Critique of the Landé g-factor and Spin Quantum Number, and Reconstruction of Classical Atomic Structure Theory

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Article

Critique of the Landé g-factor and Spin Quantum Number, and Reconstruction of Classical Atomic Structure Theory

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Abstract

This paper aims to provide a thorough critical analysis of two foundational concepts in modern physics — the Landé g-factor and the electron spin quantum number 1/2. Through meticulous historical examination and logical analysis, this paper argues that these concepts are essentially mathematical fitting parameters introduced to bridge the gap between the old quantum theory and experimental data, lacking a solid foundation in physical mechanism. The core contradiction lies in the subsequent development of wave mechanics, which concluded that "the orbital angular momentum of the hydrogen atom ground state is zero," a conclusion that fundamentally conflicts with observational facts such as the Stern-Gerlach experiment, forcing the spin concept to assume a "remedial" role it never needed to bear. As a solution, this paper presents a new framework based on the "Great Tao Model" and the "Unified Theory of Atomic and Molecular Structure." This framework firmly returns to the realism of classical physics, affirms the orbital motion of electrons around the nucleus and their intrinsic angular momentum, and interprets spin as a real mechanical motion. Crucially, this theory naturally derives the universal magnetic moment-angular momentum relation $\mu = (e/m)\,L$ from the "Existence Field" principle, eliminating the need for any artificial correction factors. Based on this, the paper successfully provides a unified and self-consistent explanation for key phenomena such as the Stern-Gerlach experiment and the normal and anomalous Zeeman effects, thereby achieving a simpler and more fundamental description of physics at the atomic scale.

Keywords: Landé g-factor; spin quantum number; orbital angular momentum; Great Tao Model; Existence Field theory; Zeeman effect; Stern-Gerlach experiment

I. Introduction: Theoretical Divergence and the Birth of Fitting Parameters

The rapid development of atomic physics in the early 20th century, while bringing brilliant achievements, also planted seeds that deviated from physical reality. To explain increasingly precise spectroscopic experimental data, particularly the complex splitting patterns of the anomalous Zeeman effect, theoretical physicists were forced to introduce a series of extraordinary concepts within the Bohr-Sommerfeld old quantum theory framework. The g-factor proposed by Alfred Landé in 1921 [1], and the electron spin hypothesis along with its spin quantum number 1/2, proposed by George Uhlenbeck and Samuel Goudsmit in 1925 [2], became two of the most representative concepts.

For a long time, these concepts have been regarded as key to the success of quantum theory in explaining the microscopic world. However, a crucial historical fact that has been overlooked is that the proposal of these concepts predated and was independent of the counterintuitive conclusion in wave mechanics that "the orbital angular momentum of the hydrogen atom ground state is zero." This paper argues that the Landé g-factor and spin quantum number are essentially products of a "black-box" mathematical fitting strategy adopted by the old quantum theory when confronted with incomprehensible physical phenomena. They did not stem from deep insight into physical mechanisms but were empirical parameters introduced to "make calculations match the data."

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A more serious problem is that the subsequent conclusion from Schrödinger's wave mechanics (1926) regarding **zero ground state angular momentum** [3] created an irreconcilable contradiction with the non-zero magnetic moment of ground state atoms observed in the Stern-Gerlach experiment (1922) [4,5]. This, in turn, pushed the spin concept into a "savior" position it should not have occupied — it had to solely bear the responsibility of explaining the source of the ground state magnetic moment. This series of theoretical patches ultimately constructed a seemingly self-consistent but actually complex system based on circular reasoning and mathematical fitting.

This paper aims to systematically dissect the logical fallacies in this historical process and, on this basis, demonstrate a new path based on the "Great Tao Model" and the "Unified Atomic and Molecular Structure Theory." By returning to the realistic picture of classical physics and starting from the unified origin of the "Existence Field," this theory not only naturally eliminates the need for the Landé g-factor and the spin quantum number 1/2 but also provides a simpler and more unified physical explanation for key experimental phenomena.

II. Reconstructing Historical Context: The Evolution of Angular Momentum Images and the Formation of Theoretical Dilemmas

2.1. The Sommerfeld Old Quantum Theory Era: The Non-Zero Angular Momentum Classical Picture (1913-1925)

In the system developed by Bohr and Sommerfeld, the motion of electrons still retained the realistic core of classical physics. Although quantum conditions were introduced during this period, the basic understanding did not depart from "electrons moving in deterministic orbits around the nucleus." The concept of angular momentum was consistent with classical physics.

In the old quantum theory, the core quantum numbers describing electron states included the principal quantum number n and the azimuthal quantum number k. The principal quantum number n determined the main energy levels of the atom, taking positive integer values (n=1,2,3...); the azimuthal quantum number k was directly related to the electron's orbital angular momentum, its value ranging from 1 to n, with the magnitude of orbital angular momentum strictly following $L = k\hbar$ ($\hbar$ being the reduced Planck constant). This quantization condition originated from the Bohr-Sommerfeld orbital quantization assumption, ensuring orbital stability and preventing electrons from collapsing into the nucleus due to energy loss from electromagnetic radiation.

For the hydrogen atom ground state (n=1), since the maximum value for k is n, k can only be 1, corresponding to an orbital angular momentum $L = 1 \times \hbar = \hbar$. This conclusion was a consensus in the physics community at the time: the ground state electron of the hydrogen atom moved along a definite orbit with non-zero angular momentum. This picture conformed to the basic law in classical mechanics that "periodic orbital motion must have angular momentum" and was consistent with the experimental fact of hydrogen atom stability.

During this period, Landé (1921) and Uhlenbeck & Goudsmit (1925) conducted their research under the theoretical premise of "non-zero ground state angular momentum." The core difficulty they faced was not the "source of ground state magnetic moment" but the complexity of excited state spectral splitting and the conflict with classical magnetic moment theory — clarifying this historical context is a key prerequisite for understanding the essence of the Landé factor and the spin concept.

2.2. Classical Magnetic Moment Theory and Preliminary Interpretation of the Zeeman Effect

2.2.1. Intrinsic Link Between Classical Magnetic Moment and Angular Momentum

In classical electromagnetic theory, the orbital motion of an electron around the nucleus is equivalent to a miniature current loop, and its orbital magnetic moment has a strict intrinsic relationship with angular momentum. For an electron with charge -e and mass m, if the orbital radius is r and linear velocity is v, the orbital current is $I = e / (2\pi r/v) = ev/(2\pi r)$, the loop area is $S=\pi r^2$. According to the magnetic moment definition, $\vec{\mu}=I\vec{S}$, the orbital magnetic moment can be derived as

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$\mu_L = (e/2m)\ L$ (where $L = mvr$ is the orbital angular momentum). This formula shows that the magnetic moment is proportional to angular momentum, with the proportionality coefficient (gyromagnetic ratio) being $e/2m$, a natural corollary of classical electromagnetic theory.

In the absence of an external magnetic field, atomic magnetic moments are randomly oriented, canceling each other out, so the atomic system does not exhibit magnetism macroscopically. When an external magnetic field B is applied, the magnetic moment experiences a torque $\tau = \mu \times B$, causing the atom to acquire additional energy $\Delta E = -\mu \cdot B$. This additional energy splits the original single energy level into multiple sublevels, leading to the splitting of spectral lines — this is the core physical mechanism of the Zeeman effect.

2.2.2. Classical Successful Interpretation of the Normal Zeeman Effect

In 1896, Zeeman first observed the splitting of spectral lines in a magnetic field [6]. Subsequently, Lorentz successfully explained the case where spectral lines split into three equally spaced lines (the normal Zeeman effect) using classical electromagnetic theory. This success became a major achievement of classical physics in the microscopic domain.

Lorentz's theoretical derivation was based on the model of "the electron as a classical harmonic oscillator": without an external magnetic field, the electron oscillates around the nucleus with angular frequency ω_0, emitting a single-frequency spectral line; after applying an external magnetic field, the electron experiences the Lorentz force $F = -e\ (v \times B)$, which superimposes on the Coulomb attraction from the nucleus, altering the electron's equation of motion. By decomposing the electron's two-dimensional vibration in the xy plane into two circular motions in opposite directions, Lorentz found that the frequency of one circular motion increased to $\omega_+ = \omega_0 + \omega_L$, while the frequency of the other decreased to $\omega_- = \omega_0 - \omega_L$ (where $\omega_L = eB/2m$ is the Larmor precession frequency), and the vibration frequency along the magnetic field direction (z-axis) remained ω_0.

The corresponding spectral lines split into three: frequencies $\nu_+ = \omega_+/2\pi = \nu_0 + \Delta\nu$, $\nu_0 = \omega_0/2\pi$, $\nu_- = \omega_-/2\pi = \nu_0 - \Delta\nu$ (where $\Delta\nu = eB/4\pi m$), with splitting spacing proportional to the magnetic field strength B. Simultaneously, the three spectral lines have definite polarization characteristics: ν_+ corresponds to left-handed circularly polarized light, ν_- corresponds to right-handed circularly polarized light, and ν_0 corresponds to linearly polarized light along the magnetic field direction. The splitting pattern, spacing law, and polarization characteristics of the normal Zeeman effect perfectly matched the predictions of classical magnetic moment theory, further validating the effectiveness of the classical magnetic moment-angular momentum relationship.

2.2.3. Emergence of the Anomalous Zeeman Effect: The Collapse of Classical Theory

However, subsequent experiments soon found that the splitting of spectral lines for most elements in a magnetic field was not simply three lines but exhibited more complex patterns: sodium's D lines (yellow doublet) split into 4 and 6 lines, mercury's spectral lines split into even more lines with unequal spacing — this phenomenon was called the anomalous Zeeman effect, becoming an insurmountable obstacle for classical theory.

The core contradiction of the anomalous Zeeman effect lies in: The classical magnetic moment theory only considered electron orbital motion, predicting a number of splitting lines ($2k+1$, where k is the azimuthal quantum number) inconsistent with experimental observations, and the splitting spacing could not be explained by the classical gyromagnetic ratio ($e/2m$). For example, the sodium atom ground state corresponds to the 3s orbital ($k=1$ in old quantum theory). According to classical theory, the energy level should split into $2\times1+1=3$ lines, corresponding to 3 spectral lines, but the experimental splitting of sodium D lines far exceeded this prediction.

The collapse of classical theory did not stem from "zero ground state angular momentum" but from its magnetic moment model only containing orbital contributions, unable to explain the additional source of magnetic moment in excited states — this dilemma directly led to the birth of the Landé factor, whose essence was an "emergency correction tool" introduced to fit experimental data when classical theory failed to recognize electron spin (real mechanical motion).

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2.3. Proposal of the Landé Factor: Phenomenological Fitting and Theoretical Compromise

In 1921, to solve the spectral splitting puzzle of the anomalous Zeeman effect within the old quantum theory framework, Landé proposed an empirical correction factor (the Landé g-factor). Its core purpose was to adjust the proportional relationship between magnetic moment and angular momentum, forcing theoretical calculations to match experimental data.

Landé's starting point was: the angular momentum of excited state atoms was known (determined by quantum number k), but the magnetic moment calculated using the classical formula $\mu = (e/2m)\, L$ could not explain the splitting patterns of the anomalous Zeeman effect. For example, for an excited state with azimuthal quantum number k=1 (L=$\hbar$), the classical magnetic moment $\mu = (e/2m)\, \hbar \approx 9.27\times10^{-24}$ J/T (the Bohr magneton μ_B), but the experimentally observed magnetic moment values and splitting spacings deviated from this expectation.

To resolve this contradiction, Landé abandoned the strict derivation of classical magnetic moment theory and instead proposed a corrected magnetic moment formula: $\mu_J = g \times (e/2m)\, J$ (where J is the **total angular momentum quantum number**). Here, the g-factor is the correction coefficient, no longer fixed at 1 but varying with the quantum numbers of the atomic energy level. By analyzing extensive spectroscopic data from the anomalous Zeeman effect, Landé summarized an empirical formula for the g-factor:

$$g = 1 + [J(J+1) + S(S+1) - L(L+1)] / [2J(J+1)]$$

Where J is the **total angular momentum quantum number**, L is the orbital angular momentum quantum number (corresponding to k-1 in the old quantum theory), and S is the "**intrinsic angular momentum quantum number**" (later the spin quantum number). The essence of this formula is to quantitatively correct the magnetic moment by introducing adjustable parameters S and J, making the calculated energy level splitting consistent with experimental observations.

It is important to clarify that when Landé proposed the g-factor, a clear physical picture of "electron spin" had not yet been formed. The S in the formula was merely an abstract quantum number needed to fit the data, its physical meaning completely unknown at the time — Landé himself could not explain why this correction factor was needed, only confirming its mathematical effectiveness. Therefore, the Landé factor, from its inception, lacked a foundation in physical mechanism. It was a phenomenological parameter introduced by the old quantum theory to conceal theoretical defects after the failure of classical magnetic moment theory. Its core function was "mathematical fitting" rather than "physical interpretation."

2.4. Proposal of Spin Quantum Number 1/2: The Distorted Role from Fitting Parameter to "Savior"

2.4.1. Initial Positioning of the Spin Concept: Supplementing Angular Momentum Sources

In 1925, Uhlenbeck and Goudsmit, while analyzing the doublet spectra of alkali metal atoms (such as the fine structure of sodium D lines), found that classical orbital angular momentum could not explain the double splitting of energy levels. To solve this problem, they proposed the hypothesis that "the electron possesses intrinsic spin": in addition to orbital motion around the nucleus, the electron also has a rotational motion around its own axis, corresponding to an additional intrinsic angular momentum (spin angular momentum).

The initial spin hypothesis was still based on the premise of "non-zero ground state angular momentum." Its core purpose was to supplement the source of angular momentum in excited states — the coupling of spin angular momentum with orbital angular momentum caused excited state energy levels to split into multiplets, thereby explaining the fine structure of spectra and the complex splitting of the anomalous Zeeman effect. According to the hypothesis, the magnitude of electron spin angular momentum is $S = \sqrt{[s(s+1)]}\, \hbar$, where s is the spin quantum number. To fit the doublet splitting pattern, s was set to 1/2 (corresponding to spin angular momentum projection along the magnetic field direction being $\pm\hbar/2$). Simultaneously, **to make the spin magnetic moment consistent**

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with experimental data, it was necessary to assume the spin magnetic moment $\mu\_S=(e/m)\ S$ (i.e., the spin gyromagnetic ratio is twice the orbital gyromagnetic ratio). This setting directly corresponds to the S=1/2 value in the Landé factor formula.

At this stage, the spin concept remained an "auxiliary fitting parameter" with a vague physical image (**even questioned due to contradictions like potential superluminal speed from "electron self-rotation**"), but it successfully explained the number of split lines and spacing in the anomalous Zeeman effect mathematically. It is crucial to emphasize that the 1925 spin hypothesis did not involve the "source of ground state magnetic moment" — because in the theoretical framework of that time, the ground state orbital angular momentum $L=\hbar$ could naturally produce an orbital magnetic moment. Spin existed only as a supplementary angular momentum for excited states.

2.4.2. The Subversion of Wave Mechanics: The Forced Distortion of Spin's Role

In 1926, Schrödinger proposed wave mechanics. By solving the Schrödinger equation for the hydrogen atom, a completely different conclusion regarding angular momentum from the old quantum theory was obtained. Wave mechanics described electron motion as a probabilistic "wave function." When solved in spherical coordinates, the wave function is separated into radial and angular parts. The solution for the angular part is determined by the orbital angular momentum quantum number l (l=0,1,...,n-1). For the hydrogen atom ground state (n=1), l can only be 0. Substituting into the wave mechanics angular momentum formula $L = \sqrt{[l(l+1)]}\ \hbar$ yields the conclusion that the ground state orbital angular momentum L = 0 [7].

This conclusion directly subverted the core understanding of the old quantum theory, leading to a fatal logical contradiction: According to classical magnetic moment theory, if ground state orbital angular momentum L=0, then the orbital magnetic moment $\mu_L = (e/2m)\ L = 0$. However, the 1922 Stern-Gerlach experiment had clearly confirmed that silver atoms (with a ground state electron configuration similar to hydrogen) possess a non-zero ground state magnetic moment (the atomic beam split into two beams in an inhomogeneous magnetic field). The splitting of hydrogen atom ground state spectra in the Zeeman effect further verified the existence of a ground state magnetic moment.

To resolve this contradiction, the physics community was forced to "reshape the role" of the spin concept: since wave mechanics negated the existence of ground state orbital angular momentum, the non-zero ground state magnetic moment could only be attributed to electron spin — spin transformed from "auxiliary angular momentum for excited states" to "the sole source of ground state magnetic moment." Its physical significance was forcibly elevated, becoming the "theoretical savior" rescuing wave mechanics from its contradictions.

This role distortion completely detached the spin concept from its original fitting purpose, making it a tool to conceal the core defects of wave mechanics. More critically, the wave mechanics angular momentum formula $L = \sqrt{[l(l+1)]}\ \hbar$ itself suffers from the problem of detachment from physical reality: its derivation stems from the mathematical properties of the wave function (l=0 corresponds to spherically symmetric angular wave function), but it is forcibly interpreted as "the physical attribute of electron motion," confusing the boundary between mathematical abstraction and physical reality — the actual motion speed of the hydrogen atom ground state electron is about 2.2×10^{6} m/s, and the orbital radius is about 0.529×10^{-10} m. Substituting into the classical angular momentum formula gives $L = mvr \approx 1.054\times10^{-34}$ J·s = ħ, directly proving that the ground state angular momentum cannot be zero.

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III. Critical Analysis: The Fitting Nature and Logical Fallacies of the Landé Factor and Spin Quantum Number

3.1. The Essence of the Landé Factor: Empirical Correction Lacking Physical Mechanism

The core defect of the Landé factor lies in its "existence for fitting" nature. It lacks any foundation in underlying physical mechanisms, representing a passive compromise of the old quantum theory after the failure of classical magnetic moment theory.

From the perspective of derivation logic, the Landé factor formula does not originate from basic physical principles but is obtained through reverse fitting of spectroscopic data. Without knowing the physical nature of "intrinsic angular momentum," Landé introduced abstract quantum numbers S and J, adjusting parameter values to match magnetic moment calculations with experimental splitting patterns. This "data-driven" rather than "mechanism-driven" approach to theory construction violates the basic requirements of scientific theory for "simplicity and self-consistency." For example, for an electron with spin quantum number s=1/2, the Landé factor formula gives g=2. This value can only be explained as "the spin magnetic moment is twice the orbital magnetic moment," but it cannot explain why the spin gyromagnetic ratio should be twice the orbital gyromagnetic ratio. It can only be attributed to "an inherent property of the electron," essentially avoiding the question of physical mechanism.

In terms of applicability, the Landé factor can only adapt to magnetic moment corrections for excited states and is completely powerless against the ground state contradiction. Within the old quantum theory framework of "non-zero ground state angular momentum," the Landé factor could compensate for deviations between excited state magnetic moments and experiments by adjusting the g value. However, it cannot solve the "source of magnetic moment" problem arising after wave mechanics proposed "zero ground state angular momentum" — if L=0, regardless of the g value, the magnetic moment $\mu = g \times (e/2m)\ L$ is inevitably zero, conflicting with experimental facts. This limitation shows that the Landé factor, from its inception, was not a universal physical theory but a targeted "patch tool."

A more profound critique is that the introduction of the Landé factor conceals the issue of the applicability boundary of the classical magnetic moment formula. The classical magnetic moment formula $\mu = (e/2m)\ L$ originates from the macroscopic current loop model. Directly applying it to microscopic electron orbits itself contains a logical flaw — the electron as a point charge has orbital motion fundamentally different from the current distribution in a macroscopic loop. The "Existence Field theory" indicates that the correct relationship for microscopic magnetic moment should be $\mu = (e/2m)\ L$. The 1/2 factor in the classical formula is an improper migration of the macroscopic model. The "correction" by the Landé factor is actually a secondary compensation for this erroneous migration, belonging to a logical cycle of "correcting one error with another."

3.2. The Fictional Nature of Spin Quantum Number 1/2: An Abstract Concept Born to Fill Contradictions

The assignment of the electron spin quantum number 1/2 is essentially a mathematical construct lacking physical reality. Its proposal and development have always revolved around "filling theoretical contradictions" rather than objectively describing physical phenomena.

First, the physical image of the spin concept cannot be self-consistent. Uhlenbeck and Goudsmit initially interpreted spin as "electron self-rotation." However, according to classical mechanical estimates, if the electron radius is less than 10^{-15} m (the modern experimental upper limit), to produce a spin angular momentum of $\hbar/2$, its surface linear velocity would far exceed the speed of light, violating relativity principles. To avoid this contradiction, quantum mechanics later redefined spin as an "intrinsic property without a classical counterpart," completely abandoning the realism of the physical image. This transformation meant that spin regressed from "understandable mechanical motion" to "an unvisualizable abstract symbol," violating the basic requirements of scientific theory for "observability and interpretability."

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Secondly, the value of the spin quantum number s=1/2 is the result of reverse deduction, not a theoretical prediction. To explain the doublet spectra of alkali metal atoms, Uhlenbeck and Goudsmit needed an angular momentum quantum number that could produce two energy level splittings, hence setting s=1/2 (corresponding to spin magnetic quantum number $m_s = \pm 1/2$). Its value is entirely forced by experimental data, not derived from basic physical principles. This practice of "experimental results first, theoretical parameters later" is essentially mathematical fitting, not physical discovery — if spectral splitting were of a different number of lines, quantum mechanics would have to assign a different spin quantum number, lacking theoretical necessity.

Finally, the role distortion of the spin concept exposes its "patch nature." As mentioned earlier, spin was initially proposed to explain excited state spectral splitting. However, after wave mechanics triggered the "zero ground state angular momentum" contradiction, it was forcibly assigned the function of "source of ground state magnetic moment." This role change lacks coherence in physical logic: if spin is an inherent property of the electron, why do its roles in the ground state and excited states differ drastically? More critically, the magnetic moment of silver atoms in the Stern-Gerlach experiment is mainly contributed by the orbital magnetic moment of the outermost electron (with spin magnetic moment playing only a secondary role). Quantum mechanics attributing it entirely to spin is a misreading of experimental facts — the root of this misreading lies in wave mechanics' erroneous judgment of ground state angular momentum, not the true physical effect of spin.

3.3. The Logical Closed Loop of Quantum Mechanics: Circular Reasoning and Loss of Reality

The combination of the Landé factor and the spin quantum number forms a seemingly self-consistent but actually circular logical closed loop within quantum mechanics. This closed loop conceals its nature of detachment from physical reality through the method of "abstract concepts mutually supporting each other."

The logical chain of quantum mechanics is: Wave mechanics derives "ground state angular momentum is zero" → Contradicts the experimental fact of non-zero ground state magnetic moment → Introduces the spin concept, attributing ground state magnetic moment to spin → Uses the Landé factor to correct the proportional relationship between spin and orbital magnetic moments → Achieves mathematical self-consistency through the total angular momentum coupling formula $g = 1 + [J(J+1) + S(S+1) - L(L+1)] / [2J(J+1)]$. In this chain, each link depends on the erroneous premise of the previous link: "Ground state angular momentum is zero" is a misinterpretation of the mathematical properties of the wave function; the spin concept is fabricated to fill the contradiction arising from this error; the Landé factor is a correction parameter introduced to adapt to the coupling of spin and orbit; the total angular momentum coupling formula is a mathematical tool forcibly binding these abstract concepts. The entire system lacks direct connection with physical reality. Its "self-consistency" exists only at the mathematical level, not the physical level.

For example, in quantum mechanics, the total angular momentum quantum number $J = L + S$ (L is orbital angular momentum quantum number, S is spin quantum number). For the hydrogen atom ground state (L=0), $J = S = 1/2$. Substituting into the Landé factor formula gives g=2, corresponding to a magnetic moment $\mu = 2 \times (e/2m) \times \hbar/2 = e\hbar/2m = \mu_B$, consistent with the experimentally observed Bohr magneton. This calculation appears perfect, but its essence is the cycle of "parameter presupposition and result fitting": the setting of spin quantum number s=1/2 itself aims to obtain this magnetic moment value, and the Landé factor formula is to adapt to this setting. The entire process involves no explanation of physical mechanism, only achieving mathematical self-consistency.

This "mathematics over physics" approach to theory construction causes quantum mechanics to lose the realistic core of classical physics. It no longer attempts to describe the real trajectory and physical mechanism of electron motion but is content with using abstract formulas to fit experimental data, ultimately falling into the dilemma of "agnosticism" — as Einstein said: "Quantum mechanics is certainly imposing. But an inner voice tells me that it is not yet the real thing."

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IV. The Great Tao Model and Unified Theory: Framework Reconstruction Returning to Physical Reality

4.1. Core Principles of the Great Tao Model

According to the strict definition in *The Great Tao Model* [8], the Existence Field is an inherent property of elementary particles (electron, positron, matteron) — charge and mass, as fundamental physical quantities, diffuse physical information into the surrounding space at a constant speed (the speed of light c), forming a continuous field distribution:

4.1.1. The Essence and Mathematical Expression of the Existence Field

The core of the Existence Field is the "propagation of physical information," not the spatial distribution of matter itself. For an electron, the strength of its charge Existence Field (electric field) follows the inverse square law:

$$\vec{E}_e = k_e \frac{e\hat{r}}{4\pi r^2}$$

Where $k_e = 1/\varepsilon_0$ (vacuum permittivity), $\hat{r}$ is the radial unit vector, and r is the distance from the field source.

The key characteristics of the Existence Field are:

Propagation speed is constant at c, independent of particle motion state;

Only transmits physical information, does not carry mass or charge;

Existence fields of the same physical quantity only interact with the same kind of physical quantity (charge field only with charge, mass field only with mass), with no cross-coupling.

4.1.2. The Mechanical Nature of Electron Spin: Tidal Locking and the Complete Resolution of the Superluminal Problem

The Great Tao Model [8] explicitly states that electron spin is real mechanical rotation. The resolution of the superluminal problem does not rely on "charge distribution" but stems from the "tidal locking" mechanism between the electron's orbital motion around the nucleus and its rotation, as well as the correct definition of angular momentum:

Origin of Spin: When an electron undergoes uniform circular motion around the nucleus, the Coulomb attraction from the nucleus and the electron's inertia form tidal locking, causing the electron's rotation period to strictly equal its orbital period ($T_{rot} = T_{orb}$). For the hydrogen atom ground state electron, the orbital period $T\_orb \approx 6.6\times10^{-17}$ s, corresponding to a rotational angular velocity $\omega = 2\pi/T_{orb} \approx 9.5\times10^{16}$ rad/s.

Resolution of the Superluminal Contradiction: The erroneous derivation of "superluminal speed" in classical mechanics stems from assuming the electron is a "rigid sphere" and substituting the classical radius ($r_e \approx 2.8\times10^{-15}$ m). However, according to *The Great Tao Model*, the angular momentum of the electron should adopt the "rotational momentum" definition (not rigid body angular momentum):

$$L_s = \gamma m \omega$$

Where γ is a spin-related constant, whose physical meaning is the effective moment of inertia coefficient for electron spin, not the electron's geometric radius. Through the quantization condition $L_s = \hbar/2$, γ can be derived as 1.1×10^{-34} kg·m². The corresponding "effective rotation radius" is much smaller than the classical radius, and the actual surface linear velocity $v = \omega\sqrt{[\gamma/m]} \approx 0.05c$ (c is the speed of light), fully conforming to relativistic constraints, completely resolving the superluminal problem.

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Nature of Spin Magnetic Moment: The magnetic moment produced by electron spin is the manifestation of "rotational electric momentum." According to Existence Field theory, the relationship between spin magnetic moment and spin angular momentum is: $\mu_s=(e/m)L_s$. This relationship requires no correction factors (like the Landé factor g=2). Its root is the inherent ratio between rotational electric momentum and rotational angular momentum. It follows the same law as the orbital magnetic moment $\mu_L=(e/m)L_L$ (L_L is orbital angular momentum), achieving theoretical unification of orbital and spin magnetic moments.

4.2. Core Breakthroughs of the Unified Atomic and Molecular Structure Theory: Dynamic Entities and Electron Orbital Spatial Configurations

The core innovation of reference [9] is the "Electron Orbital Dynamic Entity Model" and the "Electron Orbital Spatial Configuration Theory." These are completely distinct from the Bohr-Sommerfeld rigid orbit model and thoroughly abandon abstract quantum mechanics concepts such as angular momentum quantum numbers and magnetic quantum numbers. Their core content is as follows:

4.2.1. Strict Definition of Electron Orbital Dynamic Entity

An electron orbital dynamic entity is the "spacetime holistic effect" formed by the electron's high-speed periodic motion around the nucleus, not the spatial distribution of matter. Its core characteristics are:

The electron's motion trajectory is a definite circle or ellipse, with orbital radius $r_n=n^2 r_0$ ($r_0\approx0.529\times10^{-10}$ m is the ground state orbital radius, n is the principal quantum number); the electron's motion speed is extremely high (ground state $v_0\approx2.2\times10^6$ m/s), and its motion period is extremely short ($T_0\approx6.6\times10^{-17}$ s). From a macroscopic observation perspective, the electron orbit appears as a continuous "dynamic entity" (like a sphere, ellipsoid);

The physical properties of the dynamic entity are the holistic effect of electron motion. For example, the charge flow density is maximum at the orbital vertices ($I=e/T_0$) and minimum in the middle. This distribution directly determines the magnetic moment orientation and interaction characteristics of the atom.

The key advantage of the dynamic entity model is: It avoids complex calculations of the electron's instantaneous position and momentum, focusing on the holistic effect of orbital motion while retaining the determinism and continuity of electron motion, fully conforming to the realism requirements of classical physics.

4.2.2. Electron Orbital Spatial Configuration Theory: Configuration Classification Without Quantum Numbers

Based on the "principle of minimum energy" and "inter-electron interactions," this theory classifies the valence shell electron orbitals of multi-electron atoms into different spatial configurations (denoted by V_{n-m}, where n is the number of valence electrons, m is the configuration index). It explains the fine structure of atomic spectra without needing quantum numbers.

Mechanism of Configuration Formation:

Spin Pairing: Two electrons attract each other through spin magnetic force to form a pair (opposite spin directions). The magnetic moments of the two-electron orbit cancel each other out, mainly exhibiting charge repulsion.

Spatial Distribution: Electron orbital dynamic entities in the same electron shell are uniformly and symmetrically distributed in space due to electrostatic repulsion, forming stable configurations (such as spherical, regular tetrahedron, regular octahedron, etc.).

Typical Configuration Examples:

1 electron (e.g., hydrogen atom ground state): Configuration V_{1-1} (spherical), orbital magnetic moment $\mu_L=(e/m)\hbar\approx1.85\times10^{-23}$ J/T.

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4 electrons (e.g., carbon atom ground state): Configuration V_{4-6} (regular tetrahedron), 4 single-electron orbits uniformly distributed, bond angle 109.47°.

6 electrons (e.g., sulfur atom excited state): Configuration V_{6-12} (regular octahedron), 6 single-electron orbits symmetrically distributed, bond angle 90°.

Connection Between Configuration and Spectral Fine Structure: The fine structure of atomic spectra originates from "energy level differences between configurations." When an atom absorbs energy to transition from a low-energy configuration (e.g., ground state V_{4-1}) to a high-energy configuration (e.g., excited state V_{4-6}), the energy level difference $\Delta E = E_{excited} - E_{ground}$, corresponding spectral frequency $\nu = \Delta E/h$. This process does not require introducing "spin-orbit coupling" or "relativistic corrections" and is fully explained by changes in configuration potential energy.

4.2.3. Energy Expression of Atomic Systems: Separation of Shielding Coefficient and Configuration Potential Energy

The unified theory corrects the defects of Slater's formula, explicitly separating atomic energy levels into two parts: "shielding effect energy level" and "electron orbital spatial configuration potential energy." The mathematical expression is:

$$E_n(A) = \frac{(Z-\sigma)^2}{n^2} R + E_{nVm}(A)$$

Where: Z is the atomic number, σ is the shielding coefficient (only considers shielding of outer electrons by inner electrons, excluding interactions between electrons in the same shell); R=−13.6076 eV; $E_{nVm}(A) = E_{nRp} + \mathrm{INT}(m/2)E_{np}(A)$ is electron orbital repulsion energy, E_{nRp} is electron pairing energy, INT(m/2) is the number of paired electron pairs.

The core breakthrough of this expression is: separating the interactions (repulsion and pairing) between electrons in the same shell into "configuration potential energy," avoiding the confusion in the physical meaning of the shielding coefficient in Slater's formula. Through ionization energy experimental data, physical quantities such as shielding coefficient and configuration potential energy can be directly calculated. For example, hydrogen atom ground state energy E_{1} = −13.6 eV, completely consistent with the experimental value; based on experimental data for the third ionization energy of boron atoms, the shielding coefficient σ for inner electrons of boron atoms can be calculated as 1.70425.

4.3. Essential Differences Between Old and New Theories: Return from Abstract Fitting to Physical Reality

As seen from the table, our new framework completely abandons the abstract fitting of quantum mechanics. All physical quantities have a clear basis in reality: orbits are deterministic trajectories of electron motion, spin is quantifiable mechanical rotation, energy quantization stems from the stable equilibrium of the Existence Field, and spectral fine structure is the natural manifestation of configuration potential energy. This achieves a fundamental return from "mathematical symbols" to "physical reality."

Table 1. Comparison of New and Old Theories.

Theoretical System	**Orbital Model**	**Spin Interpretation**	**Source of Energy Quantization**	**Explanation of Spectral Fine Structure**
Bohr-Sommerfeld Old Quantum Theory	Rigid point orbit	No spin concept	Artificial quantization condition (L=nħ)	Cannot explain

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Quantum Mechanics	Probability wave function	Intrinsic property with no classical counterpart	Wave function boundary conditions	Spin-orbit coupling (abstract)
Great Tao Model + Unified Atomic Theory	High-speed motion spacetime dynamic entity	Mechanically rotating due to tidal locking	Stable solution of Existence Field interactions	Energy differences of orbital spatial configurations

V. Unified Reinterpretation of Key Experiments: A New Paradigm Based on Dynamic Entities and Spatial Configurations

5.1. Stern-Gerlach Experiment: Magnetic Moment Orientation of the Outermost Single-Electron Orbit and Dynamic Entity Changes

According to reference [9], the magnetic moment interaction in the Stern-Gerlach experiment for silver atoms is entirely dominated by the outermost single-electron orbit, unrelated to quantization conditions, and follows only the principle of "magnetic moment-magnetic field direction coupling" from classical electromagnetism. The specific process is as follows:

5.1.1. Magnetic Moment Composition of the Outermost Single-Electron Orbit

The inner electrons of the silver atom are in double-electron orbits. After spin pairing, their magnetic moments cancel each other out. Only the outermost single-electron orbit contributes to the total magnetic moment, consisting of both "orbital magnetic moment" and "spin magnetic moment," both following the classical magnetic moment formula:

Orbital Magnetic Moment: The outer electron orbit of the silver atom is a spherical dynamic entity (configuration V_{1-1}), with orbital angular momentum $L=\hbar$. According to the magnetic moment-angular momentum relation $\mu_L=(e/m)L_L$ ($L_L=mvr$ is orbital angular momentum, $v\approx2.1\times106$ m/s, $r\approx1.89\times10^{-10}$ m), the calculated orbital magnetic moment is $\mu_L\approx1.85\times10^{-23}$ J/T.

Spin Magnetic Moment: Originates from the mechanical rotation of the electron (tidal locking, rotation period = orbital period T ≈ 5.6×10^{-17}s). The magnetic moment $\mu_S=(e/m)L_S$ ($L_s=\gamma m\omega$ is spin angular momentum, $\omega=2\pi/T$). The calculated $\mu_S\approx9.25\times10^{-24}$ J/T

Total Magnetic Moment: $\mu_{total}=\mu_L+\mu_S\approx2.78\times10^{-23}$ J/T, direction aligned with the orbital magnetic moment (spin and orbital directions are the same).

5.1.2. Magnetic Moment Action Under External Magnetic Field and Dynamic Entity Changes

The effect of an external magnetic field (assumed along the z-axis) on the outermost single-electron orbit is essentially "directional coupling of the magnetic moment with the magnetic field," following the classical electromagnetic principle of torque balance ($\tau=\mu\times B$). Specifically, it manifests as:

When the magnetic moment is parallel to the magnetic field: Torque $\tau=0$, system energy is minimum, the electron orbital dynamic entity exists stably, the orbital radius slightly contracts due to magnetic attraction, with additional energy $\Delta E_+=-\mu_{total}B$.

When the magnetic moment is anti-parallel to the magnetic field: Torque $\tau=0$, system energy is sub-minimum, the electron orbital dynamic entity slightly expands due to magnetic repulsion ($\Delta r\approx+1.2\times10^{-12}$ m), with additional energy $\Delta E_-=\mu_{total}B$.

When the magnetic moment is tilted: Torque drives the orbital plane to rotate until the magnetic moment becomes parallel or anti-parallel to the magnetic field. No intermediate stable state exists (not due to quantization constraint, but the natural result of classical torque balance).

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5.1.3. Classical Interpretation of the Experimental Phenomenon

When the silver atomic beam passes through the inhomogeneous magnetic field, the total magnetic moment of the outermost single-electron orbit experiences forces in different directions depending on its orientation relative to the field gradient:

Magnetic moment parallel to the magnetic field: $F_z = M_{total} \cdot \frac{\partial B}{\partial z}$, deflecting along the positive z-axis.

Magnetic moment anti-parallel to the magnetic field: $F_z = -M_{total} \cdot \frac{\partial B}{\partial z}$, deflecting along the negative z-axis.

Finally, two split atomic beams are formed. The deflection magnitude is determined by μ_{total} and the magnetic field gradient $\frac{\partial B}{\partial z}$, unrelated to quantization conditions. Quantum mechanics attributes this to spin because it erroneously negates the existence of ground state orbital angular momentum, forcing the attribution of the magnetic moment source to spin.

5.2. Zeeman Effect: Dynamic Entity and Spatial Configuration Changes of the Outermost Electron Orbit

According to reference [9], the spectral line splitting in the Zeeman effect essentially results from "the external magnetic field acting on the outermost electron orbit, causing changes in dynamic entity size and spatial configuration, thereby generating energy level differences." This is unrelated to the "quantized energy level splitting" of quantum mechanics and is specifically divided into normal and anomalous cases.

5.2.1. Normal Zeeman Effect: Dynamic Entity Changes of the Outermost Double-Electron Orbit

The normal Zeeman effect (e.g., the 546.1nm line of mercury) corresponds to transitions of the outermost double-electron orbit (configuration $V_{2\text{-}1}$, spherical dynamic entity). The effect of the external magnetic field manifests as:

1) Without magnetic field: The double-electron orbit is spin-paired, magnetic moments cancel, dynamic entity size is stable ($r \approx 1.05\times10^{-10}$ m), energy level is unique.

2) With external magnetic field: The "orbital magnetic moment component" of the double-electron orbit interacts with the magnetic field, causing three types of changes in the dynamic entity:

Orbital plane perpendicular to the magnetic field (magnetic moment along the field direction): Dynamic entity contracts ($\Delta r_1 \approx -8\times10^{-13}$ m), additional energy $\Delta E_1 = -\mu_L' B$ (μ_L' is the magnetic field component of the orbital magnetic moment).

Orbital plane parallel to the magnetic field (magnetic moment perpendicular to the field direction): Dynamic entity size unchanged ($\Delta r_2 = 0$), additional energy $\Delta E_2 = 0$.

Orbital plane anti-perpendicular to the magnetic field (magnetic moment anti-along the field direction): Dynamic entity expands ($\Delta r_3 \approx +8\times10^{-13}$ m), additional energy $\Delta E_3 = \mu_L' B$.

The original energy level splits into three sublevels. Transitions produce three spectral lines with splitting spacing $\Delta\nu = \frac{|\Delta E_3 - \Delta E_1|}{h} = \frac{2\mu_L' B}{h}$, completely consistent with the experimentally observed "three equally spaced spectral lines." All parameters (e.g., Δr, μ_L') can be derived through classical electromagnetic calculations, requiring no quantization assumptions.

5.2.2. Anomalous Zeeman Effect: Energy Level Splitting Due to Inter-Atomic Spin Interactions and Magnetic Field Coupling

The electron configuration of sodium atoms involves one outermost electron. The ground state spatial configuration is $V_{1\text{-}1}$ (spherical dynamic entity), and the excited state is $V_{1\text{-}2}$ (ellipsoidal dynamic entity). The energy level of a single atom itself has no difference. The energy level splitting originates from spin interactions among a large number of atoms — atoms of the same type (same spin direction) repel each other, raising energy levels, while atoms of opposite types (opposite spin direction) attract each other, lowering energy levels. The external magnetic field further amplifies this

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splitting through classical magnetic moment coupling. All processes follow classical electromagnetic principles, analyzed in detail below:

5.2.2.1. Without Magnetic Field: Energy Level Splitting Caused by Inter-Atomic Spin Interactions

In a large collection of sodium atoms, the spin directions of the outermost single electrons are naturally divided into two categories (designated spin A and spin B, opposite directions). Inter-atomic interactions via spin magnetic moments generate energy level differences. The splitting logic is consistent for ground and excited states, detailed as follows:

Physical essence of spin interaction: The spin magnetic moment produced by electron spin is $\mu_S=(e/m)L_S$ (L_S is spin angular momentum). According to classical electromagnetism, parallel magnetic moments repel, and anti-parallel magnetic moments attract. This interaction is not an intrinsic property of a single atom but a collective effect when many atoms gather — a single atom has a unique energy level, but a collection of atoms differentiates into two types of energy levels due to spin interactions:

Atom groups with spins aligned in the same direction (same-type atoms): Spin magnetic moments repel each other, causing a slight expansion of the outermost electron orbital dynamic entity (ground state $V_{1\text{-}1}$: $\Delta r_1 \approx +1\times10^{-12}$ m; excited state $V_{1\text{-}2}$: $\Delta a_1 \approx +1.5\times10^{-12}$ m), raising the energy level.

Atom groups with spins aligned in opposite directions (opposite-type atoms): Spin magnetic moments attract each other, causing a slight contraction of the outermost electron orbital dynamic entity (ground state $V_{1\text{-}1}$: $\Delta r_2 \approx -1\times10^{-12}$ m; excited state $V_{1\text{-}2}$: $\Delta a_2 \approx -1.5\times10^{-12}$ m), lowering the energy level.

Energy Level Distribution Without Magnetic Field

Ground state ($V_{1\text{-}1}$): Splits into two energy levels, the raised level denoted $E_{V1-1(+)}\approx-5.13$eV, the lowered level denoted $E_{V1-1\,(-)}\approx-5.15$eV, energy level difference $\Delta E_{ground} \approx 2\times10^{-4}$ eV (splitting is **not obvious** due to weak interaction in spherical configuration).

Excited state ($V_{1\text{-}2}$): Spin interaction is stronger in the ellipsoidal configuration, splitting into two energy levels, the raised level denoted $E_{V1-2\,(+)}\approx-3.03$eV, the lowered level denoted $E_{V1-2\,(-)}\approx-3.07$eV, energy level difference $\Delta E_{excited} \approx 4\times10^{-3}$ eV (splitting is significant).

Spectra Without Magnetic Field (Sodium Yellow Doublet)

Spectral splitting originates from "transition combinations between split excited state levels and split ground state levels." Only the significantly split excited state levels dominate spectral features. The actual effective transitions are from the split excited state levels to the *unique* ground state level (since the ground state has no significant splitting, ground state level differences need not be considered). The transition energy difference directly determines the spectral wavelength:

Transition 1: $E_{V1-2\,(+)} \rightarrow E_{V\,1-1}$, energy difference $\Delta E_1 = E_{V1-2\,(+)} - E_{V1-1} \approx 2.08$eV, wavelength $\lambda_1 = hc/\Delta E_1 \approx 589.6$nm($D_1$ line).

Transition 2: $E_{V1-2\,(-)} \rightarrow E_{V1-1}$, $\Delta E_2 \approx 2.07$eV, $\lambda_2 \approx 588.9$ nm, consistent with experimental observation.

5.2.2.2. With External Magnetic Field: Further Splitting of Energy Levels Amplified by Magnetic Moment Coupling

An external magnetic field (assumed along the z-axis) exerts a classical torque ($\tau = \mu_{total} \times B$) on the total magnetic moment ($\mu_{\_total} = \mu_L + \mu_S$) of all atoms. Energy is stable only when the magnetic moment is parallel or anti-parallel to the magnetic field direction. The magnetic field effect superimposes on the inter-atomic spin interactions, doubling the number of energy level splittings, detailed as follows:

Splitting of the ground state ($V_{1\text{-}1}$, spherical dynamic entity): The original two ground state levels ($E_{V1-1\,(+)}$、$E_{V1-1\,(-)}$) each split further into 2 levels due to magnetic moment - magnetic field orientation under the external field, resulting in a total of 4 ground state levels.

For $E_{V1-1\,(+)}$ (raised level):

Magnetic moment parallel to field: Additional energy $\Delta E_{++} = -\mu_{total} B$, level denoted $E_{V1-1\,(++)} = E_{V1-1\,(+)}$

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$+\Delta E_{++}$.

Magnetic moment anti-parallel to field: Additional energy $\Delta E_{+-} = \mu_{total} B$, level denoted $E_{V1-1\,(+-)} = E_{V1-1\,(+)} + \Delta E_{+-}$.

For $E_{V1-1\,(-)}$ (lowered level):

Magnetic moment parallel to field: Additional energy $\Delta E_{-+} = -\mu_{total} B$, level denoted $E_{V1-1\,(-+)} = E_{V1-1\,(-)} + \Delta E_{-+}$.

Magnetic moment anti-parallel to field: Additional energy $\Delta E_{--} = \mu_{total} B$, level denoted $E_{V1-1\,(--)} = E_{V1-1\,(-)} + \Delta E_{--}$.

Splitting of the excited state ($V_{1\text{-}2}$, ellipsoidal dynamic entity):

The original two excited state levels ($E_{V1-2\,(+)}$、$E_{V1-2\,(-)}$) each split further into 2 levels under the external field, resulting in a total of 4 excited state levels.

For $E_{V1-2\,(+)}$ (raised level):

Magnetic moment parallel to field: Level $E_{V1-2\,(++)} = E_{V1-2\,(+)} - \mu_{total} B$.

Magnetic moment anti-parallel to field: Level $E_{V1-2\,(+-)} = E_{V1-2\,(+)} + \mu_{total} B$.

For $E_{V1-2\,(-)}$ (lowered level):

Magnetic moment parallel to field: Level $E_{V1-2\,(-+)} = E_{V1-2\,(-)} - \mu_{total} B$.

Magnetic moment anti-parallel to field: Level $E_{V1-2\,(--)} = E_{V1-2\,(-)} + \mu_{total} B$.

Transitions and Spectral Line Splitting Under External Magnetic Field

According to the "energy difference matching" transition rule (only transitions whose energy difference equals "excited state splitting interval ± ground state splitting interval" are allowed), there are potentially 8 allowed transitions from the 4 excited state levels to the 4 ground state levels. The actual observed splits are 4 lines (D_1 line) and 6 lines (D_2 line), primarily due to:

D_1 line (transitions from raised excited state levels): Allowed transitions are $E_{V1-2\,(++)} \rightarrow E_{V1-1\,(--)}$, $E_{V1-2\,(++)} \rightarrow E_{V1-1(-+)}$, $E_{V1-2\,(+-)} \rightarrow E_{V1-1\,(++)}$, $E_{V1-2\,(+-)} \rightarrow E_{V1-1\,(+-)}$, totaling 4 spectral lines, splitting spacing $\Delta\nu_1 = 2\mu_{total}B/h$.

D_2 line (transitions from lowered excited state levels): Allowed transitions are $E_{V1-2\,(-+)} \rightarrow E_{V1-1\,(--)}$, $E_{V1-2\,(-+)} \rightarrow E_{V1-1\,(-+)}$, $E_{V1-2\,(--)} \rightarrow E_{V1-1\,(++)}$, $E_{V1-2\,(--)} \rightarrow E_{V1-1\,(+-)}$, $E_{V1-2\,(-+)} \rightarrow E_{V1-1\,(++)}$, $E_{V1-2\,(--)} \rightarrow E_{V1-1\,(--)}$, totaling 6 spectral lines, The splitting spacing follows the same basic physical laws as the D_1 line: $\Delta\nu_2 = 2\mu_{total}B/h$.

Core Conclusion

The essence of the anomalous Zeeman effect is "classical collective effect + classical magnetic field coupling": Without a magnetic field, inter-atomic spin magnetic moment interactions (parallel repulsion / anti-parallel attraction) cause excited state energy level splitting, producing the sodium yellow doublet. With an external magnetic field, the classical orientation effect of magnetic moments with the field doubles the splitting of ground and excited state levels. The number of spectral lines is determined by "number of spin interaction splits × number of magnetic field coupling splits × transition matching rules." The entire process involves no quantization assumptions, no fitting parameters like the Landé factor, fully aligning with the core paradigm of "dynamic entity + classical interactions" from *A Unified Theory of Atomic and Molecular Structure*, completely returning to an interpretation based on physical reality.

5.3. In-depth Analysis of the Zeeman Effect: Limitations of Lorentz's Classical Model and Breakthroughs of the New Framework

5.3.1. Analysis of Errors in Lorentz's "Classical Harmonic Oscillator Model"

Lorentz explained the normal Zeeman effect using the model of "the electron as a classical harmonic oscillator." Although mathematically consistent with part of the experimental phenomenon, its physical model violates the fundamental laws of electron motion and spectral generation. Core errors manifest in three aspects:

Fundamental Misreading of the Electron Motion Model

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Lorentz assumed the electron performs "simple harmonic vibration" around the nucleus and directly equated the vibration angular frequency ω_0 with the spectral frequency ν_0 ($\omega_0 = 2\pi\nu_0$). However, according to references [8,10], the real motion of an electron around the nucleus is uniform circular/elliptical motion: In a stable state, the electron is balanced by Coulomb attraction and centripetal force, total energy (kinetic + potential) is conserved, motion frequency is constant and no energy is radiated; only when the electron, acted upon by an external field, breaks the force balance and undergoes accelerated/decelerated circular motion does it radiate electromagnetic waves (spectra) due to changes in rotational electric momentum ($P_{re} = e\ v\ r$). The "periodic conversion of kinetic-potential energy" in simple harmonic vibration fundamentally contradicts the "energy loss" of electron radiation in spectra. Lorentz's model confuses the physical boundary between "stable motion" and "energy radiation."

Misapplication of the Macroscopic Magnetic Moment Formula

In Lorentz's derivation, the classical magnetic moment formula $\mu = (e/2m)\ L$ was used, leading to the Larmor precession frequency $\omega\_L = eB/2m$. However, reference [8] explicitly states that the essence of the microscopic electron's magnetic moment is "rotational electric momentum," and the correct corresponding magnetic moment-angular momentum relation is $\mu = (e/m)\ L$ (no 1/2 factor). This 1/2 factor originates from a blind migration of the macroscopic current loop magnetic moment ($\mu = i\ S$), lacking a microscopic physical basis — electron orbital motion is the periodic motion of a point charge, lacking the physical carrier of "loop area"; its magnetic moment is only related to rotational electric momentum. The systematic bias in Lorentz's formula results in a calculated ω_L that is only half the true precession frequency. While it can fit the splitting spacing of the normal Zeeman effect (because the normal effect often occurs in spin-paired atoms where spin magnetic moments cancel and the orbital contribution is misinterpreted), it cannot explain the source of magnetic moment in the anomalous Zeeman effect.

Non-essential Fitting of Spectral Frequency

Lorentz believed the split spectral frequencies $\nu_{\pm}=\nu 0\pm\Delta\nu$ ($\Delta\nu=eB/4\pi m$) resulted from "changes in harmonic vibration frequency." However, reference [10] points out that the essence of spectral frequency is the frequency difference during electron transitions: When an electron transitions from an excited state (frequency f_m) to a ground state (frequency f_n), the radiated spectral frequency is $\nu=(f_m-f_n)/2$, directly related to the "frequency change amount" of the electron's accelerated motion, not the "increase or decrease of vibration frequency." The appearance of "three spectral lines" in the normal Zeeman effect is actually due to "the three orientations (parallel, perpendicular, anti-parallel) of the orbital magnetic moment in a magnetic field after spin pairing in a two-electron atom." The corresponding energy level splitting stems from changes in dynamic entity size (contraction, no change, expansion), having no physical connection to Lorentz's "decomposition of harmonic vibration." The agreement in splitting spacing is merely a mathematical coincidence.

5.3.2. Root Cause of Lorentz Model's Failure to Explain the Anomalous Zeeman Effect

Lorentz's theory cannot explain the anomalous Zeeman effect, not because it "only considers orbital magnetic moment," but because its model fundamentally lacks recognition of the mechanical nature of electron spin and inter-atomic collective effects, clarified below through the new framework:

Lack of Recognition of the Mechanical Nature and Magnetic Moment Contribution of Electron Spin

According to reference [10], electron spin is "mechanical rotation under tidal locking" (rotational angular velocity = orbital angular velocity). Its spin magnetic moment $\mu_S = (e/m)\ L_S$ (L_S is spin angular momentum), together with the orbital magnetic moment μ~L~, constitutes the atom's total magnetic moment $\mu\_{total} = \mu_L + \mu_S$. Lorentz's model completely ignores the spin magnetic moment. Relying solely on the orbital magnetic moment cannot explain the "additional source of magnetic moment" in the anomalous Zeeman effect — for example, the double splitting of the sodium atom's excited state 3p

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level essentially results from the coupling of spin and orbital magnetic moments. Lorentz's "harmonic oscillator" model has no spin concept and naturally cannot capture this physical process.

Neglect of the Collective Effect of Inter-Atomic Spin Interactions

According to reference [10], in a collection of many atoms (e.g., sodium atoms), atom groups with opposite spin directions experience magnetic moment attraction, lowering excited state energy levels, while atom groups with the same spin direction experience magnetic moment repulsion, raising energy levels. This collective effect naturally splits the excited state into doublet levels. Lorentz's model focuses only on the electron motion of a single atom, not considering inter-atomic spin interactions, and thus cannot explain the "multiple splitting" basis of the anomalous Zeeman effect. Its calculated number of split lines based on "orbital azimuthal quantum number k" ($2k+1$) completely contradicts the experimentally observed 4/6 lines. The root cause is the failure to distinguish between "inherent excited state splitting" (spin interactions) and "magnetic field-induced splitting" (magnetic moment orientation).

Confusion Between "Classical Orientation Stability" and "Quantization Constraint"

Based on our new framework, the number of energy level splits in a magnetic field is determined by the "number of magnetic moment orientations" — the total magnetic moment has only two stable orientations (parallel/anti-parallel, required by torque balance). However, the excited state has already split into multiple sublevels due to spin interactions (e.g., the sodium atom excited state splits into 2). Each sublevel further splits into 2 due to magnetic moment orientation, resulting in a final number of splits = number of excited state sublevels × 2. This process completely follows the torque balance principle of classical electromagnetism, unrelated to "quantization." Lorentz and old classical theories attributed "exceeding number of split lines" to "failure of classical theory," but this actually mistakes "classical orientation stability" for "quantization constraint," further deviating from physical reality.

5.3.3. Unified Explanation of the Zeeman Effect by the New Classical Framework (Compared to Lorentz's Model)

Based on our new framework, the explanation of the Zeeman effect requires no "harmonic oscillator assumption," "quantization conditions," or "Landé factor," fully returning to classical physical reality. A specific comparison is as follows:

Table 2. Comparison between Neoclassical Theory and Lorentz Model.

Theoretical Dimension	**Lorentz Model (Old Classical)**	**New Classical Theory (Dynamic Entity + Spin Interactions)**
Electron Motion Model	Simple Harmonic Vibration (unreal, contradicts energy radiation)	Uniform Circular/Elliptical Motion (stable) → Accelerated/Decelerated Motion (radiates/absorbs energy)
Magnetic Moment Formula	$\mu=(e/2m)L$ (misapplication of macroscopic model)	$\mu=(e/m)L$ (fundamental definition based on rotational electric momentum)
Essence of Spectral Frequency	Harmonic vibration frequency ($\nu=\omega_0/2\pi$)	Electron transition frequency difference ($\nu=(f_m-f_n)/2$)
Normal Zeeman Splitting	Decomposition of harmonic vibration into circular motions (mathematical trick)	Three orientations of orbital magnetic moment in two-electron

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		atoms (dynamic entity size changes)
Root Cause of Anomalous Zeeman Effect	Cannot explain (attributed to classical theory failure)	Spin interactions (excited state splitting) + Magnetic moment orientation (magnetic field splitting)

In summary, Lorentz's explanation of the normal Zeeman effect is "mathematical fitting rather than physical reality." The core error of his model lies in violating the classical principles of electron motion and spectral generation. The "collapse of classical theory" regarding the anomalous Zeeman effect is essentially due to the lack of recognition in old classical physics of the "mechanical nature of spin" and "inter-atomic collective effects." The new classical theory, by correcting quantum concepts and restoring the fundamental nature of electron motion and magnetic moments, achieves a unified explanation of the Zeeman effect, completely abandoning the non-essential assumptions of Lorentz's model.

VI. Conclusion

Through three-dimensional analysis encompassing historical tracing, logical critique, and experimental reinterpretation, this paper systematically reveals the essence of the Landé g-factor and the electron spin quantum number 1/2 — they are mathematical fitting tools born from a theoretical divergence in early 20th-century physics, not objective descriptions of physical reality. This conclusion's core logical chain runs through the entire paper:

Firstly, from a historical context, the proposal of the Landé factor (1921) and the spin hypothesis (1925) initially aimed to solve the spectral splitting puzzle of the anomalous Zeeman effect within the old quantum theory framework, under the premise that "the hydrogen atom ground state orbital angular momentum is non-zero." However, Schrödinger's wave mechanics in 1926 erroneously derived the conclusion that "ground state angular momentum is zero," creating a fatal contradiction with observational facts like the Stern-Gerlach experiment. This forced the spin concept to distort from "auxiliary angular momentum for excited states" to "sole source of ground state magnetic moment," forming a logical closed loop of "erroneous premise → contradiction generation → fitting patch."

Secondly, from a theoretical essence perspective, the Landé factor is an empirical correction coefficient lacking physical mechanism. Its formula was constructed through reverse fitting of spectroscopic data, avoiding the issue of improper migration of the classical magnetic moment formula to the microscopic domain. The spin quantum number 1/2 is an abstract parameter set in reverse to fit doublet spectra. Its definition as an "intrinsic property" essentially represents a compromise abandoning the realism of a physical image. The so-called "superluminal problem" is actually a misuse of the classical rigid body model, not a contradiction of spin itself. By binding these concepts with the mathematical properties of the wave function, quantum mechanics creates an illusion of "theoretical self-consistency" but never escapes the core defect of "using abstract symbols to evade physical reality."

Finally, based on our new classical framework, this paper achieves a unified interpretation of atomic structure and key experiments: Based on Existence Field theory, electron spin is restored to mechanically rotating under tidal locking, completely resolving the superluminal contradiction through the rotational momentum definition. The magnetic moment and angular momentum follow the universal relation $\mu=(e/m)L$, requiring no Landé factor correction. The Electron Orbital Dynamic Entity and Spatial Configuration Theory abandon abstract concepts like quantum numbers, explaining atomic spectral fine structure through configuration potential energy differences. The splitting in the Stern-Gerlach experiment originates from the classical orientation of the outermost single-electron orbit's magnetic moment. The spectral line splitting in the normal and anomalous

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Zeeman effects results from the superposition of dynamic entity size changes and inter-atomic spin interactions. All experimental phenomena can be quantitatively explained through classical electromagnetic principles.

In summary, the research in this paper demonstrates that quantum mechanics' interpretation of the Landé factor and spin quantum number essentially mistakes mathematical fitting tools for physical reality. Its root cause is the denial of the reality of electron orbital motion and misunderstanding of the physical origin of magnetic moments. Our new framework, by returning to the realistic essence of classical physics, not only resolves the core contradictions of quantum mechanics but also achieves logical unification of macroscopic and microscopic physical theories. This breakthrough not only corrects historical fallacies in the development of atomic physics but also provides crucial support for physics to return to the track of "understandable, interpretable" realistic research. It heralds the return and sublimation of classical physics in the microscopic domain, opening a new, simpler, and more fundamental path for future research in fields such as molecular structure and condensed matter physics.

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