Classical Physical Explanation of the Lamb Shift Based on the Great Tao Model

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Abstract: The Lamb shift is a landmark phenomenon in the fine structure of hydrogen atomic energy levels. In mainstream physics, it is regarded as a core experimental cornerstone of quantum electrodynamics (QED), with explanations relying on abstract concepts such as vacuum fluctuations and virtual particle exchange, which lack physical reality. Based on the classical physical framework of the Great Tao Model, this paper elucidates the Lamb shift from the geometric differences between the composite structure of the proton and the dynamic entities of electron orbits. We demonstrate that the Lamb shift is not necessarily a special phenomenon requiring quantum theoretical explanation but can be understood as a natural outcome of classical electromagnetic interactions. By rigorously deriving the periodic electric field intensity formula and the spin-orbit coupling energy, and using a "first-estimate-then-optimize" method, an optimized parameter $\cos\theta \approx 0.28$ is obtained, consistent with physical reality and geometric constraints. The calculated result aligns with the experimental value of 1057 MHz. Recent research on the Lamb shift has expanded into cutting-edge fields such as anti-matter spectroscopy and precision measurements of muonic hydrogen. The classical framework proposed in this paper offers an alternative theoretical pathway for understanding these new experimental phenomena. This paper offers an alternative perspective on the theoretical status of the Lamb shift in quantum mechanics, demonstrating that the classical physical framework also possesses the potential to fully explain this microscopic phenomenon. It provides another possible theoretical path for exploring a new paradigm of fundamental physics that unifies the macroscopic and microscopic realms.

Keywords: Lamb shift; Great Tao Model; Electron orbit dynamic entity; Proton structure; Periodic electric field; Classical electromagnetic interaction; Physical paradigm

1. Introduction

In 1947, Lamb and Retherford first observed, via microwave spectroscopy, a tiny energy splitting of approximately 1057 MHz between the $2S_{1/2}$ and $2P_{1/2}$ states in the hydrogen atom's n = 2 energy level, where the principal quantum number n = 2 and the total angular momentum quantum number j = 1/2 [1]. This phenomenon was formally named the Lamb shift. Its discovery carries milestone physical significance: it directly challenged the theoretical framework of Dirac's relativistic quantum mechanics—the Dirac equation predicted that the $2S_{1/2}$ and $2P_{1/2}$ states should be degenerate, whereas the existence of the Lamb shift indicated that the energy level structure of the microscopic world required a more refined theoretical explanation [2].

As the "birth opportunity and core experimental pillar" of quantum electrodynamics (QED), the explanation of the Lamb shift became a key benchmark for testing the validity of microscopic physical theories [3]. Feynman, Schwinger, and Tomonaga, based on quantum field theory concepts such as “vacuum fluctuations”, “virtual particle exchange”, and “electron self-energy correction", successfully fitted the experimental value of the Lamb shift using renormalization techniques, establishing the theoretical foundation of QED [4]. This achievement earned them the 1965 Nobel Prize in Physics [5]. Although the computational precision of QED for the Lamb shift has reached an extremely high level, with the deviation between theoretical values and experimental results entering the kMHz range [6], the measurement of the Lamb shift has even become a key method for determining the proton charge radius in high-precision experiments such as those involving muonic hydrogen. In 2022, a team from Peking University completed the first lattice QCD calculation of the two-photon exchange contribution, laying the foundation for understanding the influence of proton structure on the Lamb shift from first principles [7]. Within the mainstream physics framework, the Lamb shift is defined as a "typical quantum phenomenon," and its existence is regarded as decisive evidence that "classical physics fails in the microscopic domain," supporting the core position of quantum field theory as the fundamental framework for microphysics [3].

However, QED’s explanation of the Lamb shift has always been accompanied by profound logical contradictions and a lack of physical imagery: concepts such as vacuum fluctuations and virtual particles lack direct experimental verification and are essentially mathematical abstractions introduced to fit calculation results [8]. Furthermore, the computational process of QED is completely disjointed from classical physical laws, failing to form an intuitive physical picture and resulting in a logical disconnect between microscopic and macroscopic physical systems [9]. Despite QED’s high mathematical precision [10,11], its abstract theoretical framework and the inherent conceptual issues stemming from its lack of realistic physical assumptions remain points of controversy in fundamental physics and have sparked ongoing, profound debates in the philosophy of science [12]. In recent years, the academic community has continued to explore alternative explanatory pathways for the Lamb shift. For example, in 2025, Yordanov proposed a derivation of the Lamb shift based on proton Brownian motion, which completely avoids reliance on renormalization techniques[13]; Meads, on the other hand, re-examined Feynman's self-interaction interpretation, attempting to eliminate the unphysical contributions introduced by ultraviolet cutoffs [14]. These explorations indicate that rethinking and reconstructing the physical picture of the Lamb shift is currently an active direction in theoretical physics research.

In recent years, based on the Yin-Yang principle and the first-principle priority of physical facts, the Great Tao Model has revealed the composite particle structure of the proton and the core characteristics of the electron orbit dynamic entity [15,16], providing a new theoretical framework for classical physics to delve into the microscopic world. This model discards the probabilistic interpretation and abstract assumptions of quantum mechanics, focusing instead on the actual structure of matter and classical laws of motion, thereby achieving logical unity between macroscopic and microscopic physics. Based on the Great Tao Model, this paper centers on the periodic non-point-charge electromagnetic field of the composite proton and the geometric configuration differences of electron orbit dynamic entities. We deduce the physical essence of the Lamb shift through classical electromagnetism and employ a “first general estimation, then physical parameter optimization” quantitative method. Without any abstract assumptions, we achieve precise alignment between theoretical results and experimental values. The research suggests that the Lamb shift may not necessarily be a special phenomenon requiring quantum theoretical explanation but can similarly be understood as a natural product of classical electromagnetic interaction. This understanding offers a different view on QED's theoretical positioning of the Lamb shift as its core experimental cornerstone, and hints that, at the level of physical imagery, there may exist another explanatory path based on the actual structure of matter. Through a systematic comparison of the core differences between the classical physical framework and quantum mechanics in explaining the Lamb shift, combined with multidimensional experimental verification and theoretical self-consistency analysis, this paper lays the key experimental and theoretical groundwork for constructing a new paradigm of fundamental physics that unifies the macroscopic and microscopic realms, as an alternative to quantum mechanics.

2. Theoretical Basis

2.1 Composite Proton Structure and Periodic Electric Field Characteristics in the Great Tao Model

The Great Tao Model specifies that the hydrogen atom's nucleus (proton) is a stable composite particle composed of two fundamental particles [15]:

Positron (e^+): Carries one unit of positive charge (+e) and undergoes uniform high-frequency rotational motion around the subston (angular frequency $\omega \approx 1.28 \times 10^{20}$ rad/s, derived based on gravitational centripetal force balance).

Subston: Electrically neutral, with a mass approximately 1835 times that of the electron, constituting the primary source of the proton's mass and forming the true core of the proton.

The uniform rotation of the positron lacks an acceleration process and therefore does not generate electromagnetic waves with energy transfer effects. However, according to the Existence Field Theory of the Great Tao Model, its periodic rotation diffuses charge information into the surrounding space, forming a **spatially non-uniform periodic electric field**—this field only exhibits periodic distribution fluctuations without energy radiation loss, belonging to an "electric field wave" rather than an energy-transferring electromagnetic wave [15].

Theoretically, the proton's true core (subston + positron rotation orbit) scale is less than 1.9×10^{-26} m. Experimentally, the proton charge radius measured via electron scattering experiments is approximately 0.84 fm (i.e., 0.84×10^{-15} m) [17]. It is worth noting that precise measurements of the Lamb shift in muonic hydrogen in 2010 yielded a significantly smaller value for the proton radius, sparking the famous "proton radius puzzle." It was not until recent years that results from high-precision electron scattering experiments and muonic hydrogen measurements converged [7]. This history fully demonstrates that the understanding of the Lamb shift is closely related to the study of proton structure. The significant difference between these two values stems from their different physical meanings: the experimental measurement value (~0.84 fm) reflects the critical distance at which significant electromagnetic interaction occurs between the proton and the detecting device, i.e., the effective range of its charge distribution; whereas the theoretical value (1.9×10^{-26} m) describes the true core scale of the internal positron rotating around the subston. When the distance r is much greater than the proton's true core radius R_p, the proton can be treated as a point charge; when r approaches R_p, the non-point-charge effects (periodic electric field) of its internal structure become significant. The interaction between the extranuclear electron and the proton is essentially a classical electromagnetic coupling with this periodic non-uniform electric field.

2.2 Electron Orbit Dynamic Entity Model

According to the Unified Theory of Atomic and Molecular Structure [16], the high-speed periodic motion of electrons around the nucleus forms an **electron orbit dynamic entity**. Its space-time holistic effect determines physical properties, eliminating the need to track the electron's instantaneous position and momentum. Within the hydrogen atom's n = 2 energy level, differences in electron motion modes, despite the same principal quantum number, cause the dynamic entity to exhibit two clearly distinguishable geometric configurations, forming the core cause of the Lamb shift:

Spherical Dynamic Entity (corresponding to the quantum mechanical $2S_{1/2}$ state): The electron performs circular motion around the nucleus while the orbital plane precesses uniformly around its own diameter, forming a spherical structure without directional bias. Its characteristic orbital radius is $r_s=4r_0=2.116\times10^{-10}$m($r_0$ is the Bohr radius), serving as the direct basis for calculating electrostatic potential energy and spin-orbit coupling energy in this configuration. Due to the smaller orbital radius, the electron interacts more closely with the proton's periodic electric field, resulting in stronger electromagnetic coupling.

Ellipsoidal Dynamic Entity (corresponding to the quantum mechanical $2P_{1/2}$ state): The electron performs elliptical motion around the nucleus with a fixed orbital plane (no precession), forming an ellipsoidal structure with major and minor axes. Its orbital semi-major axis is $a_e = 2.5 \times 10^{-10}$ m (i.e., r_e used in calculations), serving as the direct basis for quantitative calculation of all energy terms in this configuration. Due to the semi-major axis being larger than the characteristic radius of the spherical entity, the electron interacts at a greater distance from the strong-action region of the proton's periodic electric field, resulting in weaker electromagnetic coupling.

The r_s and a_e of the two dynamic entities are the core radial parameters for quantitative calculation. Their inherent numerical differences directly determine the numerical differences in electromagnetic coupling energy and electrostatic potential energy between them and the proton's periodic electric field. Superimposed with the geometric parameter correction effect of spin-orbit coupling energy, these differences ultimately form the tiny energy level splitting, i.e., the Lamb shift. All qualitative explanations are based on these numerical differences, fully corresponding to the calculation process without introducing any additional parameters or logical contradictions.

2.3 Classical Nature of Electron Spin-Orbit Coupling

In the Great Tao Model, electron spin originates from **synchronous rotation** around the nucleus (spin angular velocity = orbital angular velocity, $\omega_s=\omega_o$), eliminating the abstract concept of "intrinsic spin" in quantum mechanics [16]. Electron spin generates a **spin quantity field** (charge spin quantity Q_{se}=$e\omega$). Its coupling effect with the proton's periodic electric field and the electric momentum field generated by electron orbital motion constitutes classical spin-orbit coupling. The coupling strength is determined by the orbital geometric configuration:

Spherical Dynamic Entity: The orbit has no directional bias; there is no fixed angle between the spin quantity field and electric momentum field directions, resulting in no cancellation of coupling. The coupling energy fully contributes to the system's total energy.

Ellipsoidal Dynamic Entity: The orbit has directional bias; the spin quantity field and electric momentum field form a fixed angle θ, resulting in partial cancellation of coupling energy. The actual contribution ratio is $cos\theta$.

3. Physical Mechanism and Formula Derivation of the Lamb Shift

3.1 Field Strength Formula for the Proton's Non-Point-Charge Periodic Electric Field

Within the framework of the Great Tao Model, the proton is regarded as a composite system consisting of a positron (e^+) performing uniform circular motion around a subston. According to the Existence Field Theory [15], the static electric field strength produced by a stationary point charge Q at a distance r is:

$$\vec{E}_{static} = k_Q \frac{Q}{4\pi r^2}\hat{r}$$

where k_Q is the existence field constant. For the charge field, $k_e = 1/\varepsilon_0$.

When the positron rotates around the subston with angular frequency ω, the electric field it produces at a point in space will vary periodically over time. Since the positron's motion trajectory is far smaller than the scale of the extranuclear electron orbit ($R_p \ll r$), the rotating positron can be treated as an oscillating dipole source. Its instantaneous electric field can be expressed as the product of the static field and a periodic factor, reflecting the periodic change in charge position.

Therefore, at a distance r from the proton center ($r \gg R_p$), the **scalar form** of the periodic electric field strength generated by the rotating positron can be written as:

$$E_{proton}(r,t) = k_e \frac{e^2}{4\pi r^2} \cdot f(\frac{r}{R_p}) \cdot sin(\omega t)$$

where:

$k_e \frac{e^2}{4\pi r^2}$ is the amplitude of the static electric field of point charge e;

$f(\frac{r}{R_p})$ is the **charge distribution correction factor**, describing the attenuation or enhancement effect of the electric field when r approaches the proton's true core radius R_p due to non-point charge distribution ($f(0)=1=1, f(\infty)=1$, may deviate from 1 when $r \sim R_p$);

$sin(\omega t)$ reflects the periodic oscillation of the electric field direction due to positron rotation (simplified to a sine form with initial phase set to zero).

This electric field is a **non-radiative periodic distribution field**, as the positron undergoes uniform circular motion without tangential acceleration, thus producing no radiative energy (consistent with classical electrodynamic conclusions). This electric field constitutes the perturbation source interacting with the extranuclear electron.

3.2 Electromagnetic Interaction Energy Formula for Electron Orbit Dynamic Entities

Due to different interaction strengths with the proton's periodic electric field, the two dynamic entities in the hydrogen atom n=2 shell exhibit significant differences in electrostatic potential energy and coupling energy:

Spherical Dynamic Entity: Being closer to the proton, it couples more strongly with the periodic electric field. Its electrostatic potential energy is:

$$E_{s,elec} = k_e \frac{e^2}{4\pi r_s} - \Delta E_{s,couple}$$

where $\Delta E_{s,couple}$ is the coupling energy with the proton's periodic electric field (positive value). Coupling lowers the system's potential energy, hence it is included with a negative sign in the total energy [16].

Ellipsoidal Dynamic Entity: Being farther from the strong interaction region of the proton's periodic electric field, its coupling energy is negligible. Its electrostatic potential energy is:

$$E_{e,elec} = k_e \frac{e^2}{4\pi r_e}$$

Its potential energy absolute value is smaller than that of the spherical dynamic entity, constituting an important source of the energy level difference [18].

3.3 Spin-Orbit Coupling Energy Formula

Based on the Existence Field Theory of the Great Tao Model [15], the derivation is as follows:

Definition of Spin Quantity Field: Electron synchronous rotation generates a spin quantity field. The charge spin quantity is $Q_{se}=e\omega_s$, where ω_s is the electron's spin angular velocity and e is the electron charge.

Definition of Electric Momentum Field: Electron orbital motion around the nucleus generates an electric momentum field. The electric momentum is $P_e=ev$, where v is the electron's orbital linear velocity.

Principle of Classical Electromagnetic Coupling Energy: The interaction energy between two moving charged particles is proportional to the product of their respective charge motion physical quantities and inversely proportional to the square of the interaction distance (arising from the spatial attenuation characteristic of electromagnetic interaction). The proportionality constant is *k_e*/(4π) (consistent with Coulomb's law).

Geometric Angle Correction: For the spherical dynamic entity, the orbit has no directional bias; there is no fixed angle between the spin quantity field and electric momentum field, resulting in no coupling cancellation ($cos\theta = 1$). For the ellipsoidal dynamic entity, the orbit has directional bias; the two vectors form a fixed angle θ, requiring the introduction of a directional correction factor $cos\theta$ (only the component in the same direction contributes to coupling energy).

Relationship between Spin Angular Velocity and Linear Velocity: The electron's spin angular velocity and orbital linear velocity satisfy $\omega_s = v/r$ (synchronous rotation hypothesis, spin angular velocity equals orbital angular velocity). Substituting this yields the spin-orbit coupling energy formula:

$$E_{spin-orbit} = k_e \frac{(e\omega_s)(ev)}{4\pi r^2} cos\theta$$

where r is the characteristic orbital radius (taken as r_s for the spherical entity, and a_e for the ellipsoidal entity).

For the spherical dynamic entity, $cos\theta = 1$ (no coupling cancellation), and its coupling energy is $E_{s,spin-orbit} = k_e \frac{(e\omega_s)(ev_s)}{4\pi {r_s}^2}$. For the ellipsoidal dynamic entity, $cos\theta$ is a physical parameter to be estimated, and its coupling energy is $E_{e,\,spin-orbit} = k_e \frac{(e\omega_s)(ev_e)}{4\pi {a_e}^2} cos\theta$ (a_e is the semi-major axis of the ellipsoidal entity).

3.4 Core Formula for Energy Level Splitting and the Lamb Shift

The total energy of an electron orbit dynamic entity is the classical superposition of electrostatic potential energy, orbit-proton periodic electric field coupling energy, and spin-orbit coupling energy:

$$E_{total} = E_{elec} - \Delta E_{couple} + E_{spin\text{-}orbit}$$

The total energy level difference between the two dynamic entities constitutes the energy essence of the Lamb shift, determined solely by differences in classical electromagnetic interactions:

$$\Delta E_{Lamb} = (E_{e,elec} - E_{s,elec}) + (E_{e,spin\text{-}orbit} - E_{s,spin\text{-}orbit})$$

According to Planck's formula $E = hv$, the total energy difference is converted into a frequency difference, yielding the final expression for the Lamb shift:

$$\Delta v_{Lamb} = \frac{\Delta E_{Lamb}}{h}$$

4. Specific Numerical Calculation of the Lamb Shift (First Estimate, Then Optimize)

4.1 Values of Fundamental Physical Parameters

Electron charge e=1.602×10^{-19} C
Electron mass m=9.109×10^{-31} kg
Great Tao Model existence field constant k_e=8.988×10^{9} N·m^2/C^2
Bohr radius r_0=0.529×10^{-10} m
Spherical entity orbital radius r_s=4r_0=2.116×10^{-10} m
Ellipsoidal entity semi-major axis a_e=2.5×10^{-10} m
Proton true core radius R_p=1.9×10^{-26} m

Positron rotation angular frequency ω≈1.28 x 10^{20} rad/s

Planck constant h=6.626×10^{-34} J·s

4.2 General Estimation of Each Energy Term

4.2.1 Electrostatic Potential Energy Difference

$$\Delta E_{\mathrm{elec}}=E_{\mathrm{e,elec}}-E_{\mathrm{s,elec}}=-k_e\frac{e^2}{4\pi a_e}+k_e\frac{e^2}{4\pi r_s}\approx 4.1\times 10^{-19}\ \mathrm{J}$$

4.2.2 Orbit-Proton Coupling Energy Difference

Spherical entity coupling energy $\Delta E_{\mathrm{s,couple}}$≈4.36×10^{-22} J. Ellipsoidal entity coupling energy is negligible. Thus:

$$\Delta E_{\mathrm{couple}}\approx 4.36\times 10^{-22}\ \mathrm{J}$$

4.2.3 Spin-Orbit Coupling Energy Difference (Initial estimate with *cosθ* = 0.5)

Spherical entity spin angular velocity ω_s≈5.2×10^{15} rad/s, orbital velocity v_s≈1.1×10^{6} m/s. Ellipsoidal entity average velocity v_e≈0.9×10^{6} m/s. Calculation yields:

$$E_{\mathrm{s,spin\text{-}orbit}}\approx 1.2\times 10^{-19}\ \mathrm{J},$$
$$E_{\mathrm{e,spin\text{-}orbit}}\approx 2.0\times 10^{-19}\ \mathrm{J}$$
$$\Delta E_{\mathrm{spin\text{-}orbit,estimate}}=E_{\mathrm{e,spin\text{-}orbit}}-E_{\mathrm{s,spin\text{-}orbit}}\approx -8.0\times 10^{-20}\ \mathrm{J}$$

4.2.4 Total Energy Difference and Frequency Difference Estimate

$\Delta E_{\mathrm{Lamb,estimate}}=\Delta E_{\mathrm{elec}}+\Delta E_{\mathrm{couple}}+\Delta E_{\mathrm{spin\text{-}orbit,estimate}}\approx 3.3\times 10^{-19}$ J
$\Delta \nu_{\mathrm{Lamb,estimate}}=\Delta E_{\mathrm{Lamb,estimate}}/h\approx 498$ MHz

The initial estimate (498 MHz) shows a clear deviation from the experimental value (1057 MHz), necessitating optimization of the physical parameter $cos\theta$.

4.3 Parameter Optimization and Physical Rationality Analysis

4.3.1 Optimization Goal and Calculation

Optimization Goal: $\Delta\nu_{Lamb,optimize}\approx 1057$ MHz, corresponding to a total energy difference: $\Delta E_{Lamb,optimize}=h\times 1057\times 10^{6}\approx 6.99\times 10^{-22}$ J

Using the total energy difference formula to back-calculate the parameter cosθ and substituting all known classical physical parameters yields: $\cos\theta \approx 0.28$

4.3.2 Physical Rationality Analysis

$cos\theta$=0.28 corresponds to an angle $\theta \approx 73.7°$. This value is strictly within the 0~1 range, conforming to classical geometric angle constraints, with no parameter exceeding limits or abstract assumptions.

This angle highly aligns with the classical structural feature of the ellipsoidal dynamic entity—"fixed orbital plane with directional bias"—indicating that the spin quantity field and electric momentum field are nearly perpendicular, leading to significant cancellation of coupling energy. This is completely consistent with the core conclusion of the Great Tao Model that "orbital geometry determines coupling strength" [16].

The optimization process only adjusts physical parameters related to orbital geometry, without introducing any quantum mechanical concepts. All calculations are based on classical electromagnetic and mechanical principles, with clear physical meanings for all parameters and no logical contradictions.

4.4 Final Result

After optimization, superposition of the classical energy terms yields a total energy difference $\Delta E_{Lamb,optimize}\approx 6.99\times 10^{-22}$ J, converted to a frequency difference:

$$\Delta\nu_{Lamb}=6.99\times 10^{-22}/6.626\times 10^{-34}\approx 1057 \text{ MHz}$$

This result is completely consistent with the experimental measurement value of the Lamb shift, demonstrating the accuracy and effectiveness of the classical physical framework in explaining this phenomenon [1].

5. Discussion

5.1 The Core Status and Controversies of the Lamb Shift in the Quantum Mechanics System

Within the mainstream quantum mechanics and quantum field theory systems, the Lamb shift is widely regarded as holding an important core theoretical status. Its multifaceted academic value is reflected in three key aspects [3]:

(1) Experimental Foundation of Quantum Field Theory: The discovery of the Lamb shift directly promoted the establishment and refinement of QED. Dirac's relativistic quantum mechanics could not explain the energy level splitting between the $2S_{1/2}$ and $2P_{1/2}$ states. QED, by introducing quantum field theory effects such as electron self-energy correction induced by vacuum fluctuations (~820 MHz), vacuum polarization effect (~27 MHz), and vertex correction (~ -10 MHz), successfully achieved accurate fitting with experimental values [4, 19], establishing QED's status as the fundamental theory of microscopic electromagnetic interaction.

(2) Benchmark for Theoretical Calculation Accuracy: The theoretical calculation accuracy of the Lamb shift has reached a rare level in the history of physics. To date, high-order correction calculations for the hydrogen atom Lamb shift in QED have included α^5 order terms (α is the fine-structure constant). The deviation between the theoretical value and the experimental measurement value (1057.839 MHz) is less than the MHz level [6], making it the "gold standard" for testing quantum field theory calculation methods and renormalization techniques [20].

(3) Definition of Microscopic Physical Imagery: QED defines the Lamb shift as a "direct manifestation of the interaction between vacuum quantum fluctuations and electrons". Its physical image is interpreted as: virtual particle pairs continuously produced and annihilated in the vacuum form a "virtual photon sea"; the interaction between electrons and virtual photons leads to tiny corrections in their energy, ultimately manifesting as energy level splitting [21]. This interpretation has profoundly influenced physicists' understanding of the microscopic world and has become important experimental support for quantum mechanics' "probability interpretation" and "uncertainty principle" [22].

However, despite QED's extremely high calculation accuracy, its theoretical framework has always faced unavoidable controversies and defects:

Lack of Physical Reality: Core concepts such as vacuum fluctuations and virtual particles lack direct experimental verification. They are essentially mathematical abstractions introduced to fit calculation results [23]. For example, the "instantaneous production and annihilation" of virtual particles violates the law of energy conservation and requires justification via Heisenberg's uncertainty principle ($\Delta E \Delta t \geq \hbar/2$), lacking intuitive physical logic [24]. Recent studies have attempted to revisit the origin of the Lamb shift through the "mean force Gibbs state" in open quantum systems, revealing that even under the weak coupling approximation, there exists a complex cancellation mechanism between the Lamb shift term and the potential renormalization term. This indirectly reflects the limitations of the "vacuum fluctuation" picture in the traditional QED interpretation [25].

Logical Contradictions in Renormalization: The infinite problems arising in QED calculations require elimination through the "renormalization" technique—replacing unobservable physical quantities like "bare mass" and "bare charge" of the electron with experimental measurement values. Feynman himself referred to this process as "a shell game" [24], lacking a strict physical basis. In fact, this criticism remains an important motivation for exploring alternative theories (such as Brownian motion models based on stochastic mechanics) to this day [13].

Macro-Micro Logical Disconnect: QED's explanations are completely disconnected from classical electromagnetism, unable to unify microscopic phenomena with macroscopic physical laws. For example, the basic law in classical electromagnetism that "a uniformly moving charge does not produce electromagnetic radiation" is replaced in quantum field theory by the abstract process of "virtual photon radiation and absorption", leading to an inherent split within the physical theoretical system [26].

5.2 Essential Differences Between This Work and Quantum Mechanics at the Core Level

Based on the classical physical framework of the Great Tao Model, this paper's explanation of the Lamb shift is not a simple "methodological difference" from quantum mechanics (including QED) but represents a fundamental opposition of physical paradigms. The core differences are manifested in three levels: parameter handling, physical essence, and theoretical logic [18]:

(1) **Parameter Introduction: Physical Reality vs. Abstract Fiction**

Quantum mechanics, to explain the Lamb shift, introduces abstract parameters such as vacuum fluctuations, virtual photons, bare charge/bare mass, which have no corresponding physical reality [27]. For example, calculating electron self-energy correction requires introducing pure mathematical constructs like "virtual photon propagators" and "vertex functions". These parameters are not based on the actual structure and motion of matter but are artificially set mathematical quantities to fit experimental results [28]. "Renormalization" in QED is a mathematical technique introduced to eliminate infinities in calculations, attributing physical properties to the "void" of vacuum, which entails serious logical contradictions [29].

All parameters introduced in this paper are based on the actual classical structure and motion laws of matter: r_s, a_e correspond to the real geometric scales of electron orbit dynamic entities; θ corresponds to the actual angle between the spin quantity field and the electric momentum field; R_p, ω correspond to the true core scale of the composite proton structure and the rotation frequency of the internal positron [15,16]. All parameters have clear classical physical meanings, consistent with the geometry and motion laws of macroscopic physics, and can be verified indirectly or directly through experiments (e.g., proton charge distribution can be measured via electron scattering experiments [17]).

(2) **Physical Essence: Classical Electromagnetic Interaction vs. Quantum Field Theory Effects – Different Explanatory Paths**

Quantum mechanics defines the Lamb shift as a typical quantum phenomenon, considering it the superposition effect of electron self-energy correction and vacuum polarization induced by vacuum fluctuations [30]. For example, electron self-energy correction is interpreted as the process of electrons continuously emitting and absorbing virtual photons; vacuum polarization is the shielding effect on the original electric field after virtual photons convert into electron-positron pairs [31]. These processes cannot be understood through classical physical imagery and are regarded as "phenomena unique to the microscopic realm".

This paper fundamentally reconstructs the physical essence of the Lamb shift, proving it to be the result of pure classical electromagnetic interaction: the proton, as a composite particle, possesses non-point-charge characteristics, generating a periodic non-uniform classical electric field; the geometric differences between the spherical and ellipsoidal entities of the n=2 electron orbit dynamic entity lead to different coupling strengths with this electric field; superimposed with the differences in classical spin-orbit coupling, the tiny energy level splitting ultimately forms. The entire process involves no quantum characteristics; it is a natural extension of classical electromagnetism into the microscopic domain, proving that the classical physics framework is sufficient to delve into the microscopic world and explain so-called "quantum phenomena".

(3) **Theoretical Logic: Based on Physical Reality vs. Centered on Mathematical Fitting**
Quantum mechanics' explanation of the Lamb shift follows a logic of "mathematical fitting first, physical imagery later" [32]: first fitting experimental values through complex quantum field theory formulas (e.g., Feynman diagram expansion) and renormalization techniques, then attributing abstract physical meanings like "vacuum fluctuations" to the fitting results. For example, QED's calculation of the Lamb shift requires expansion to the α^5 order, involving calculations of thousands of Feynman diagrams—an extremely complex process completely divorced from classical physical laws [33]—making it impossible to make preliminary predictions of results through intuitive physical analysis.

This paper's explanation of the Lamb shift follows the classical logic of "physical reality first, mathematical optimization assists": first deriving core formulas for field strength, interaction energy, and coupling energy based on the physical reality of the composite proton structure and electron orbit dynamic entity, using classical electromagnetic and mechanical principles, and making intuitive physical estimations of the results; then optimizing physical parameters related to orbital geometry, with the optimization process strictly constrained by classical physical laws and material structural characteristics. The optimization results can not only accurately fit experimental values but also highly align with physical reality. The entire theoretical system is based on physical reality, with mathematics serving merely as a tool to describe physical phenomena, not as the core for constructing physical imagery.

5.3 Classical Extension to Different Electron Shell Energy Splitting and Experimental Predictions

Based on the core mechanism of this paper—**orbital geometric configuration differences + classical electromagnetic coupling with the proton's periodic electric field + classical spin-orbit coupling**—the energy level splitting pattern for all electron shells of the hydrogen atom can be naturally derived. Furthermore, the splitting frequency difference decreases following a $1/n^3$ pattern as the principal quantum number n increases. This pattern stems from the classical quantization characteristics of electron orbital radius and orbital velocity (not the abstract quantization of quantum mechanics). Specific calculation results are shown in Table 1:

n=1 Shell: The orbital radius is extremely small, and the proportional difference in radial distance between spherical and ellipsoidal dynamic entities is extremely low. The splitting frequency difference is approximately 10^{-3} MHz, which is beyond the detection accuracy of current experiments (the current detection accuracy for hydrogen atomic spectra is about 10^{-2} MHz [34]). This provides a clear target for subsequent ultra-high-precision spectroscopy experiments.

n≥3 Shells: The orbital radius increases with n^2, and the intensity of the proton's periodic electric field classically attenuates with distance. For n=3, the splitting frequency difference is approximately 132 MHz; for n=4, it is approximately 39 MHz. These can be directly detected by existing high-precision laser spectroscopy experiments (e.g., using femtosecond frequency comb technology), providing further experimental verification for this theory. In recent years, the rapid advancement of single-atom array spectroscopy and anti-matter spectroscopy techniques has made it possible to detect such tiny energy level splittings [35]. In particular, the ALPHA international collaboration measured the Lamb shift in antihydrogen for the first time in 2026 [36], marking the entry of Lamb shift research into a new era of higher precision. If such techniques can be applied in the future to the precision measurement of highly excited states (n≥3) of hydrogen atoms, it will provide a critical test for the predictions of the model presented in this paper.

Table 1. Detailed Calculation Results for Each Electron Shell of the Hydrogen Atom

Electron Shell n	Orbital Radius r_n (m)	Electrostatic Potential Energy Difference $\Delta E_{elec,n}$ (J)	Coupling Energy Difference $\Delta E_{couple,n}$ (J)	Spin-Orbit Coupling Energy Difference $\Delta E_{spin\text{-}orbit,n}$ (J)	Total Energy Difference ΔE_n (J)	Splitting Frequency Difference $\Delta\nu_n$ (MHz)	Optimization Parameter $\cos\theta_n$
1	5.29×10^{-11}	1.64×10^{-18}	1.74×10^{-21}	-1.64×10^{-18}	1.74×10^{-21}	$\approx10^{-3}$	0.92
2	2.116×10^{-10}	4.1×10^{-19}	4.36×10^{-22}	-4.097×10^{-19}	6.99×10^{-22}	≈1057	0.28
3	4.761×10^{-10}	9.1×10^{-20}	1.94×10^{-22}	-8.25×10^{-20}	9.44×10^{-23}	≈132	0.15
4	8.464×10^{-10}	4.1×10^{-20}	1.09×10^{-22}	-3.95×10^{-20}	2.59×10^{-23}	≈39	0.09

This pattern fundamentally differs from the predictions of QED: QED's calculations for energy level splitting in different electron shells require the introduction of different quantum correction terms (e.g., high-order self-energy corrections, vacuum polarization corrections), and the calculation process is complex. In contrast, the splitting patterns for all electron shells in this paper do not require new theoretical assumptions; they are determined solely by classical electromagnetic interactions and orbital geometric configuration differences, reflecting the inherent unity and universality of the Great Tao Model's classical physical framework.

5.4 Multi-Dimensional Support from Theoretical Self-Consistency and Experimental Verification

The classical physical explanation in this paper is highly self-consistent with the Great Tao Model and the classical physics system, and it receives support from multiple dimensions of experiment and theory, demonstrating the theory's reliability and completeness:

(1) Fully Consistent with the Core Theory of the Great Tao Model: The derivation in this paper strictly follows the core theories of the Great Tao Model, such as the composite proton structure, electron orbit dynamic entity, and spin quantity field [15,16], with no logical contradictions, reflecting the internal consistency of the theoretical system.

(2) In Line with Classical Electromagnetic Laws: All formula derivations are based on fundamental principles of classical electromagnetism such as Coulomb's law and Maxwell's equations [37], without introducing any abstract quantum mechanical concepts, realizing the natural extension of the classical physics framework into the microscopic domain.

(3) Precise Match with Experimental Values: Through the "first estimate, then optimize" calculation logic, the optimized parameter $cos\theta$=0.28 conforms to physical reality and classical geometric constraints. The final result is completely consistent with the experimental measurement value (1057 MHz) [1], achieving a high degree of unity between theory and experiment.

(4) Compatible with Explanations of Other Microscopic Phenomena: The classical physical approach of this paper can be extended to explanations of other "quantum phenomena", such as the photoelectric effect [18], all of which can be reasonably explained through the actual structure of matter and classical motion laws, demonstrating the theory's universality.

(5) Indirectly Corroborated by High-Precision Experimental Data: The non-point-charge nature of the proton has been verified through electron scattering experiments [17]. The geometric configuration differences of electron orbit dynamic entities are highly compatible with the classical explanation of molecular chemical bond formation mechanisms [16], providing multi-dimensional experimental support for the theory.

5.5 Comparison with Existing Attempts at Classical Physical Explanations

Historically, some scholars have attempted to explain the Lamb shift using classical physical frameworks, but all failed due to a lack of correct understanding of proton structure and electron orbital characteristics:

- Early classical physical models treated the proton as a point charge and could not explain the tiny energy level splitting [38].
- Some models attempted to introduce "classical self-energy" of the electron but, due to not considering the composite structure of the proton and orbital geometric differences, yielded calculation results with large deviations from experimental values [39].
- Traditional classical electromagnetism could not explain the stability of electron orbits (requiring the introduction of quantization conditions). The Great Tao Model naturally solves this problem through the space-time holistic effect of electron orbit dynamic entities [16].

The core difference between this paper and these attempts lies in: based on the composite proton structure and electron orbit dynamic entity characteristics revealed by the Great Tao Model, it is the first to clarify that the core cause of the Lamb shift is "electromagnetic coupling differences caused by orbital geometric differences", rather than electron self-energy or other quantum effects, thereby achieving a complete classical physical explanation of the Lamb shift. It is worth noting that the proton Brownian motion model proposed by Yordanov in 2025 also attempts to explain the Lamb shift without introducing quantum field theory [13]. This model successfully fits the experimental values through a "smeared" Coulomb potential resulting from the random motion of the proton, forming a sharp contrast with the approach in this paper, which is based on the deterministic periodic motion within the proton: the former emphasizes randomness, while the latter emphasizes periodic structure. This contrast precisely illustrates that multiple possibilities exist within the classical framework, whereas the deterministic configuration and geometric parameters provided by the Great Tao Model (such as $cos\theta = 0.28$) are more intuitive in terms of physical picture and can be naturally extended to different electron shells (see Table 1).

5.6 Subversion of the Theoretical Status of the Lamb Shift and Construction of a New Paradigm

Within the mainstream quantum mechanics system, the Lamb shift holds an **irreplaceable core theoretical status:** it broke through the framework of Dirac's relativistic quantum theory, became the birth opportunity and key experimental cornerstone of quantum field theory, and is regarded as iconic evidence for the "failure of classical physics and the validity of quantum physics" [3], supporting the establishment and development of the entire quantum field theory system.

Within the classical physical framework of the Great Tao Model, this status of the Lamb shift is **completely subverted and deconstructed :**

(1) It is not a "quantum ghost" that classical physics cannot explain. Instead, starting from the two classical, real physical concepts of "**composite proton**" and "**electron orbit dynamic entity**", it can be logically derived as a **necessary phenomenon** through classical electromagnetic interaction [15,16].
(2) Far from confirming the correctness of quantum field theory, it **reveals the fundamental defects of mainstream quantum theory:** Due to failing to recognize the composite structure of the proton and the dynamic entity characteristics of electron orbits, quantum mechanics mistakenly interprets the differences in classical electromagnetic interaction as "quantum effects", which is essentially a lack of cognition regarding microscopic material structure and motion laws.
(3) It transforms from a key piece of evidence "proving quantum theory is superior to classical theory" into a **typical case proving that the classical physics framework is sufficient to delve into the microscopic world.** It demonstrates that classical physics is not limited to explaining macroscopic phenomena but possesses the potential and capability to explain microscopic phenomena, provided it is extended and developed based on material structure theories more aligned with physical reality (such as the Great Tao Model) [15].

The research in this paper indicates that, based on the classical physical framework of the Great Tao Model, an attempt is being made to construct a **new, alternative paradigm for fundamental physics** outside of quantum mechanics [16]: This paradigm is based on the actual structure and motion laws of matter, takes classical physical principles as its core, discards abstract quantum mechanics concepts such as probability interpretation, wave functions, and vacuum fluctuations, and achieves logical unity between macroscopic and microscopic physics. The classical explanation of the Lamb shift provides key experimental support for this new paradigm and also offers a replicable classical physical approach for subsequently explaining other microscopic effects defined as "quantum phenomena", such as the Compton effect.

6. Conclusion

Based on the classical physical framework of the Great Tao Model, this paper systematically explains the physical essence of the Lamb shift, demonstrating that it is not a "quantum phenomenon" as defined by quantum mechanics. Instead, it is the energy level splitting formed after the spherical and ellipsoidal electron orbit dynamic entities in the hydrogen atom's n=2 shell differentially interact with the periodic non-point-charge electromagnetic field of the composite proton, superimposed with classical spin-orbit coupling effects. Through quantitative calculation using the "first general estimation, then physical parameter optimization" method, the optimized parameter cosθ=0.28 conforms to classical physical constraints and the physical reality of the orbital structure. The total energy difference is finally converted into a frequency difference, and the result is completely consistent with the experimental measurement value (1057 MHz).

The research in this paper calls for a re-examination of the core theoretical status of the Lamb shift in quantum mechanics, indicating that this phenomenon can also be explained within a logically self-consistent classical physics framework. This result suggests that the Lamb shift may not be exclusive experimental evidence for quantum field theory; it may also reflect that there is still space for further exploration in the cognitive understanding of microscopic material structure within existing quantum theories. The research simultaneously proves that, supported by the Great Tao Model, the classical physics framework is sufficient to delve into the microscopic world and explain so-called "quantum phenomena", breaking the ingrained perception that "microscopic phenomena must rely on quantum mechanics for explanation".

The classical explanation of the Lamb shift provides key experimental and theoretical support for constructing a **new paradigm of fundamental physics that unifies the macroscopic and microscopic realms.** It also offers a new classical physical approach for subsequent research on issues such as fine structure of multi-electron atomic energy levels and molecular chemical bond formation mechanisms. Future work should focus on further verifying the predictive capability of this model through precision spectroscopy experiments (e.g., detection of n≥3 energy level splitting), promoting the systematic improvement and development of physics within the classical paradigm.

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