin magnetic moment operator based on basic assumption 1.

Calculate the second-order number of layers for x using equation (1) and use the first set of data describing free electrons or bosons to obtain

$$-i\hbar\frac{\partial}{\partial x}\psi\,(x,t) = p\psi\,(x,t)\ . \qquad (5)$$

The electron spin angular momentum operator is

$$\hat{p} = -i\hbar\frac{\partial}{\partial x}. \qquad (6)$$

Taking the sign of in equation (4) as negative, $\mu = -\frac{e}{2mc}L = \frac{e}{4mc}\hbar$, and substituting the non vector form of equation (3) into it, considering $r = \lambda/2\pi = (h/2mc)/2\pi = \hbar/2mc$), we obtain

$$\mu = -\frac{e\hbar}{4m^2c^2}p. \qquad (7)$$

By replacing p in equation (7) with the momentum operator in equation (6), we obtain

$$\hat{\mu} = -i\frac{e\hbar^2}{4m^2c^2}\frac{\partial}{\partial x}. \qquad (8)$$

Equation (8) is the magnetic moment operator of the intrinsic motion (spin motion) of the free electron. Dividing both sides of equation (8) by $(-\frac{e}{2mc})$ yields the intrinsic motion (spin motion) angular momentum operator for free electrons

$$\hat{L} = i\frac{\hbar^2}{2mc}\frac{\partial}{\partial x}. \qquad (9)$$

Equation (9) can also be obtained by using the following methods: Replace r in $\vec{L} = \vec{r} \times \vec{p}$ with $\hbar/2mc$, and replace p with equation (6).

For describing bound particles or de Broglie matter waves (Taking the ground state hydrogen atom as an example), we choose the data set of $E_d = h\nu_d = \frac{1}{2}m\upsilon_d^2$, $p_d = m\upsilon_d$, $\upsilon_d = \alpha c$, $\lambda_d = h/p_d = h/(m\upsilon_d) = 2\pi r_d$, A_d, $\psi_d(x,t)$ (the third set of data), and and formula (10).

$$\psi_d(x,t) = A_d e^{-i(E_d t - x p_d)/\hbar}. \qquad (10)$$

Here, υ_d is the group velocity, not the phase velocity. Find the first derivative of equation (10) to x, and get

$$-i\hbar\frac{\partial}{\partial x}\psi_d(x,t) = p_d\frac{\partial}{\partial x}\psi_d(x,t). \qquad (11)$$

$$\hat{p}_d = -i\hbar\frac{\partial}{\partial x}. \qquad (12)$$

The angular momentum of the orbital motion of bound state electrons is

$$\vec{L}_d = \vec{r}_d \times \vec{p}_d,\ \ L_d = \left(\frac{\hbar}{m_d\upsilon_d}\right)p_d = \hbar. \qquad (13)$$

Here, $r_d = \lambda_d/2\pi = \hbar/p_d$. Substitute $\lambda_d = 2\pi r_d$, $p_d = m_d\upsilon_d$, $\hbar = h/2\pi$ into first equation in Eq. (13) and use its non vector form to obtain the second equation in Eq. (13). As long as the electron ring is turned over, L_d will change its sign. Equation (14) can be obtained by replacing p_d in Equation (13) with the momentum operator expressed in Equation (12).

$$\hat{L}_d = -i\frac{\hbar^2}{m\upsilon_d}\frac{\partial}{\partial x}. \qquad (14)$$

Here, the spin angular momentum in equation (14) has been chosen as a negative value. Substitute equation (14) into equation (7) [*i.e.*, p_d in Equation (7) is replaced by the operator form in Equation (14)], we can obtain

$$\hat{\mu}_d = -i\frac{e\hbar^2}{2m^2\upsilon_d c}\frac{\partial}{\partial x}. \qquad (15)$$

Apply equation (15) to equation (10), we can obtain $\mu_d = -i\frac{e\hbar^2}{4m^2\upsilon_d c}\frac{-i}{\hbar}m_d\upsilon_d = -\frac{e\hbar}{4mc}$. Let's take the ground state hydrogen atom as an example. According to basic assumptions 1 and 2, it can be inferred that in hydrogen atoms, the motion of bound electrons is the orbital motion of electrons, and the velocity of bound electrons is $\upsilon = \alpha c$. L_d and μ_d are the angular momentum and magnetic moment of electrons in orbital motion, respectively. In this way, the magnetogyric ratio of electron spin motion and the magnetogyric ratio of orbital motion are, respectively

$$\mu/L = -\frac{e\hbar}{4mc} \div \frac{\hbar}{2} = -\frac{e}{2mc}. \qquad (16)$$

$$\mu_d/L_d = -\frac{e\hbar}{4mc} \div \hbar = -\frac{e}{4mc}. \quad (17)$$

Comparing equations (16) and (17), it can be seen that for the ground state hydrogen atom, the magnetic spin ratio of the intrinsic motion of the electron is twice that of the orbital motion of the electron. When the particles are composite particles, the orbital radius of the particles in circular motion is not the radius of the circle surrounded by the "waveon" of De Broglie wave. That is, in this case, r_d in $\lambda_d = 2\pi r_d$ is not the orbital radius R.

5. Establish the Schrödinger Equation Based on Basic Assumptions 1 and 2 (Electronic Structure Model and Hydrogen Atom Model)

This process is described in references [1-4]. However, Eq. (11) is the momentum operator for bound state electrons. The momentum operator in the form of second-order partial derivatives is

$$\hat{p}_d^2 = -\hbar^2 \frac{\partial^2}{\partial x^2}. \quad (18)$$

In an electrodynamic equilibrium system, Viry's theorem holds, and there is a clear relationship between the kinetic energy and potential energy of particles. For the ground state hydrogen atom, this relationship is

$$T = p_d^2/2m_d. \quad (19)$$

Convert p_d^2 in Eq. (19) to operator form

$$\hat{T} = -\frac{\hbar^2}{2m}\frac{\partial^2}{\partial x^2}. \quad (20)$$

$T+V=H$ is the sum of the kinetic and potential energies of particles in an electrodynamic equilibrium system, excluding the internal energy of the system. Add V to both sides of the above equation. Then, based on the definition of the operator, we can obtain

$$\hat{H} = -\frac{\hbar^2}{2m}\frac{\partial^2}{\partial x^2} + V. \quad (21)$$

Equation (21) is the Hamiltonian operator. Applying it to the wave function yields the energy eigenvalue H.

$$\left[-\frac{\hbar^2}{2m}\frac{\partial^2}{\partial x^2} + V\right]\psi_d = \hat{H}\psi_d. \quad (22)$$

Equation (22) is also the non-relativistic Schrödinger equation. Where, ψ is the wave equation for plane polarized light. Equation (22) corresponds to the energy summation formula $T+V=H$. For the 1s electron in the ground state hydrogen atom,

$$E_d = h\nu_d = \frac{1}{2}\alpha v_e,\ p_d = h/\lambda_d = h/(274\lambda_e). \quad (23)$$

6. Electron Radius, Atomic Radius, and Hydrogen Atomic Structure Model

According to hypothesis 2, it can be inferred that when a small ring of free electrons becomes an extranuclear electron of a hydrogen atom, it undergoes the Huygens iteration process to become a large ring. That is to say, the radius of a 1s electron is 274 times that of a free electron. In this way, the structure of the ground state hydrogen atom is that the hydrogen nucleus is located at the center of a circle surrounded by 274 secondary waves. The radius of this large ring is the radius of the hydrogen atom, also known as the Bohr radius

$$a_0 = r_{1s} = 274\lambda/2\pi, \quad (24)$$

Here, λ is the radius of the free electron, sometimes written as λ_e. The value of λ is $\lambda = h/2mc = 1.213\times10^{-12}$ meters. The free electron radius is: $r_e = 1.213\times10^{-12} \div 2\pi = 1.929\times10^{-13}$meters. Therefore, $\lambda_d = 2\pi r_d$, $a_0 = rd = 274r_e = 274\times1.929\times10^{-13}$ meters $=5.2917721092\times10^{-11}$ meters, and the calculated results are consistent with the Bohr radius values.

From the above introduction, it can be seen that both free electrons and electrons in hydrogen atoms are circular, and it can be said that electrons move in one plane. The extension of the range of electron motion in hydrogen atoms to three-dimensional space was chosen without understanding the electronic structure and basic assumption 2. It seems to be an incorrect behavior now (The idea that the movement of electrons outside the nucleus is random and elusive is the result of this hasty choice). The correct choice is to extend equation (22) to two-dimensional space and use it to calculate some physical quantities of hydrogen atoms. The method is to change $\frac{\partial^2}{\partial x^2}$ in equation (22) to ∇^2, and then let Z=0, in order to solve the Schrödinger equation under the condition of $x^2 + y^2 = r_d^2$.

Previously, it was believed that the wave function of electrons in the s-shell of hydrogen atoms was spherically symmetric, with an angular quantum number $L_d = 0$, resulting in a zero orbital magnetic moment. Now it seems that this is also incorrect. We believe that the motion of bound electrons outside the nucleus is an enhanced motion (a combination motion) of the spin motion of free electrons. Spin angular momentum is also a result of this combined motion.

When the ring-shaped entity of electrons moves around nucleus, an equilibrium state can be reached. The equilibrium state equation is

$$\frac{Ze^2}{4\pi\varepsilon_0 r_d^2} = \frac{mv^2}{r_d}. \quad (25)$$

It is not difficult to see that, localized realism still holds a high position in such quantum mechanical systems. However, the existing quantum mechanics is helpless about the source of electron spin magnetic moment.

7. Establish Dirac Equation Based on Basic Assumptions 1 And 2 (Electronic Structure Model and Hydrogen Atom Model)

We can also derive Klein Gordon equation and Dirac equation based on the electronic structure model of the photojunction [7]. The first derivative of Eq. (2) ($\psi_d(x,t) = (A_d)e^{-i(Et-xp)/\hbar)}$) to t is

$$i\hbar\frac{\partial}{\partial t}\psi_d = E_d\psi_d. \quad (26)$$

Taking hydrogen atom as an example, the total energy of electrons outside the nucleus is $\sqrt{m^2c^4 + p^2c^2}$. According to Eq.

(26), we know

$$\hat{E}_d = i\hbar\frac{\partial}{\partial t}. \qquad (27)$$

This is the total energy operator of the particles.

The energy E_d of the electron outside the hydrogen nucleus is T+V, and its total energy E is: (the orbital kinetic energy of the electron T)+(potential energy V)+(the electron's intrinsic energy mc^2):

$$T + V + mc^2 = E, \qquad (28)$$

Here, m_d is m the mass of an electron (m_e). $T=mv^2/2=\alpha cp_d/2$, $V=-2T=-mv^2=-\alpha cp_d$, $T+V=-(1/2)\alpha cp_d$. The Virial theorem is a dynamic theorem for classical multi-particle equilibrium systems. Nor can relativistic effects destroy it. In Bohr's model of the hydrogen atom, it certainly holds. The virial theorem also holds for Saturn-like ring hydrogen atoms under hypothesis 2. Existing quantum mechanics also uses the virial theorem. Comparing the virial theorem $2T+V=0$, $p_d = mv_d$ and $v_d = \alpha c$ (where $Z=1$) and Eq. (28) "derived from the equilibrium Eq. (25) of classical mechanics", we can get:

$T=mv_d^2/2=\alpha c(mv_d)/2=\alpha cp_d/2$, $V=-2T=-mv_d=-\alpha cp_d$, $T+V=-(1/2)\alpha cp_d$

and

$$T+V+m_ec^2=-(1/2)\alpha cp_d+mc^2=E. \qquad (29)$$

The relationship between the kinetic energy of a moving particle and the relativistic energy is $mc^2 - mc^2 = T = (1/2)\alpha cp_d$. Using this formula to eliminate mc^2 in Eq. (29), we have (Below, some footmarks will be omitted without causing misunderstandings) . In the following description, we omit the subscript d

$$-\alpha cp+mc^2=E. \qquad (30)$$

Eq. (30) can express that the total energy of the moving particle minus the kinetic energy of the particle equals the internal energy of the particle. Replace p and E in Eq. (30) with applying the operators expressed by Eqs. (9) and (20) to $\psi(x,t)$, respectively. Result in

$$-\alpha c\hat{p}\psi + mc^2\psi = i\hbar\frac{\partial}{\partial t}\psi. \qquad (31)$$

Eq. (31) is the Dirac equation. The meaning of the Dirac equation derived in this paper is that in the electrodynamics' equilibrium system of hydrogen atom, the total energy of electrons in the system is equal to the sum of its relativistic total energy and its Hamiltonian. If the description is the motion of negative energy particles, the signs of the terms in the formula should be changed. Only by changing the sign of the mass alone can you get the exact same form as the Dirac equation. However, people only found positive antiparticles, but not negative mass particles. The α in the Eq. (31) is a specific constant — the fine structure constant, and ac is the fitted classical motion velocity (group velocity) of the electron outside the ground state hydrogen atom. However, before this article, However, people only found positive antiparticles, but not negative mass particles. In Dirac equation, α is not a simple constant (if certain conditions are met, α can take ±1). The matrix form of α is not derived from Dirac, but written to satisfy the covariance of the Dirac equation under the Lorentz transformation. It can be seen that it is not easy to deny the meaning of α given in this article. Only by solving a number of Dirac equations specifically, and seeing whether the results are consistent with the facts. Eq. (31) must correspond to the energy summation Eqs. (28)-(30), otherwise it is wrong. If α is not a fine structure constant, the energy on the left side of the equations (30)-(33) is much greater than the energy on the right side.

If it is an ns electron outside the atomic core with an effective charge of Z*, the Dirac equation for a ground-state hydrogen atom is

$$-(Z^*/n)\alpha c\hat{p}\psi + mc^2\psi = i\hbar\frac{\partial}{\partial t}\psi. \qquad (32)$$

The original Dirac original equation corresponding to Eq. (32) is

$$-\alpha c\hat{p}\psi + \beta mc^2\psi = i\hbar\frac{\partial}{\partial t}\psi. \qquad (33)$$

In the Eq. (33), $\beta = \pm 1$. $\alpha = \pm 1$. When both α and β are taken as −1, Eq. (33) becomes Eq. (34).

$$-\alpha c\hat{p}\psi - mc^2\psi = i\hbar\frac{\partial}{\partial t}\psi. \qquad (34)$$

The energy signs on both sides of the equal sign of Eq. (33) are inconsistent, which is wrong. The reasons will be stated later. The problem of Eq. (33) is also the problem of Eq. (34). Since ψ in these two equations is defined by Eq. (1), so, Eqs. (31) and (32) where $i\hbar\frac{\partial}{\partial t}\psi$ is the internal energy of the particle. As we all know, the relativistic total energy of a moving electron is $\sqrt{m^2c^4 + p^2c^2}$. The absolute value of both sides of the equality sign of Eqs. (33) and (34) cannot be greater than it. It is equal to $\sqrt{(mc^2 + pc)^2 - 2pmc^3}$, but less than ($mc^2$+$pc$). If both α and β take +1, then the left side of Eq. (32) is greater than the right side (the equation does not hold). Under the premise that both α and β are taken as −1, even if the negative energy particle is described by equation (32), the equation does not hold. The system energy summation method corresponding to equation (32) is cp+mc^2=E. This is inconsistent with the correct energy expression (31), and is also incompatible with the Bohr hydrogen atomic model. The first term ($\alpha cp\psi$) on the left side of the original Dirac Eq. (31) is the result of being erroneously enlarged by a factor of 137 by Dirac. On the premise that α=±1 is admitted, no matter whether the signs of α and β are the same or opposite, Eq. (31) is wrong. This can be seen intuitively from equation (30). The value of pc is equal to mvc and greater than mv^2. If α in equation (30) is equal to 1, two mc^2 on the left are greater than the right. The left (mvc+mc^2) is larger than the right (mv^2+mc^2).

Compared with the original Dirac equation expressed by Eq. (32), the Dirac equation [Eq. (33)] derived in this paper has at least 3 advantages: First, the meaning of α is clear; Second, the equation is more in line with the energy summation method; Third, the Eq. (29) is derived, whereas Dirac wrote his equations purely by intuition.

Taking the second-order partial derivative of Eq. (2) with respect to t and comparing it with Eq. (25), we can get

$$-i\hbar^2\frac{\partial^2}{\partial t^2}\psi=\hat{E}^2\psi. \qquad (35)$$

The total relativistic energy applicable to the overall motion of the particle is $E=\sqrt{m^2c^4+p^2c^2}$. Square both sides of the equation, divide the terms by c² and shift the terms to get

$$(E/c)^2-p^2=m^2c^2. \qquad (36)$$

Replace E^2 and p^2 in Eq. (36) with operators in Eqs. (35) and (27) respectively, and you can get

$$-\frac{\hbar^2}{c^2}\frac{\partial^2}{\partial t^2}\psi+\hbar^2\frac{\partial^2}{\partial x^2}\psi=m^2c^2\psi. \qquad (37)$$

Eq. (37) is Klein-Gordon's equation. Here ψ is the wave equation for plane polarized light. Eq. (37) corresponds to the expression of the relative momentum squared $(E/c)^2=m^2c^2+p^2$.

De Broglie waves (*i.e.*, beat waves in hypothesis 2), are also fitted matter waves. The frequency of this fitted wave is 1/274 of the frequency of the elementary photon. hνd is the kinetic energy T of the composite wave (where νd is the frequency of the fitted matter wave, that is, the frequency of the de Broglie wave). The fitted velocity (apparent velocity) of the fitted matter wave is $\upsilon=\alpha c$. This velocity was formerly known as the group velocity of de Broglie wave. The relationship between the energy and momentum of the fitted matter wave is also a classical mechanical relationship: $T=p\upsilon/2=ac p/2$. Since the classical motion is fitted, the calculation method used must include the classical mechanics method. In this case, $h\nu=E$ in Eq. (10) is the kinetic energy of the particle $E_k=T$. Meanwhile, we have $\frac{\partial}{\partial t}\psi=-i\frac{E}{\hbar}\frac{\partial}{\partial t}\psi$, $i\hbar\frac{\partial}{\partial t}\psi=E\frac{\partial}{\partial t}\psi$. Comparing Eq. (19) with Eq. (27), considering $E_k=T$, and $T+V=E$, the time-dependent Schrödinger equation can be obtained.

$$-\frac{\hbar^2}{2m}\frac{\partial^2}{\partial x^2}\psi+V\psi=i\hbar\frac{\partial}{\partial t}\psi. \qquad (38)$$

8. Simultaneously Calculating Hydrogen Molecules Based on the Material Structure Model of Localized Realism and Wave Dynamics

Quantum chemists need to know the potential energy function of the system when calculating molecules and atoms. However, due to the unknown motion state of electrons, the form of the potential energy function for the interaction between at least paired electrons is unknown. Even if some are known, the interaction energy between electrons cannot be accurately calculated due to their uncertain positions. They had to subjectively and tentatively establish a potential energy function. This makes quantum chemistry methods belong to semi empirical methods. Removing the hat of semi empirical methods and easily calculating data for some molecules must be the dream of quantum chemists.

By using pure mathematical methods to extend equation (22) to three-dimensional situations, we can obtain

$$\left[-\frac{\hbar^2}{2m}\nabla^2+V\right]\psi=\hat{H}\psi_d. \qquad (39)$$

For hydrogen atoms, this "generalization" operation is equivalent to acknowledging that the motion of electrons outside the nucleus is not a simple motion in the classical sense. It has been explained above that equation (39) can also be derived from the electronic structure model of the photojunction. Simply put, the electronic structure model of the photonic junction does not exclude existing quantum mechanical calculation methods (as long as the potential energy function can be given, atoms and molecules can greatly simplify the calculation process by using hydrogen like atoms). Just modify the concept of "probability density" to "energy density".

The three assumptions in this article are not independent, but interconnected. Specifically, they all revolve around the same core. The core is that the simplest circularly polarized photons propagate end-to-end along a circle, forming a fundamental particle with localized energy and constant charge. This type of electron has three major characteristics: composition — the simplest circularly polarized photon; Structure — wave rings connected at the beginning and end; Important feature - In a potential field, a wave can be extended into a beat wave according to Huygens' principle.

The main energy level of the 1s² electron in helium atoms should be the same, so the ionization energy should be the same. The difference in ionization energy between these two electrons is the pairing energy of 1s² electrons in helium atoms. The reason is that without the influence of another electron, the ionization energy of these two electrons is the same at 1 s². The difference in ionization energy between them is the result of the interaction between these two electrons. The difference in ionization energy of 1s ² electrons of each atom can be found in the chemistry manual. According to the ionization energy data of elements, the regression analysis method can be used to obtain the regression equation (43) between the 1s2 electron pairing energy and the effective nuclear charge number [8].

$$\Delta I_{\text{paired electron}}=E_{e^-e}=(-0.03100Z^{*2}-16.619Z^{*}+3.1613)/n^2. \qquad (40)$$

The unit of energy in equation (40) is electron volts. The regression equations calculated using different amounts of ionization energy data and software may vary slightly (readers with conditions should choose better statistical tools). Equation (40) shows that when the effective charge is zero, the energy released when free electrons pair is 3.1613 eV. This is the pairing energy Δ of free electrons.

According to assumptions 1, 2, and 3 in this article, it can be inferred that a hydrogen molecular ion is an electron sphere in an electrokinetic equilibrium system between two hydrogen nuclei.

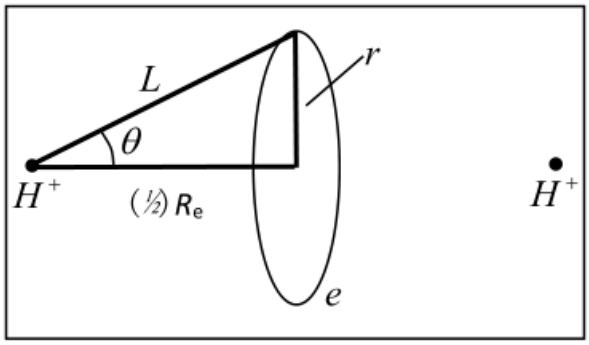

Figure 1: Hydrogen molecule-ion H_2^+.

The ground state hydrogen molecule is a charged ring with a pair of electrons overlapping between two hydrogen nuclei. This structure can achieve classical electrodynamic equilibrium and is a locally recognized microstructural system. It is inevitable to be able to use classical electrodynamics methods (or Bohr planetary models) for calculations. In this case, hydrogen molecules and helium atoms are extremely similar in composition and structure. The only difference between the two is that the two protons in a hydrogen molecule are separated, while the two protons in a helium atom are bound together. Classical electrodynamics and wave dynamics methods of planetary models can be used simultaneously. The planetary model of helium atoms involves two paired electrons rotating around a helium nucleus. The wave mechanics description of helium atoms is the Schr ö dinger equation description of two hydrogen like atoms. The author's calculation results show that the dissociation energy and bond length are D_e=−4.2 eV, and the bond length R_e≈0.71×10^{-10}m [9]. The relative experimental values are: D_e=−4.75eV, R_e=0.74×10^{-10} m. The error is related to the failure to consider the magnetic moment interaction between nuclei. The calculation results of hydrogen molecular ions in reference are as follows: D_e=−6.2eV, R_e≈1.1×10^{-10}m [4]. The corresponding experimental value is D_e=−2.8 eV, R_e≈1.06×10^{-10}m. For hydrogen molecular ions, there is a large error in the calculation of dissociation energy. The reason is that hydrogen molecular ions only have one electron, and the interaction between their orbital magnetic moment and nuclear magnetic moment is asymmetric, resulting in molecular asymmetry and significant errors.

This is the first data on hydrogen molecules calculated by humans using classical structures and wave dynamics. Although empirical formulas were used to calculate the electronic pairing energy during the calculation process, this empirical formula is a universal formula and is derived from experimental experiments (the calculation results for different situations remain unchanged). This is much more objective than the previous subjective method of providing empirical potential energy functions. The calculation method is based on local realism. This indicates that classical electrodynamics methods are compatible with wave dynamics methods. From Figure 1, it can be intuitively seen that the quantum chemistry calculation method provided in this article is a local realism approach.

The same method can be used to calculate the lithium molecule Li_2. Unlike hydrogen molecules, the bonding electrons of lithium molecules are at the n=2 energy level. The calculation result is: dissociation energy the calculation result is: dissociation energy D_e=−1.19 eV, bond length R_e≈2.56×10^{-10}m. The corresponding experimental value is D_e=−1.06eV, and the bond length R_e≈ 2.67×10^{-10}m. The error is also related to the nuclear magnetic interaction between the two nuclei.

9. The Planetary Atomic Model is Applied to Atoms other than Hydrogen and Atomic Reality

The planetary atomic model of atoms is an extended concept. Under the framework of the photojunction electron model, changing the planetary model to the Saturn model concept is more appropriate. In fact, the Saturn model of atoms is a fitted model that conforms to the laws of classical physics. The reason is that the quasi satellite rings in atoms are not solid rings, but wave rings, but overall, the mass equivalent to the energy of the ring wave is indeed distributed on the ring electrons in this way, there are no stability and quantization difficulties. Due to the high compatibility between the Saturn model of atoms and the wave dynamics model, we can simultaneously use the wave dynamics method and the classical electrodynamics method under the Saturn model to calculate the energy of atoms. In other words, we can add a planetary model calculation scheme for all atoms.

From sections 1-9, readers can see that the application results of this section are inevitable. These are also some successful application examples of localized realism quantum mechanics.

10. Method and Conclusion

Firstly, an assumption was made that "electrons are a circle surrounded by a specific electromagnetic wave (a circularly polarized photon). Then derive some inferences based on this assumption. Based on this assumption and its inference, calculate the mass, spin angular momentum, and spin magnetic moment of the electron. It is explained that the specific way of electron spin (the motion of circularly polarized photons propagating along a small circle).The Huygens principle also applies to such free electrons. This determines that the radius of electricity can undergo quantized changes. In this case, it is entirely possible that the hydrogen atom is a mechanically balanced structure with a double electron ring located between two hydrogen nuclei. The calculated results (bond length and dissociation energy) based on this structure are in good agreement with experimental values. The mechanical equilibrium structure of hydrogen atoms determines that we can calculate it using both classical mechanics and quantum mechanics methods simultaneously. This situation can also be extended to other diatomic molecules. The calculated results of the diatomic molecules have been quite satisfactory. The author's contribution is to provide a specific source of ideal electron spin angular momentum and spin magnetic moment. This clearly blurs the gap between classical mechanics and quantum mechanics. A much clearer picture of quantum mechanics has been presented than before. This has caused a huge impact on the explanatory system of quantum mechanics.

The exploration of the essence of electron spin and the explanation of the source of electron spin magnetic moment

laid the theoretical foundation for the compatibility of classical mechanics and quantum mechanics, and the establishment of the Schr ö dinger equation that can describe the Earth's revolution [10,11].

11. Brief Summary

The author has completed the following list of 10 scientific events that occurred for the first time in human society. That is to say, the following ten groundbreaking works have been completed for the first time in the history of technology to fill the world gap. The occurrence of the following 10 scientific events is based on revealing the internal composition, structure, and motion forms of electrons.

a) A complete electronic structure model of optical junction is established (a new scheme of electronic internal composition, structure and movement is proposed, and hundreds of application examples are provided).

b) The electron radius is calculated by classical structure, classical rotation and classical electromagnetism.

c) The electron spins angular momentum and the electron spin magnetic moment, as well as the electron spin angular momentum operator and the electron spin magnetic moment operator, are calculated by using the classical structure and the classical mechanical method.

d) Using classical structure, classical rotation and classical mechanics methods, the electronic orbital angular momentum of hydrogen atom is calculated (note: it was previously thought that electrons in hydrogen atom have no orbital motion).

e) The electronic orbital magnetic moment of hydrogen atom and its operator are calculated by classical structure and classical mechanical method (note: it was previously thought that the electrons in hydrogen atom have no orbital motion).

f) Using classical structure and classical mechanics method, the experimental measurement method of electron pairing energy-the difference of ionization energy of two paired electrons is obtained.

g) The theoretical basis of the compatibility between the planetary model or Saturn model method and the quantum mechanics method is established, and a large number of examples of the mixed use of these two methods are given.

h) The bond length and dissociation energy of hydrogen molecule and hydrogen molecule ion are calculated by classical structure and classical mechanical method.

i) The mathematical formal system of quantum mechanics is established by using the internal composition, structure and intrinsic motion form of electrons, as well as classical mechanical laws (for example, classical momentum-velocity relationship p=mυ, classical kinetic energy-momentum relationship $E_k = p^2/2m$, planetary motion equation under electrodynamics, angular momentum expression $\vec{L} = \vec{r} \times \vec{p}$ and electric potential energy expression f(r,Z,e,etc.) of planetary equilibrium system. This lays a theoretical foundation for the compatibility and even equivalence between quantum mechanical methods and classical mechanical methods under the background of Bohr planetary model.

j) The specific form of electron spin function, the angular momentum operator of electron orbital motion, the magnetic moment operator of electron orbital motion and the specific meaning of α in Dirac equation-fine structure constant are given by using the internal composition, structure and intrinsic motion state of electrons.

The conclusion of this article is that classical mechanics and quantum mechanics are compatible. The direct manifestation of this compatibility is that we can simultaneously use classical mechanics and quantum mechanics theories and methods to describe the same object. The application research results show that both classical mechanics and quantum mechanics methods were used to calculate some atoms (ions) and small molecules, and the calculated results are consistent with the experimental results.

The inevitable result of the compatibility between the two theories and methods mentioned above is that, in addition to using classical mechanics and quantum mechanics to describe the same microscopic object, they can also be used to describe the same macroscopic system simultaneously. It is natural for the modified Schr ö dinger equation to describe the Earth's orbital motion. The author of this article has indeed provided the Schr ö dinger equation for the Earth's revolution, which can also describe the motion of planets [10,11].

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