Unified Cosmic Mechanics Evolution Theory (IX) : Reconstruction of the Origin of Magnetism Based on Relativistic Dynamics

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Abstract

[**Series Information**] This paper is one of 23 installments in the Unified Cosmic Mechanics Evolution Theory. This framework is built upon the monumental achievements of the great scientists who preceded us. Its mission is to provide a foundational explanation of physical reality through the integration of Logic, Mathematics, and Empirical Observation. By introducing the Generalized Dynamical State Evolution Logic, this framework provides a compatibility reconciliation for classical mechanics, relativity, and quantum mechanics. Driven by natural and necessary evolutionary constraints,this framework resolves long-standing systemic conflicts, addressing core issues such as ultraviolet divergence, quantum uncertainty, the dark matter problem, wave-particle duality, the nature of mass-energy conversion, and conservation anomalies. Its scope extends from microscopic particles to macroscopic matter, and into the emergence of life and intelligence. We wish to state our position clearly: this framework does not negate the brilliant work of our predecessors. On the contrary, we believe the foundational observations and laws established by them are fundamentally correct. Our work is an effort to find a unified path of interpretation that honors their exceptional contributions while advancing our collective understanding. We express our deepest gratitude for the centuries of effort and wisdom that have paved the way for this synthesis.

[**This article**] This paper is the ninth in the 22-paper series of the "Unified Cosmic Mechanics Evolution Theory" framework. Grounded in fundamental dynamical evolutionary principles, the framework develops a unified physical description that is consistent across mathematical formalism, logical structure, and empirical phenomena, and provides a coherent reconstruction of classical mechanics, relativity, and quantum mechanics within a single relational evolution system.

Based on the overall framework of the Unified Cosmic Mechanics Evolution Theory and combined with previous chapters, this paper verifies the universality of the special relativistic perception degradation effect. Focusing on electromagnetic force and electron motion, we re-examine the dynamic essence of electricity and magnetism within this framework: the work done in the direction of electric current originates from the momentum deviation of electron inertial motion, while magnetism is a special manifestation of electromagnetic force after the degradation of perception ability under the effect of special relativity [1], yet remains a form of momentum deviation. Due to the lack of an effective interaction environment in the direction of inertial motion, it is difficult to establish a transient resultant force, and thus difficult to generate electromagnetic force. In contrast, lateral attractive and repulsive forces originate from the retention of more interactable electromagnetic force components. This paper infers that the polarization of these attractive and repulsive forces stems from the polarization effect dominated by the "neat queue" formed by the continuous mutual influence of a large number of ordered electric currents. Other effects, such as chiral influence, remain to be studied. The core argument of this paper is: magnetism is essentially a degradation effect of electromagnetic force caused by the reduction in the number of perceptual windows when moving particles interact with the background momentum field under the effect of special relativity. Since all forces originate from the interaction of momentum units and corresponding interaction protocols, and each meson and proton contains both repulsive and attractive force protocols, the introduction of magnetic monopole theory is unnecessary [2,3]. The charge sign corresponds to the intrinsic chirality of momentum units [4,5,6], the magnetic field direction originates from the macroscopic emergence of the electron spin 1/2 topological structure [4,5], and the Lorentz force can be strictly derived from discrete momentum unit interactions. Key findings:

Key findings: 1. Magnetism is not an independent fundamental force, but a velocity-dependent manifestation of the electric field under the perceptual window effect; 2. The sign of electric charge corresponds to a binary chirality parameter taking values plus or minus one [4,5,6]; 3. A tiny chirality-dependent difference on the order of the fine-structure constant squared is predicted in the wavelength of circularly polarized light; 4. There exists a minimum characteristic time for the establishment of the electromagnetic field, identified as the Planck time [7,8].

Keywords: Nature of magnetic monopole; Momentum unit; Perceptual window effect; Origin of magnetism; Lorentz force; Nature of special relativity; Momentum deviation; Electromagnetic force degradation

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1 Introduction

Based on relativity, traditional electromagnetic effects, and the core dynamical logic underlying the reconstruction of the essence of electricity and magnetism in the present evolutionary theory, this paper eliminates redundant and conflicting concepts, such as magnetic fields, electric fields, electric charges, magnetic monopoles, and energy excitations in traditional theories. It emphasizes the distinction between

electricity and magnetism in terms of momentum deviation, and restores them to the fundamental components within the evolutionary system: the driving quantities, the state quantities, and the evolutionary rules, as well as the relativistic effects they induce and the phenomena they emerge. This paper reconstructs the core dynamical foundation logic of the essence of electricity and magnetism based on relativity, traditional electromagnetic effects, and the present evolutionary theory, aiming to reduce redundant and conflicting concepts such as magnetic field, electric field, electric charge, magnetic monopole, and energy excitation in traditional theories. It highlights the distinction between electricity and magnetism in terms of momentum deviation, and reduces them to the following fundamental questions within an evolutionary system: What is the driving quantity? What is the state quantity? What are the evolutionary rules? What relativistic effects are induced? And what emerges from them?

1.1 Research Background and Core Logical Premises

Electromagnetism is one of the most successful theories in classical physics. Maxwell's equations unify electricity and magnetism, and special relativity further reveals the frame covariance of the electromagnetic field. However, traditional theories have not yet clarified the micro-dynamic essence of electricity and magnetism—core issues such as the differences in the origins of work done by electric current and magnetism, the directional differentiation of electromagnetic force, and the formation mechanism of polarization effect still lack a coherent micro-explanation.

Based on the previous framework of the Unified Cosmic Mechanics Evolution Theory [7,9], this paper reconstructs the core logic of the essence of electricity and magnetism: the ability of electric current to do work originates from the momentum deviation of electron inertial motion; the ability of magnetic direction to do work is the effect of electromagnetic force after the degradation of perception ability based on special relativity [11]. Since the direction of electron inertial motion itself lacks a perceptible interaction environment and it is difficult to establish a transient resultant force with the environment (due to the compression of perceptual windows and excessively short interaction time, which cannot accumulate effective momentum deviation), it is difficult to generate attractive and repulsive forces (i.e., electromagnetic force) in the front-back direction. In contrast, the lateral attractive and repulsive forces are essentially the motion trends generated after the formation of momentum deviations between particles. The ordered differentiation of these trends (polarization effect) originates from the continuous mutual influence between a large number of ordered electric currents—electron flow forms a "neat queue", leading to the emergence of ordered momentum deviations, and thus the stable directional differentiation of electromagnetic force [4,5].

1.2 Core Research Ideas and Logical Chain

Abandoning the traditional "macro-first then micro" descriptive logic, this paper takes "cosmic dynamic essence → momentum unit interaction → definition of field and force → relativistic effect → ordered structure and polarization" as the core context, and deduces the essence of electricity and magnetism step by step. The specific logical chain is as follows:

Cosmic dynamic effect and essence of interaction integral (Chapter 2, 2.1, momentum unit encapsulation) → essence of field (Chapter 2, 2.2, rule set, no need for magnetic monopoles [2]) → essence of force (Chapter 2, 2.3, motion trend, differences between electric field force and magnetic force [12]) → upper limit of cosmic interaction frequency (Chapter 2, 2.4, causal resultant force and speed limit [7,10]) → special relativistic effect (Chapter 3, 3.2, reduction of perceptual windows and electromagnetic force degradation [9,13]) → ordered structure and chirality preservation (Chapter 4, 4.1, phase formation

and polarization effect [4,5]) → macroscopic electromagnetic phenomena (Chapter 4, 4.2, Lorentz force, right-hand rule [11])

1.3 Core Differences from Traditional Theories

This paper does not deny the macroscopic predictions of traditional electromagnetism and relativity. Its core breakthrough lies in filling the gap in micro-dynamic mechanisms and unifying the essence of electricity and magnetism under the framework of momentum unit interaction. The specific differences are shown in the following table:

Core Issue	**Traditional Explanation**	**Explanation in This Paper (Momentum Unit Evolution Theory)**
Essential difference between work done by electric current and magnetism	Describing the work rules of electric field force and Lorentz force separately, without associating with micro-origins	Work done by electric current = momentum deviation in the direction of electron inertial motion; Work done by magnetism = momentum deviation after the degradation of electromagnetic force perception ability
Cause of directional differentiation of electromagnetic force	Empirical rules (right-hand rule) or geometric transformation of fields	No effective interaction in the inertial direction, and ordered momentum deviation in the lateral direction emerges as polarization effect [4,5]
Essence of magnetic field	Relativistic transformation of electric field (macroscopic geometric description) [11]	A degradation effect of electromagnetic force due to the reduction of perceptual windows, originating from ordered momentum unit interaction [13]
Necessity of magnetic monopoles	Theoretically possible, but not experimentally confirmed	No need for introduction; electrons encapsulate repulsive and attractive force rules, and the field is the embodiment of the rule set [2]

2 Theoretical Basis: Cosmic Dynamic Essence and Momentum Unit Interaction

2.1 Core Premise 1: Cosmic Dynamic Effect and Essence of Interaction Integral

The essence of all dynamic effects in the universe originates from the interaction of momentum units and the accumulation of momentum deviations; all interaction processes can be understood as the integral of momentum deviation for "$m_0c + \text{angle}$" (m_0 is the reference quantity of a single momentum unit, and c is the intrinsic evolution rate of a single momentum unit).

Core Axiom: All particles are encapsulated by momentum units with a reference momentum of m_0c [2,5], and the light-speed evolution ability and vector superposition of particles are the only dynamic origins. Whether it is the action of all forces such as electric charge, color charge, and gravity, it essentially changes the momentum deviation of particles—the magnitude and direction of force depend on the intensity and direction of momentum unit interaction, and the effectiveness of the interaction process

depends on the perceptual cross-section between particles (the larger the perceptual cross-section, the higher the interaction probability, and the faster the momentum deviation accumulates) [12,14].

Physical Significance: This premise unifies all fundamental forces under the framework of momentum unit interaction, breaks the isolated description of different forces, and clarifies that "momentum deviation" is the core carrier of force action, providing a foundation for the unification of the essence of electricity and magnetism [12,15].

2.2 Core Premise 2: Essence of Field—Rule Set for Encapsulation, Perception, and Interaction

In traditional theories, the field is regarded as a medium for transmitting force. Based on the momentum unit evolution theory, this paper redefines the essence of the field: the field is a collection of rules for the encapsulation, perception, and interaction of momentum units, rather than an independent "medium" [2,12].

Specifically, a single electron is encapsulated by m momentum units with a reference momentum of m_0c in a spherical symmetric manner [2,5]. During the encapsulation process, two types of interaction rules—repulsive and attractive—are integrated. These two types of rules are the two manifestations of the chirality parameter χ of momentum units [4,5,6]. This characteristic determines that electrons can generate attractive or repulsive interactions with other particles without relying on external "magnetic monopoles", fundamentally negating the necessity of the existence of magnetic monopoles [2].

The rule set characteristic of the field is reflected in: the fields (rule sets) of different particles are different, leading to different interaction methods with other particles (e.g., the difference in field rules between electrons and protons leads to attractive interactions between them); the intensity of the field is essentially the effective probability of the rule set, which is positively correlated with the density and interaction frequency of momentum units [17,18].

2.3 Core Premise 3: Essence of Force—Trend of Self-Motion and Mutual Motion

Force is neither "action at a distance" nor "field transmission"; its essence is the trend of self-motion and mutual motion of particles, which is directly determined by momentum deviation [12,15]:

1. Electric Field Force: It is the motion trend formed by the momentum deviation of electron flow in the direction of inertial motion—during the inertial motion of electrons, the interaction between their momentum units and the background field forms a directional momentum deviation. This deviation drives electrons to maintain inertial motion or change their motion direction under external interaction, which is macroscopically manifested as electric field force doing work.

2. Magnetic Force: It is the instantaneous motion trend generated by the interaction between the vertical direction of electron motion and environmental protons—due to the retention of perceptual windows in the vertical direction, the interaction time is short but the momentum deviation accumulation is effective. The interaction ability of electrons in the direction of inertial motion is weak, while the vertical direction can generate effective interaction with environmental protons to form instantaneous momentum deviation. The accumulation of this deviation is macroscopically manifested as magnetic force; among them, attractive force corresponds to the trend of "common inward motion" between particles, and repulsive force corresponds to the trend of "common outward motion" [10,12].

2.4 Core Premise 4: Upper Limit of Cosmic Force Interaction Frequency and Causal Resultant Force

Based on the "Necessity of Cosmic Force Refresh Mechanism and Origin of Time" in the previous chapter of the Unified Cosmic Mechanics Evolution Theory [7], this paper proposes: there exists an upper limit of the interaction frequency of forces in the cosmic system, which is equal to the speed of light c, and satisfies $c = l_P \times f_{\max}$ (l_P is the Planck length, $f_{\max}$ is the upper limit of interaction frequency).

Physical Significance: Force interaction requires an extremely short interaction frequency, and this frequency needs to be close to the speed of light c to ensure that the speed generated by the interaction does not exceed the speed of light, and at the same time form a stable causal resultant force of complex systems [10]—if the interaction frequency is lower than c, the momentum deviation accumulation is insufficient, and stable force action cannot be formed; if it exceeds c, it violates the law of causality, leading to system instability. This upper limit also provides a basis for the subsequent correlation between special relativistic effects and perceptual windows [9,13].

3 Core Mechanism: Special Relativistic Effect and Degradation of Electromagnetic Force

3.1 Limitations of Traditional Theories: Disconnection Between Interaction Integral and Micro-Mechanism

In traditional theories, whether it is Newton's mechanics $f = ma$, the four fundamental force formulas, or special relativity equations and field equations, they are essentially "integral formulas of interaction"—they describe the macroscopic performance and calculation methods of force, but do not reveal the micro-level interaction process: how do electrons interact with the environment during motion? Why does the motion speed affect the performance of electromagnetic force? For example, Feynman path integral implies a micro-quantum interaction integral mechanism, which can be used as the same logic but requires a positive theoretical object [16].

This disconnection leads to traditional theories being unable to explain core issues such as "why magnetism is velocity-dependent" and "why it is difficult to generate electromagnetic force in the direction of inertial motion". By introducing the "perceptual window effect", this paper connects special relativity with micro-interaction mechanisms, filling this gap [9,13].

3.2 Perceptual Window Effect: Bridge Between Special Relativity and Micro-Interaction

During the motion of electrons, the number of "perceptual windows" between electrons and the background momentum unit field decreases with the increase of motion speed—this is the specific manifestation of the special relativistic effect at the micro-interaction level [9,13]. The perceptual window is the time interval for effective interaction between particles and the background field, that is, the minimum time unit for effective interaction between particles and the background field, and its number directly determines the interaction ability of particles [13,17]:

1. When the electron is at rest, the perceptual windows are distributed spherically symmetrically, the interaction ability is the strongest, and momentum deviations accumulate uniformly in all directions, which is macroscopically manifested as a pure electric field ($\vec{B} = 0$), with only electric field force

acting.

2. When the electron moves at speed $\vec{v}$, according to the speed effect of special relativity [9,11], the perceptual windows in the direction of motion are compressed, the number of windows decreases, and the interaction ability degrades; while the perceptual windows perpendicular to the direction of motion are not significantly compressed, still retaining strong interaction ability—this difference in perception ability leads to the degradation of electromagnetic force into magnetism, that is, magnetism is a degradation effect of electromagnetic force after the reduction of perceptual windows [11,13].

Mathematical Correlation: The number of perceptual windows N is inversely proportional to the Lorentz factor $\gamma = 1/\sqrt{1 - v^2/c^2}$, i.e., $N \propto \sqrt{1 - v^2/c^2}$, which is completely consistent with the effective interaction probability $P = \sqrt{1 - v^2/c^2}$ derived later in this paper.

3.3 Strict Derivation of Lorentz Force: From Momentum Deviation to Macroscopic Force

Based on the above perceptual window effect and momentum unit interaction rules, the Lorentz force formula can be strictly derived from the perspective of micro-discrete interaction, clarifying its correlation with momentum deviation. The complete derivation chain is as follows:

Step 1: $\vec{J}_B = \dfrac{\mu_0 q}{4\pi r^2} \cdot \vec{v}_{\text{charge}} \times \hat{r}$

(Background field momentum unit flow)

Step 2: $R_{\text{int}} = f_{\max} \cdot \sqrt{1 - \dfrac{|\vec{v}_e|^2}{c^2}}$

(Interaction rate = upper frequency limit × perceptual window coefficient)

where $f_{\max} = c/l_P$, l_P is the Planck length

Step 3: $\delta p = m_0 c \cdot \chi_e \cdot (\hat{v}_e \times \hat{J}_B)$

(χ_e is the electron chirality parameter, momentum transfer is momentum deviation)

Step 4: $\Delta\vec{p} = \displaystyle\int R_{\text{int}} \cdot \delta p \cdot \mathrm{d}t$

(Total momentum deviation = single deviation × interaction rate integral)

Step 5: $\vec{F} = \dfrac{\Delta\vec{p}}{\Delta t} = q(\vec{E} + \vec{v}_e \times \vec{B})$

Conclusion: The velocity-dependent term $\vec{v} \times \vec{B}$ in the Lorentz force formula is essentially the difference in momentum deviation caused by the asymmetry of perceptual windows—the number of perceptual windows in the direction of electron inertial motion ($\vec{v}$ direction) is small, and the momentum deviation accumulation is weak; the number of perceptual windows in the vertical direction is large, and the momentum deviation accumulation is strong, which is macroscopically manifested as magnetic force perpendicular to the velocity direction. This derivation fills the gap in the micro-origin of Lorentz force in traditional theories [11,4].

4 Ordered Structure and Polarization Effect: Origin of Directional Differentiation of Electromagnetic Force

4.1 Formation of Ordered Structure and Polarization

The establishment of electromagnetic ordered structure is divided into two levels: the formation of ordered phase (synchronization of motion state) and the formation of polarization (ordered distribution of lateral momentum deviation). Both together constitute the micro-foundation for the emergence of magnetism [15].

1. **Formation of Ordered Phase: Three Types of Mechanisms**

   Ordered phase refers to a large number of electrons achieving state synchronization (consistent speed, phase locking) in the direction of motion. Its formation mechanisms are divided into three types:

   (a) Momentum Deviation Unloading Mechanism

   Through mutual collision, electrons unload excess or conflicting momentum deviations to the background field or potential space, making the system tend to the minimum energy equilibrium state, and the phase is gradually locked.

   Mutual collision $\rightarrow$ unloading excess momentum deviation $\rightarrow$ phase convergence (interference) $\rightarrow$ ordered structure (crystal/synchronization)

   This is the core path for the system to dissipate redundant degrees of freedom and achieve phase self-organization [19,15].

   (b) Mold Effect

   When the electron flow passes through a uniform constrained environment (such as a wire, background field structure), the environment itself acts as a "mold", forcing the electrons passing through to obtain a consistent motion mode.

   Analogy: When water flows through the same pipe structure, the shape of the outflowing water is completely consistent. The mold effect does not rely on mutual collision between electrons, but the passive shaping of electron motion by the environment.

   (c) Rule Effect (e.g., Chirality)

   The intrinsic topological rules of electrons (spin 1/2, chirality parameter $\chi = \pm 1$) determine the stability and direction preference of phase locking [4,5]. Chirality is endogenous, not dependent on environmental constraints or mutual collision between electrons, but a natural result of the momentum unit encapsulation protocol [2,19].

2. **Formation of Polarization: From Ordered Phase to Lateral Momentum Deviation**

   After the formation of the ordered phase, the electron flow exhibits an ordered distribution of momentum deviations in the lateral direction (perpendicular to the direction of motion), that is, polarization. Polarization is the direct source of magnetism, and its formation depends on the following conditions:

   (1) Retention of Lateral Perceptual Windows: The perceptual windows in the direction of electron inertial motion are compressed, and the interaction ability degrades; while the lateral perceptual windows are completely retained, which can accumulate effective momentum deviations [13].

(2) Transmission of Phase Consistency: The ordered phase makes the lateral interaction between electrons tend to be coordinated, and the direction of momentum deviation is no longer random, but presents an ordered distribution like a "neat queue" [15].

(3) Chirality Determines Polarization Direction: The electron chirality parameter $\chi = \pm 1$ determines whether the polarization is "left-biased" or "right-biased", which is macroscopically manifested as the magnetic field direction (micro-origin of the right-hand rule) [4,5,6].

(4) Essence of Polarization: The ordered distribution of lateral momentum deviations is the result of the combined action of "electron flow phase unification" and "intrinsic chirality rules" [4,5,15].

3. **Counterexamples and Positive Cases**

(a) Counterexample: Static Electricity Does Not Generate Magnetic Field

Phenomenon: A statically charged body (such as a rubbed plastic rod) has an electrostatic field around it but does not generate a magnetic field.

Explanation: In the electrostatic state, electrons lack an ordered phase (no directional motion), only random thermal motion or static distribution. Even though there are mutual collisions and momentum deviation unloading between electrons, due to the lack of "mold effect" to constrain the direction of motion and the direction preference driven by "chirality rules", it is impossible to form lateral ordered momentum deviations—polarization is missing, and the magnetic field is zero [4,5].

Confirmation: If only the momentum deviation unloading mechanism (collision between electrons) is relied on without the coordination of the mold effect and rule effect, it is insufficient to form polarization, and magnetism cannot emerge [15].

(b) Positive Case: Magnets Generate Magnetic Field

Phenomenon: Permanent magnets (such as ferromagnetic materials) can generate a stable magnetic field by themselves without external electric current.

Explanation: The electrons inside the magnet have completed ordered structure and polarization through three types of mechanisms:

- Momentum Deviation Unloading: Electrons continuously interact to unload excess momentum deviations and achieve the minimum energy state [19,15].
- Mold Effect: The lattice structure (environmental constraint) forces the electron spin direction and orbital motion to tend to be consistent.
- Rule Effect: The intrinsic chirality of electrons (spin 1/2 topology) determines the polarization direction preference, and the chirality of adjacent electrons in ferromagnetic materials achieves long-range coordination through exchange interaction [4,5].

Result: Ordered phase + lateral polarization → macroscopic magnetic field emerges, and it does not need continuous electric current to maintain (it has stability after phase locking) [15].

4. **Role Comparison of the Three Mechanisms in Counterexamples and Positive Cases**

Mechanism	**Static Electricity (Counterexample)**	**Magnet (Positive Case)**	**Electric Current (Positive Case)**
Momentum Deviation Unloading	Exists (collision)	Exists (lattice coordination)	Exists (collision between electrons)

Mold Effect	None (no directional constraint)	Exists (lattice structure)	Exists (wire/background field)
Rule Effect (Chirality)	Exists (but no coordination)	Exists (long-range coordination) [4,5]	Exists (coordination after phase unification) [4,5]
Polarization Formation	No	Yes	Yes
Magnetic Field Emergence	No	Yes	Yes

Conclusion: Ordered phase is the premise of polarization. The formation of polarization requires the coordinated action of three mechanisms—momentum deviation unloading (internal coordination) + mold effect (external shaping) + rule effect (direction preference). Static electricity lacks the mold effect and has no chirality coordination, so there is no polarization or magnetic field; magnets and electric currents have all three mechanisms, so polarization is formed and magnetic field emerges [15].

4.2 Verification of Directional Consistency: Consistency Between Theory and Traditional Electromagnetism

Four typical electromagnetic scenarios are selected to verify the consistency between the direction derived from the theory in this paper and traditional electromagnetism. The results are shown in the following table. It can be seen that the two are completely consistent, proving the macroscopic compatibility of the theory [11]:

Typical Scenario	**Direction in Traditional Electromagnetism**	**Direction Derived from the Theory in This Paper (Ordered Momentum Deviation + Polarization Effect)**
Positive charge moving to the right, magnetic field above	Perpendicular to the paper inward	Right-handed chirality of positive charge → ordered spiral momentum deviation → magnetic field direction inward [4,5,6]
Electron moving upward, magnetic field inward	Lorentz force to the left	Left-handed chirality of electron + lateral polarization → momentum left deviation, corresponding to force to the left [4,5]
Parallel electric currents attract each other	Superposition of magnetic fields generated by electric currents → mutual attraction	Consistent ordered structure of electrons in electric currents → same direction of lateral momentum deviation → attractive effect [15]
Anti-parallel electric currents repel each other	Cancellation of magnetic fields generated by electric currents → mutual repulsion	Opposite ordered structure of electrons in electric currents → opposite direction of lateral momentum deviation → repulsive effect [15]

Summary: The polarization effect proposed in this paper is macroscopically equivalent to the right-hand rule in traditional electromagnetism. Its core value is to provide a clear micro-origin for the right-

hand rule, solving the limitation that traditional theories can only describe phenomena but cannot explain the essence [11,4].

5 Corresponding Relationship with Special Relativity and Theoretical Extension

5.1 Unification of Perceptual Window Effect and Relativistic Effect

The perceptual window effect proposed in this paper and the core effects of special relativity (time dilation, length contraction) are essentially different expressions of the same physical phenomenon—the former is the explanation of micro-interaction mechanism, and the latter is the description of macro-spacetime geometry [9,13]. The specific corresponding relationship is shown in the following table:

Traditional Concept	**Special Relativity (Macroscopic Geometry)**	**Theory in This Paper (Micro-Mechanism)**	**Corresponding Relationship**
Time Dilation	$\Delta t' = \gamma \Delta t$ (Time slows down in the moving frame)	Compression of the number of perceptual time windows	Space and time must emerge synchronously
Length Contraction	$L' = L/\gamma$ (Length shortens in the direction of motion)	Compression of the number of perceptual space windows	Space and time must emerge synchronously, not one fast and one slow
Speed Limit	Required by causality, speed does not exceed c	Upper limit of interaction frequency is c/l_P, which cannot be broken	The number of interactable space-time windows decreases after high-speed motion

5.2 Essence of Chiral Topology and Charge Sign

The essence of the charge sign is the intrinsic chirality parameter $\chi = \pm 1$ of momentum units, which is directly related to the electron spin 1/2 topological structure [4,5], and is also the basis for the formation of ordered structures—chirality stability provides the basis for polarization repeatability. The specific corresponding relationship is shown in the following table:

Particle Type	**Chirality Parameter** χ	**Helical Winding Direction**	**Topological Period**	**Macroscopic Charge**
Electron (e^-)	-1	Left-handed (counterclockwise)	720°	$q = -e$
Positive charge (e^+, p^+)	+1	Right-handed (clockwise)	720°	$q = +e$
Photon	± 1	Circular polarization direction	360°	No charge

Physical Significance: Chirality preservation ensures the convergence of electron spin directions, providing a geometric basis for ordered structures and polarization effects [4,5]; at the same time, charge

conservation is equivalent to chirality conservation—the total number of left-handed and right-handed momentum units in the universe is always balanced, which is consistent with the conservation law [6].

5.3 Unique Predictions and Experimental Verification

Based on the theoretical framework of this paper, 5 testable unique predictions are proposed, which are different from traditional electromagnetism, providing empirical support for the validity of the theory. The specific details are shown in the following table, where indicates the highest priority (verification can be quickly realized under existing conditions):

Prediction Content	**View of Traditional Electromagnetism**	**Theoretical Prediction in This Paper**	**Experimental Verification Method**	**Priority**
Minimum time for electromagnetic field establishment	No minimum time, continuous distribution	$t_{\min} = t_P \approx 5.4 \times 10^{-44}$ s (Planck time) [7,8]	Ultrafast laser pump-probe technology [8]	Ordinary
Chirality dependence of circularly polarized light wavelength	No chirality dependence, same wavelength	$\frac{\Delta\lambda}{\lambda} \approx \alpha^2 \approx 5 \times 10^{-5}$ (α is the fine structure constant)	Measurement with ultra-high precision spectrometer	Highest
Magnetic force saturation at ultra-high speed	$F \propto v$, no saturation	When $v \to c$, perceptual windows $\to 0$, Lorentz force tends to saturation [13]	LHC particle accelerator experiment	Highest
Discreteness of vacuum electromagnetic fluctuations	Continuous quantum field, no discrete characteristics	Originates from discrete momentum unit interaction, with discreteness [13,19]	High-precision measurement of Casimir effect	Ordinary
Velocity dependence of low-speed particle deflection	Deflection angle is independent of v	Deflection angle $\theta \propto 1/v^2$, the lower the speed, the more obvious the deflection	Cold atomic beam experiment measurement	Ordinary

Among them, the measurement of circularly polarized light wavelength difference (achievable with existing precision) and the verification of magnetic force saturation of ultra-high energy particles at LHC (no need for new equipment) are the most feasible experimental paths, which can quickly verify the validity of the theory.

6 Conclusions and Future Research

6.1 Core Conclusions

Based on the framework of cosmic dynamic essence and momentum unit interaction [2,12], this paper reconstructs the essence of electricity and magnetism, and draws the following core conclusions:

1. **Essence of Force:** All forces originate from the trend of self-motion and mutual motion. When two particles move inward together, attractive force emerges; when they move outward together, repulsive force emerges. A particle establishes extensive force relationships with the environment, which originates from the trend of motion and evolution in multiple directions under the constraint of internal rules of the particle. This understanding unifies all fundamental forces into the same dynamic origin [12,15,14].

2. **Unified Essence of Electricity and Magnetism:** The work done by electric current originates from the momentum deviation of electron inertial motion, and magnetism is a degradation effect of electromagnetic force under the special relativistic perceptual window effect [11,13]. Both originate from the interaction of momentum units and the accumulation of momentum deviations. It is not that where the particle moves, an adjustable field follows to exert electricity or magnetism, but the result of particle encapsulation and interaction [2,19].

3. **Micro-Mechanism of Magnetism:** Magnetism is not an independent fundamental force, but the net momentum deflection caused by the reduction in the number of perceptual windows for interaction with the environment when moving particles interact with the background momentum unit field [13]. The Lorentz force can be strictly derived from discrete momentum unit interactions [11,4].

4. **Inferred Main Origin of Polarization Effect:** The main origin of polarization effect depends on ordered structures (phase unification, chirality preservation) [4,5]. When the environment cannot support the electron flow to form a "neat queue", lateral momentum deviations cannot emerge in an ordered manner, the polarization effect disappears, and only radial momentum deviations remain—macroscopically manifested as electrostatic force. Therefore, the essential difference between electrostatic force and magnetic force does not lie in the force itself, but in the order degree of electron motion state: ordered $\rightarrow$ polarization $\rightarrow$ magnetism; disordered $\rightarrow$ isotropic $\rightarrow$ electrostatic force. This inference is consistent with the theory of ordered structure formation [15] and awaits experimental verification.

5. **Essence of Charge and Field:** The charge sign is the chirality parameter $\chi = \pm 1$ of momentum units [4,5,6], and the field is a collection of rules for the encapsulation, perception, and interaction of momentum units [2,12]. There is no need to introduce magnetic monopoles [2] or external magnetic fields [20]. The underlying driving force is the speed of light and vector superposition ability. The encapsulation rules determine the evolution direction, and the evolution direction can emerge repulsive or attractive forces [1,5,15].

6. **Essence of Relativity:** Relativity is essentially an integral effect of interaction processes [9]. The origin of special relativity lies in: the upper limit of the interaction frequency of forces in the cosmic system is c [7,10]. When particles move, the number of their perceptual space-time windows decreases, and the interaction ability weakens [13]. Therefore, spacetime contraction is not an intrinsic geometric change, but a contraction formed by the number of statistical interaction windows under the frequency of constant interaction energy c; the Lorentz transformation is not a

description of relative relationships, but an integral projection of intrinsic interaction relationships [9].

6.2 Theoretical Significance

The value of this paper lies in providing a micro-mechanism for traditional electromagnetism and relativity, and unifying the essence of electricity and magnetism into the same quantum mechanism field. The details are as follows:

Micro-Mechanism: For the first time, from the perspective of ordered momentum deviation and perceptual window effect, the degradation mechanism of magnetism and the origin of polarization effect are explained [13,15], and the micro-origin of Lorentz force is strictly derived [11,4].

Essential Breakthrough: This framework reveals the common dynamic origin of electricity and magnetism—momentum deviation, and thus points out the logical contradiction between the four core concepts in traditional theories: (1) If the magnetic field is an independent entity, there is no need for magnetic monopoles as the "source of the magnetic field"; (2) If magnetic monopoles are introduced, the magnetic field should not be an independent entity, but a derivative effect of magnetic charge; (3) If mass and energy are equivalent, force and field should be dynamic statistical effects of mass/energy distribution; (4) If relativity and electromagnetic force have been unified (the magnetic field has been proved to be a relativistic effect of the electric field), there should be no need to introduce independent magnetic field entities or magnetic monopoles, but directly find the micro-mechanism of magnetism in the interaction between electrons and protons. Traditional theories try to retain both (4) and (1), acknowledging that the magnetic field is a relativistic effect of the electric field, while treating the magnetic field as an independent entity and even looking for magnetic monopoles—which is itself a logical contradiction. With momentum units as the only underlying reality, this framework reduces charge to the chirality parameter $\chi = \pm 1$, reduces magnetic field force to a relativistic effect of electromagnetic force under perceptual window degradation, reduces the field to a rule set, and reduces the directional differentiation of magnetism to the polarization effect of ordered electron flow. The micro-mechanism of electricity and magnetism is directly realized in the interaction between electrons and protons, without independent magnetic field entities or magnetic monopoles, achieving a complete dynamic unification of electricity and magnetism [2,4,5,6].

Theoretical Unification: A micro-correlation between electromagnetic force and special relativity is established [9,13], providing a new idea and model for the unification of the four fundamental forces [12,14].

Falsifiability: Five testable predictions are proposed, providing empirical support for the validity of the theory [8], which conforms to the core requirements of scientific theories.

6.3 Future Research Directions

Based on the theoretical framework of this paper, future research can be carried out in the following 5 directions to further improve the theoretical system:

1. Improve the vector algebra modeling of chiral momentum units, refine the vector calculation process of momentum unit interaction, improve the accuracy of theoretical derivation, and adapt to complex micro-particle interaction scenarios [4,5].

2. Extend the theoretical framework to weak force and strong force, explore the unified micro-

mechanism of the four fundamental forces, and promote the research on unified field theory [12,14].

3. Explore the momentum unit basis for electromagnetic-gravitational unification, establish a correlation model between electromagnetic interaction and gravitational interaction, solve the problem of unifying gravity with other fundamental forces [12,14].

4. Promote experimental verification, focus on carrying out experiments on circularly polarized light wavelength difference and magnetic force saturation of ultra-high energy particles, and combine the breakthrough of quantum detection technology to verify the details of momentum unit interaction at the Planck scale [13,8].

5. Improve the geometric encapsulation rules without interaction objects in the front and back, further explain the micro-geometric mechanism why it is difficult to generate electromagnetic force in the direction of inertial motion [10,5], and supplement the complete theoretical system of momentum unit encapsulation [2,19].

References

[1] Laplace, P. S. (1825). *A Treatise on Celestial Mechanics* (Vol. 1–5). London: Chelsea Publishing. (Original work published 1799 as *Traité de Mécanique Céleste*). — The article infers that the speed of gravity is at least millions of times the speed of light, proving that force has a high-frequency refresh mechanism, providing core premise theoretical support for the origin of relativistic effect (perceptual window number compression) during motion.

[2] Xiao, Bo. (forthcoming). Unified Cosmic Mechanics Evolution Theory (XI): Field and Particle: Momentum Topological Coding Deterministic Quantum Theory. [In Press]. — Expounds the encapsulation rules and topological coding mechanism of momentum units, supporting the argument in this paper that the charge sign corresponds to the chirality parameter χ and that magnetic monopoles are not needed.

[3] Upreti, A., & MoEDAL Collaboration. (2024). Physical Review Letters, 133, 071803. DOI: 10.1103/PhysRevLett.133.071803. — Recent experiments have not found magnetic monopoles.

[4] Hestenes, D. (1990). The zitterbewegung interpretation of quantum mechanics. *Foundations of Physics*, 20(10), 1213–1232. — Interprets electron spin as micro-local motion through geometric algebra, providing geometric dynamic support for the intrinsic chirality parameter χ of momentum units and the polarization effect generated by it defined in this paper.

[5] Penrose, R. (1971). Angular momentum: An approach to combinatorial spacetime. In T. Bastin (Ed.), *Quantum Theory and Beyond*. Cambridge: Cambridge University Press. — Proposes the concept of spin network and combinatorial spacetime, providing a geometric picture support for the chiral topological structure and non-local encapsulation of momentum units in this paper.

[6] Aharonov, Y., & Bohm, D. (1959). Significance of electromagnetic potentials in the quantum theory. *Physical Review*, 115(3), 485–491. DOI: 10.1103/PhysRev.115.485. — The Aharonov-Bohm effect reveals the physical reality of potentials at the quantum level, providing experimental and theoretical evidence for the charge sign corresponding to the chirality parameter χ and its modulation of momentum phase in this paper.

[7] Xiao, Bo. (forthcoming). Unified Cosmic Mechanics Evolution Theory (IV): The Necessity of the Cosmic Force Refresh Mechanism and the Origin of Time. [In Press]. — Demonstrates the upper limit of refresh frequency c and the minimum interaction time $t_{\min} = t_P$ at the Planck scale, providing a time-scale basis for the perceptual window effect proposed in this paper.

[8] Günter, G., Walther, T., Khalili, E. A., et al. (2009). Sub-cycle switch-on of ultrastrong light–matter interaction. Nature, 458(7235), 178–181. DOI: 10.1038/nature07860. — Experimentally observed the switch-on process of electromagnetic interaction on an ultra-short time scale, providing experimental physical background support for the prediction in this paper that there exists a minimum time t_P for the establishment of the electromagnetic field.

[9] Xiao, Bo. (forthcoming). Unified Cosmic Mechanics Evolution Theory (VI): The Relationship Between Relativity, Classical Mechanics, and Quantum Mechanics. [In Press]. — Reconstructs special relativity as the integral projection of intrinsic interaction relationships, providing theoretical connection for the discussion in Chapter 5 of this paper on mechanical degradation caused by perceptual window compression.

[10] Bombelli, L., Lee, J., Meyer, D., & Sorkin, R. D. (1987). Space-time as a causal set. Physical Review Letters, 59(5), 521–524. DOI: 10.1103/PhysRevLett.59.521. — Proposed the causal set theory, supporting the view in this paper that force is a causal resultant force generated by a sequence of discrete events, and helping to explain the difference mechanism between the direction of inertial motion and lateral interaction ability.

[11] Purcell, E. M. (1965). Electricity and Magnetism (Berkeley Physics Course, Vol. 2). New York: McGraw-Hill. — Provides a classical theoretical basis for deriving electrostatic force as magnetic force through special relativistic transformation (length contraction), verifying the macroscopic consistency of magnetic force as a relativistic degradation effect of electromagnetic force in this paper.

[12] Verlinde, E. (2011). On the origin of gravity and the laws of Newton. Journal of High Energy Physics, 2011(4), 029. DOI: 10.1007/JHEP04(2011)029. — Proposed the view that gravity originates from entropic force or information flow, supporting the non-fundamental force logical framework in this paper that “force is the evolutionary trend of momentum deviation” and “field is the emergence of a rule set”.

[13] Rovelli, C. (2004). Quantum Gravity. Cambridge: Cambridge University Press. — Discusses the discrete quantum nature of spacetime, providing a physical picture support under the background of quantum gravity for the “number of perceptual windows” proposed in this paper as discrete interaction units.

[14] Jacobson, T. (1995). Thermodynamics of spacetime: The Einstein equation of state. Physical Review Letters, 75(7), 1260–1263. DOI: 10.1103/PhysRevLett.75.1260. — Proposed that the Einstein equation can be regarded as the state equation of spacetime thermodynamics, supporting the unified description in this paper of gravity and inertia as information interaction imbalance effects.

[15] Laughlin, R. B. (2005). A Different Universe: Reinventing Physics from the Bottom Down. New York: Basic Books. — Emphasizes the core role of emergentism and collective behavior in physical laws, supporting the non-reductionist position in this paper that reconstructs fundamental forces as momentum flow deviations.

[16] Feynman, R. P., & Hibbs, A. R. (1965). Quantum Mechanics and Path Integrals. New York: McGraw-Hill. — The path integral formulation provides a mathematical formal basis for the encoding mechanism in this paper where momentum units traverse all topological paths and sum them with weights.

[17] Bekenstein, J. D. (2003). Information in the holographic universe. Scientific American, 289(2), 68–73. — Expounds the holographic principle and entropy density limit, supporting the discussion in this paper on the limited information capacity within perceptual windows and the field strength saturation mechanism.

[18] Zeilinger, A. (2008). On the interpretation and philosophical foundation of quantum mechanics. In E. Kaldis (Ed.), Encyclopedia of Life Support Systems. Oxford: EOLSS. — Discusses the fundamentality of information and the quantum no-cloning theorem, supporting the discussion in this paper on information refresh and measurement limits within perceptual windows.

[19] 't Hooft, G. (2016). The Cellular Automaton Interpretation of Quantum Mechanics (Fundamental Theories of Physics, Vol. 185). Cham: Springer. DOI: 10.1007/978-3-319-41285-6. — Discusses that quantum phenomena can emerge from underlying deterministic cellular automaton rules, supporting the view in this paper on the determinism of topological coding and the generation of random appearances by perceptual rule sets.

[20] Wheeler, J. A., & Feynman, R. P. (1945). Interaction with the absorber as the mechanism of radiation. Reviews of Modern Physics, 17(2–3), 157–181. DOI: 10.1103/RevModPhys.17.157. — Proposed the absorber theory, supporting the view in this paper that electromagnetic interaction must satisfy the global momentum conservation boundary, and there is no independent electromagnetic field, but an endogenous influence.