Cosmic Theory of Electric Primitives and Magnetic Primitives (I)

Ultimate Quantum: Phase Transition & Big Bang

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Abstract

The origin of the cosmic singularity and vacuum zero-point energy, long-standing puzzles in Big Bang cosmology challenging current physical frameworks, remain central issues in modern physics. Based on the Cosmic First Principles, this study establishes "Electric Primitives" and "Magnetic Primitives" as the ultimate quantum primitives of the universe, constructs the "Cosmic Theory of Electric Primitives and Magnetic Primitives", and proposes a phase transition-driven mechanism for singularity evolution.

Key findings: True Vacuum consists of Primordial Unities formed by the symmetric fusion of Electric Primitives and Magnetic Primitives; False Vacuum is composed of Electric Primitives, Magnetic Primitives, and Electromagnetic Primitives—all generated from phase transitions of Primordial Unities. Together, these structural features reveal the microscopic origin of vacuum zero-point energy. Their self-organization drives phase transitions, the Big Bang, and spacetime evolution.

The logical consistency of the proposed phase transition mechanism and cosmic evolution framework is verified via thought experiments, providing theoretical operability for interpreting unobservable early cosmic processes.

This study establishes a theoretical bridge linking quantum primitives to cosmic evolution, offering a groundbreaking framework for resolving the mystery of cosmic origin and advancing the unification of quantum mechanics and relativity.

Keywords：Electric field quantization; Magnetic field quantization; Cosmic Theory of Electric Primitives and Magnetic Primitives (CTEPMP); Vacuum zero-point energy; Cosmic singularity; Big Bang；Unification of Quantum Mechanics and Relativity

1. Introduction

Modern cosmology and fundamental physics have established a standard cosmic evolution model, yet core origin questions—particularly the quantum origin of cosmic singularities and the nature of vacuum zero-point energy—remain key bottlenecks for theoretical unification. As a pillar of modern physics, general relativity[1-10] successfully describes macroscopic spacetime and gravity, but faces quantization dilemmas at singularities (infinite curvature renders physical laws invalid). Quantum mechanics[11-20] has advanced Big Bang[21,22] and vacuum energy[23-26] research, though its quantum zero-point energy prediction exceeds observations by

122 orders of magnitude[27,28]. These contradictions are not mere technical discrepancies; they suggest existing frameworks may need refinement at the "spacetime-quantum" interface, constraining cosmological self-consistency.

While classical theories accurately explain a wide range of observational phenomena, fundamental gaps remain: the universe's ultimate constituent units and the unified mechanism of spacetime-matter generation remain unclear. This study takes the Cosmic First Principles —established in our series of work—as its logical basis[29]. Building on Dirac's electromagnetic field quantization framework, we propose independent quantization of electric and magnetic fields, defining discretely quantized "Electric Primitives (EPs)" and "Magnetic Primitives (MPs)" as the universe's ultimate units, breaking the traditional continuous field assumption. Building on the previously established "Cosmic Theory of EPs and MPs" [29], this paper analyzes the intrinsic logic of primitive evolution to offer a new theoretical perspective for resolving the aforementioned fundamental physics impasses and advancing the unification of quantum mechanics and relativity.

As the series' foundational first paper, it focuses on two questions: (1) How to define EPs/MPs' quantized properties and evolution rules? (2) How does their self-organization avoid singularity divergence and unify vacuum energy explanations? Quantitative analysis clarifies their energy quantization (e.g., $0.5hv$ minimum unit) and proposes a "Primordial Unities (PUs)→ Electromagnetic Primitives (EMPs)" phase transition mechanism, providing a quantum starting point for singularity formation and Big Bang initiation. This framework will permeate subsequent studies: Paper II on nonlocality, Paper III on unification of the four fundamental forces (wherein the resolution to the spacetime-quantum interface contradiction will be elaborated), and Paper IV on dark matter/energy[30]—all relying on the rules herein. Together, they form a "ultimate primitives→cosmic phenomena" loop, offering a systematic paradigm for understanding the universe.

2. Fundamental Concepts

A core challenge in modern physics lies in the dichotomy between quantum mechanics and relativity—long regarded as separate systems belonging to the microcosmic and macrocosmic realms, respectively, they thus struggle to collectively account for fundamental phenomena such as singularities and vacuum energy. This study is grounded in addressing this predicament: based on the "unity of opposites" from the universe's first principle [29], it proposes, for the first time, the separate quantization of electric and magnetic fields, directly targeting the essence of the universe's ultimate constituents.

Two fundamental quantized units are defined:
- Electric Primitives (EPs): The minimal quantized unit of electric fields;
- Magnetic Primitives (MPs): The corresponding minimal quantized unit of magnetic fields.

Their unity of opposites is specifically manifested as follows: EPs correspond to electric fields and mediate gravitation, while MPs correspond to magnetic fields and mediate repulsion; the two coexist as an indivisible whole. Both undergo circular motion with the speed of light in vacuum as their tangential velocity, forming "electric core domains" and "magnetic core domains," respectively.

The core value of this system resides in: quantum properties and relativistic laws are not confined to distinct scales, but naturally integrate through the global behavior of EPs and

MPs—exhibiting both quantum properties and relativistic effects at the microscale, while encompassing relativistic laws and remaining rooted in quantum behavior at the macroscale. This deep intertwining fundamentally bridges the divide between the two theories, providing a unifying framework for explaining the universe's underlying phenomena.

2.1 Electric Primitives (EPs)

EPs are the smallest quantized electric field units, derived from electric field quantization deductions.

2.1.1 Quantum Properties

As discrete components of the electric field, EPs revise the classical assumption of "continuous distribution." Their discreteness circumvents singularity divergence, while energy quantization (e.g., $0.5hv$) offers potential for addressing vacuum energy discrepancies—aligning with the core tenets of quantum field theory.

2.1.2 Mechanical Effects

EPs exhibit inherent primordial gravitational interactions—an intrinsic property, not a macroscopic derivative. Macroscopic gravitation emerges from the collective superposition of gravitational forces generated by vast numbers of EPs, providing a quantum-level origin for classical gravity and bridging microscopic behavior to macroscopic phenomena.

2.1.3 Motion Patterns

As ultimate quantum units, EPs exhibit point-like properties (scale approaching infinitesimality), with hierarchical correlations between intrinsic and emergent characteristics in their quantum state motion:

- Intrinsic characteristic: They move along a one-dimensional circle at the vacuum speed of light (c_0), forming a fundamental constraint; their positions on the circle are random, governed by the uncertainty principle.

- Emergent characteristic: Constrained by the geometric trajectory of the circle, their positions in two-dimensional space present a probability distribution via quantum emergence, an extension of intrinsic uncertainty at the macroscopic scale.

The trajectory forms an "electric core domain" (ranging from 10^{-42} meters to 10^{42} meters), the effective boundary for attractive effects—beyond this domain, attraction vanishes entirely.

2.1.4 Energy States

Quantum field theory confirms the discreteness of electromagnetic field energy, with Dirac deriving its quantized expression via field quantization. In independent electric field quantization, this study further demonstrates that electric and magnetic field energies each follow quantized laws, with symmetric distribution in any electromagnetic unit (0.5 quantum units each).

Based on electric field quantization assumptions, combined with the Dirac-Einstein mass-energy relation ($E=mc_0^2$) and Planck-Einstein energy-frequency relation ($E=hv$), the energy expression of EPs can be rigorously derived. Since electric field energy occupies 0.5 quantum units in electromagnetic quantization, the energy of a single EP satisfies:

$$E_{ep} = m_{ep}c_0^2/2 = hv/2 \tag{1}$$

Here, E_{ep} denotes the energy of an EP (J); m_{ep} represents the relativistic mass of an EP (kg); c_0 is the

speed of light in vacuum (m/s); h is the Planck constant (J·s); and v is the swirling frequency of the

EP (Hz).

When an EP's rotational frequency is $v=1$ Hz, its energy is $0.5h$ (J), defined as the basic energy quantum unit of the electric field. This value is a core parameter for quantifying the microscopic energy structure of electric fields, providing quantitative support for the quantized definition of EPs.

2.2 Magnetic Primitives (MPs)

MPs are the smallest units derived from independent magnetic field quantization. Together with EPs, they form the ultimate primitives of electromagnetic field quantization. Their core characteristics, derived from magnetic field quantization laws, are as follows:

2.2.1 Quantum Properties

As the ultimate product of magnetic field quantization, MPs are the basic discrete components of magnetic fields, directly embodying their quantum nature. This breaks classical electromagnetic theory's assumption of continuous magnetic fields, aligning with quantum field theory's core understanding of "fields' quantized essence" and supporting the microscopic discrete structure of magnetic fields.

2.2.2 Mechanical Effects

MPs exhibit inherent primordial repulsive interactions—an intrinsic property representing the quantum origin of all macroscopic repulsive phenomena (e.g., cosmic expansion, interparticle repulsion). Macroscopic repulsive behavior arises from collective superposition of repulsive forces from vast numbers of MPs. This mechanism explains processes like cosmic diffusion and material separation, unifying microscopic primitive repulsion with macroscopic repulsive phenomena logically.

2.2.3 Motion Patterns

As ultimate quantum units, MPs have an almost identical movement pattern to EPs (see 2.1.3). The only difference is that their trajectory forms a "magnetic core domain" (10^{-42} m to 10^{42} m), the effective boundary for repulsive effect; beyond which the repulsive force vanishes.

2.2.4 Energy States

The energy state of MPs is analogous to that of EPs (see 2.1.4). The energy of a single MP satisfies:

$$E_{mp}=m_{mp}c_0^2/2 =hv/2 \tag{2}$$

Here, E_{mp} denotes the energy of an MP (J); m_{mp} represents the relativistic mass of the MP (kg); c_0 is the speed of light in vacuum (m/s); h is the Planck constant (J·s); and v is the swirling frequency of the MP (Hz).

When an MP's rotational frequency is $v=1$ Hz, its energy is $0.5h$ (J), defined as the basic energy quantum unit of the magnetic field. This value serves as a core parameter for quantifying the microscopic energy structure of magnetic fields.

Combining the EP energy equation (1) and MP energy equation (2), since a single EP and a single MP have equal energy at the same frequency, we directly derive:

$$m_{ep}=m_{mp} \tag{3}$$

Equation (3) shows that the relativistic masses of a single EP and MP are numerically equal.

This conclusion provides quantitative evidence for the symmetry between EPs and MPs, laying a foundation for subsequent derivations of primitive coupling and evolution mechanisms.

3. The True Vacuum and False Vacuum Cosmic Systems Based on PUs and EMPs

There exists a ground-state neutralizing force between the mutually conjugate EPs and MPs in the universe [29], which is the most fundamental force in the universe. Guided by energy or information, they combine through this force to form Primordial Unities (PUs) or Electromagnetic Primitives (EMPs); conversely, when triggered by energy or information, PUs/EMPs decompose into independent EPs/MPs, thereby enabling dynamic transformations between different forms of existence.

A regional domain in the universe is referred to as a True Vacuum region when only PUs exist within it; a regional domain is termed a False Vacuum region when only EPs, MPs, EMPs, and PUs are present. False Vacuums are generated within True Vacuum regions. In terms of carriers, PUs are the sole carrier of True Vacuums, while EPs, MPs, and EMPs are the main carriers of False Vacuums—and these two types of systems form a dynamic connection through the aforementioned processes of coupling, differentiation, and transformation of EPs and MPs.

3.1 PUs and the True Vacuum Cosmic System

3.1.1 Formation of PUs

As shown in Fig. 1, when a conjugate EP-MP pair encounters within a region with a scale of $\leq 10^{-42}$ m, their electric core domain and magnetic core domain will fully overlap. At this point, the ground-state neutralizing force drives their deep fusion, forming a symmetrically embracing, independent PU structure. As an undifferentiated unity of EPs and MPs, the intrinsic scale of a PU approaches zero infinitely—epitomizing their highly integrated, absolutely symmetric state at the ultimate microscopic level.
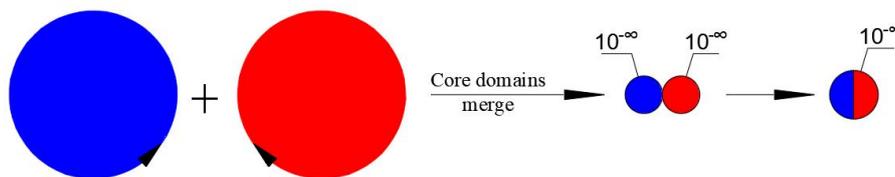

Figure 1. Schematic Diagram of the PU Formation Process. The blue area: motion region of a MP; the red area: motion region of an EP; circumferential arrow: direction of rotational movement.

3.1.2 The True Vacuum Cosmic System

Within the framework of this theory, the connotation of "True Vacuum" can be clarified based on an innovative division of microscale regions: Every point in the universe encompasses regions of different scales, and we take the Planck scale (approximately 10^{-35} meters) as a critical boundary—regions at or above this scale correspond to physical space, which aligns with the understanding of modern science (modern science generally holds that regions smaller than this scale lack observable physical significance). This theory further refines the regions smaller than

the Planck scale: the interval from 10^{-35} meters to 10^{-42} meters is defined as the False Vacuum region, and the region with a scale $\leq 10^{-42}$ meters is defined as the True Vacuum region.

Specifically, "True Vacuum" refers to the tiny region with a scale $\leq 10^{-42}$ m contained in every point in the universe, serving as the ultimate fundamental substrate of the universe. The genesis of all derivative structures (including False Vacuum, physical space, etc.) takes it as the initial support, and its existence does not depend on any other cosmic forms. Within this region, there exist neither the material forms in traditional physical space nor the various forms of existence in the False Vacuum; it consists solely of absolute vacuum and PUs (PUs are the only form of existence in this region). All such tiny regions collectively constitute the overall True Vacuum, with their distribution spanning all spatial points in the universe, forming a boundaryless and gapless global coverage.

All PUs form the True Vacuum cosmic system through synergistic interactions. This system is composed of the aforementioned absolute vacuum and PUs, and its state can be naturally defined as the "True Vacuum state": Since there is no material disturbance within the region, thermal motion completely vanishes, and the system naturally exists in an environment of absolute zero. Thus, it stably persists in the ground state and satisfies the zero-energy eigenvalue condition (with zero explicit energy, and all energy existing in the form of implicit energy). This state exactly meets the conditions for the formation of Bose-Einstein condensation (BEC)—at absolute zero and without external disturbances, a large number of identical quantum units spontaneously occupy the same quantum ground state. Therefore, as the only quantum units in the True Vacuum state, PUs naturally exhibit BEC characteristics: they possess completely consistent intrinsic properties and quantum states, with no observable individual differences (i.e., identity), and due to being identical and co-occupying the same ground state, they have no hierarchical division of center-edge or dominant-subordinate in the system, presenting an absolutely equal coexistence relationship; they occupy completely identical quantum states (consistent with their indistinguishability), thereby giving rise to macroscale quantum synergy and ultimately forming an extremely stable structure with time-translational invariance. In view of the holographic property of PUs—a single PU, being identical to other units in the system, contains the complete information of the True Vacuum system, and the entire system carries the preset information of all derivative structures in the universe—this system is also termed the holographic primitive system.

3.1.3 The "Quantum Primitive Self-Organization" Mechanism

The PUs in the True Vacuum state serve as the foundation for cosmic genesis within this theoretical framework—their "identicality" and "holography" are not isolated characteristics, but precisely the fundamental prerequisites for cosmic evolution:

The identicality of PUs is the starting point of all this. As revealed by the quantum properties of Bose-Einstein condensation, PUs are strictly indistinguishable at the quantum state level. This "identicality" means there are no state barriers between them, and they naturally exist in a state of synergistic connection. It is precisely this identicality that provides the basis for the existence of holography: because all PUs are identical and free of barriers, the multi-dimensional evolutionary information of the universe since its origin can be completely stored in each PU—each PU thus becomes a "miniaturized carrier" of cosmic information, which is how holography arises. It can be said that holography is a natural extension of identicality, while identicality is the fundamental

prerequisite for holography; together, they constitute the underlying laws of cosmic genesis.

What is more crucial is that such characteristics are not an accidental presence in a certain local area: every point in the universe contains a tiny True Vacuum region with a scale $\leq 10^{-42}$ meters, and the PUs in each such region necessarily possess the aforementioned identicality and holography. This means that the True Vacuum state is the "universal substrate" of the universe—no matter where in the universe one looks, as long as such a tiny region is found, the state of the PUs it contains is completely consistent with that of the True Vacuum PUs at any other point. This universality allows identicality and holography to cover the entire cosmic system, becoming "intrinsic attributes" independent of external conditions.

From this, the logic of the "quantum primitive self-organization" mechanism becomes clear: identicality enables all PUs to naturally synergize and form a globally connected quantum storage matrix; holography, on the other hand, allows this matrix to carry all the informational guidance for cosmic evolution. When PUs achieve synergy through identicality and transmit information by virtue of holography, the process of self-organization spontaneously initiates—the evolution of the universe is not a random process divorced from its origin, but a process that takes the True Vacuum state at each point as its "root" and "foundation," and under the guidance of holographic information, always maintains coordination and consistency with the origin. This setting also provides an essential explanation, based on the identicality of primitives, for the "holography" mentioned in modern science: the root of holography lies precisely in the identicality and connection of such fundamental units as PUs.

3.2 EMPs and the False Vacuum Cosmic System

3.2.1 Formation of EMPs

Within the True Vacuum cosmic system, PUs inherently exist stably in their ground state, and their phase transition occurs only under specific conditions: the phase transition process initiates solely when, within a tiny True Vacuum region with a scale of 10^{-42} m, the aggregation degree of PUs reaches a critical value, or when PUs in this region meet the threshold conditions for "PU Phase Transition" under the guidance of energy and information.

At this point, PUs undergo PU Phase Transition, differentiating into independent EPs and MPs, which are distributed in the four quadrants of the Cartesian coordinate system (see Fig. 2a). When a conjugate EP-MP pair encounters, the ground-state neutralizing force drives their coupling, thereby forming a stable EMP structure.

EMPs generate and evolve synchronously within the four quadrants. In a single EMP, the EP and MP rotate around the same intersection in the same plane, and the range of their trajectories constitutes the "electromagnetic core domain" (see Fig. 2b). This symmetric rotation mode based on four-quadrant distribution forms an intrinsic balance mechanism—it not only ensures the structural stability of EMPs but also achieves coordinated evolution among the quadrants, laying a structural foundation for the subsequent expansion of spatial dimensions and the generation of matter.
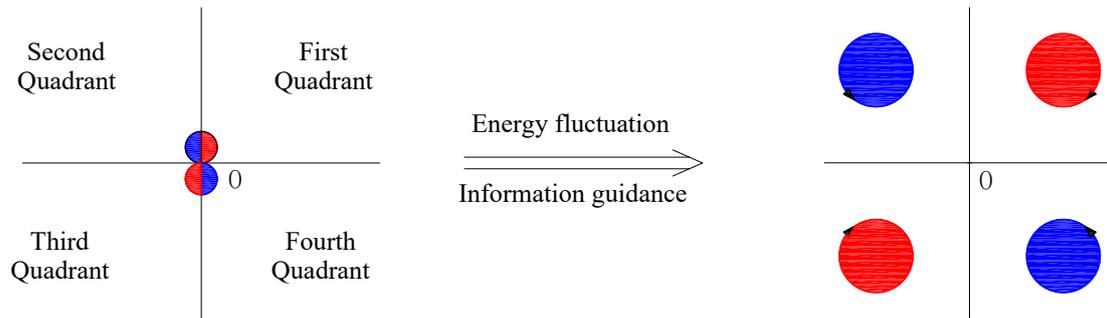
(a) Quadrantal balance of PUs phase transition
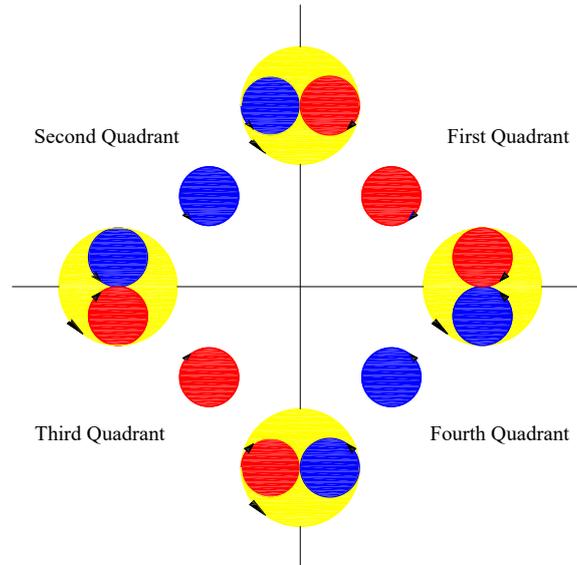
(b) Quadrantal Balance of EMPs

Figure 2. Generation Process Diagram of Quadrantal Balance of EMPs. The blue area: motion region of a MP; the red area: motion region of an EP; the yellow area: motion region of an EMP; circumferential arrow: direction of rotational movement.

3.2.2 The False Vacuum Cosmic System and Bidirectional Time

The scope of the False Vacuum cosmic system is determined by both the PU phase transition and the Principle of Inversion Symmetry: Based on the Principle of Inversion Symmetry[29], the PU phase transition occurs simultaneously at the microscale of 10^{-42} meters and the macroscale of 10^{42} meters. Thus, the entire domain ranging from 10^{-42} meters to 10^{42} meters collectively constitutes the False Vacuum cosmic system—and the entire region is in a False Vacuum state.

EPs, MPs, and EMPs form this system through the symmetry breaking of the aforementioned PU phase transition. This process transforms the eternal time symmetry of the True Vacuum cosmic system into a bidirectional time-symmetric system based on the "eternal invariance" of primitive time: The system exhibits both differentiation (manifested as bidirectional time flows) and complementarity, and it is precisely through such directional time differentiation that symmetry breaking maintains logical self-consistency.

Within this system, primitives exhibit ordered quantum covariant motion at absolute zero under the action of bidirectional symmetry, and this motion follows the "Inversion Symmetry Principle"[29]: primitives at the microscale diffuse outward via energy potential differences, with their direction of motion consistent with the observable time flow; in contrast, primitives at the

macroscale converge inward in the opposite direction. This inward macroscale motion can be analogous to time-reversal symmetry in quantum physics (i.e., the symmetric characteristic where the trajectory of motion is opposite to the direction of time flow), forming a strict complementary relationship with the outward microscale motion—though their directions are opposite, they jointly constitute the dynamic equilibrium symmetry of primitives at the cosmic scale (Fig. 3).
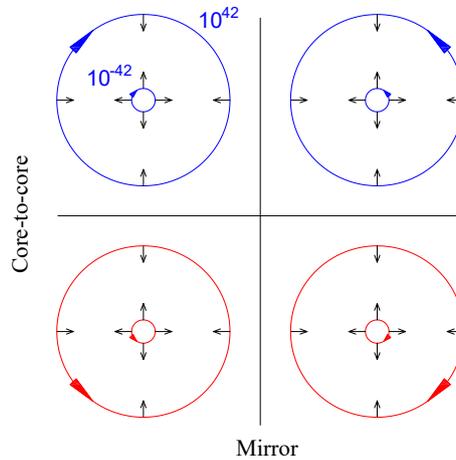

Figure 3. Bidirectional Movement Schematic. The area enclosed by the blue line: motion region of the MP; the area enclosed by the red line: motion region of the EP;circumferential arrow: direction of rotational movement; radial arrow: direction of motion change.

These bidirectional time flows form a causal loop, not mere opposition: forward time drives space expansion and energy release (analogous to relativity's measurable time); reverse time sustains conservation/equilibrium via information retrospection. Together, they reflect "constant time," achieving "symmetric core preservation amid breaking."

Their synergy generates an information mechanism: EPs/MPs/EMPs form "electric/magnetic /electromagnetic cores," creating a cosmic information network (storage, reading, transmission) via bidirectional interactions, integrating into the system. This bidirectional feature names it the temporal primitive system.

3.3 Energy Properties of PUs and EMPs

As coupled unities of EPs and MPs, PUs and EMPs carry energy equal to the sum of their constituent units' energies (EPs and MPs), described by:

$$E_{pu}= E_{emp}= E_{ep}+ E_{mp}= m_{ep}c_0^2/2+m_{mp}c_0^2/2 =hv \tag{4}$$

Where, E_{pu} denotes the energy of an PU (J); E_{emp} denotes the energy of an EMP (J); E_{ep} denotes the energy of an EP (J); E_{mp} denotes the energy of an MP (J); m_{ep} represents the mass of an EP (kg); m_{mp} represents the mass of a MP (kg); c_0 is the speed of light in vacuum (m/s); h is the Planck constant (J·s); and v is the swirling frequency of the EP (Hz).

According to equation (3), where，$m_{ep}= m_{mp} = m$, the equation (4) simplifies to:

$$E_{pu}= E_{emp}= mc_0^2=hv \tag{5}$$

Within this framework, when EPs and MPs rotate at v=1 Hz, a single PU/EMP's energy remains constant at h (J), defined as the fundamental quantum of their fields. This quantized energy aligns with Planck's hv, breaking traditional electromagnetic oscillation limits and extending h's significance from microscopic particles to cosmic primitives. It expands energy quantization to the universe's essential dimension, linking PU-EMP theory with classical quantum theory logically.

The energy of EPs, MPs, PUs, and EMPs differs fundamentally from nuclear, kinetic, or thermal energy in modern science: the former constitutes unmanifested primordial energy in the cosmic ground state—i.e., the cosmic vacuum zero-point energy—while the latter denotes observable, quantifiable energy forms. To delineate their distinctions in existence modalities and operational mechanisms, this theory designates the ground-state energy of EPs, MPs, PUs, and EMPs as "latent energy"—the intrinsic driver of cosmic evolution—and observable energy forms as "explicit energy." This demarcation establishes a conceptual cornerstone for subsequent analyses of energy evolution.

4. EMP Phase Transition and 3D Physical Space

After False Vacuum Cosmic System formation, EMP aggregation at a 10^{-35}m-diameter singularity with energy reaching a critical threshold triggers the second key phase transition: EMP phase transition.

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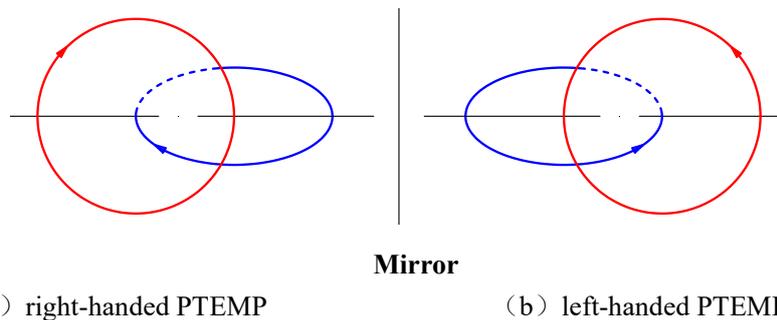（a）right-handed PTEMP　　　　　（b）left-handed PTEMP

Figure 4. The Structure Schematic Diagram of the PTEMPs. The area enclosed by the blue line: motion region of a MP; the area enclosed by the red line: motion region of an EP; circumferential arrow: direction of rotational movement.

EMP phase transition generates phase-transformed EMPs (PTEMPs) with symmetry breaking: as 2D entities, original EMPs had bidirectional time symmetry, but this symmetry breaks during 3D physical space formation, differentiating into two complementary 3D PTEMPs with strict mirror-symmetric rotation—following the universal logic that "symmetry breaking preserves balance via compensation."

- Right-handed PTEMPs [Fig. 4(a)]: EPs and MPs rotate in accordance with the right-hand rule. Their dense aggregated state forms observable matter and is detectable by conventional physical methods.

- Left-handed PTEMPs [Fig. 4(b)]: Rotation follows the left-hand rule. These remain in a hidden state, with their dispersed aggregated state constituting a core component of dark matter, which is undetectable by current technologies.

5. Innovative Solution to the Big Bang Singularity Problem

Traditional Big Bang theory has logical gaps in explaining singularity nature and early evolution. This study proposes a "dual phase-transition driven" mechanism based on EP/MP laws, offering a self-consistent cosmic origin picture.

5.1 PU Phase Transition Big Bang: Birth of Bidirectional Time and 2D Space

In the True Vacuum Cosmic System, time persists as a constant primordial state, with energy condensed into PU (forming a stable structure in the True Vacuum state via quantum synergy; see 3.1.2). Upon the PU singularity (scale 10^{-42}m, derived from the Cosmic First Principles, to be deduced in Series Paper II) reaching critical energy, PU undergoes phase transition and the first Big Bang—a symmetry break from True Vacuum to False Vacuum. This collapse of PU symmetry shatters time's constancy, generating False Vacuum, EPs, MPs, and EMPs. Space evolves from PU's 0D to EP/MP 1D trajectories, then to 2D structure via EMPs.

The core breakthrough of the PU phase transition lies in a novel time symmetry mechanism: forward and reverse time in dynamic equilibrium form a bidirectional system. Forward time governs energy diffusion; reverse time, paired with 2D space, achieves stabilization via energy conservation and constructs a "cosmic information storage system," encoding evolutionary data (energy fluctuations, dimensional transitions, etc.) into spacetime quantum states to underpin cosmic order.

5.2 EMP Phase Transition Big Bang: Birth of 3D Space and Matter

After the formation of the False Vacuum Cosmic System, EMPs aggregate at a singularity of 10^{-35}m (corresponding to the Planck length). When critical energy is reached, it triggers the second Big Bang via phase transition. This breaks the symmetry of bidirectional time, generating "physical space" and "PTEMP domains," driving space from 2D to 3D. The original bidirectional time differentiates into unidirectional time adapted to 3D matter space, evolving into our observed universe.

This "dual phase-transition Big Bang" mechanism resolves singular evolution into a coordinated, stepwise spacetime progression: space transitions from 0D, via 1D and 2D (volumeless), to 3D (volumetric); time evolves from a primordial constant state to bidirectional, finally differentiating into 3D matter-adapted unidirectional time. This phase-transition-driven Big Bang sequence avoids traditional infinities, and through coupled spacetime dimensional evolution, unifies explanations for spatial substantialization, the emergence of time's arrow, and matter genesis—offering a logically self-consistent framework for early cosmic evolution.

6. Verification of the Dual-Phase Transition Big Bang Mechanism via Thought Experiments

Given the unobservability of early cosmic processes, this paper combines the "cosmic first principles" with fundamental laws of quantum mechanics (such as quantum fluctuation, superposition principle, etc.) and designs two logical reasoning thought experiments to verify the

self-consistency of the "PU phase transition big bang" and "EMP phase transition big bang" mechanisms. The core lies in restoring the "phased release of energy from implicit energy to explicit energy" and the "differentiated evolution of gravity and repulsion".

6.1 Experiment 1: Simulation of PU Phase Transition Big Bang—Bidirectional Time, Two-Dimensional Space, and First Release of Implicit Energy

6.1.1 Experimental Setup

A "True Vacuum-False Vacuum phase transition simulation model" is constructed, equipped with virtual observation devices. The initial state is a True Vacuum system:

- Environment: No matter, absolute zero temperature, containing only dense PUs (Primordial Unities, a fusion of EPs and MPs) in an absolutely static condensed state, with energy stored in the form of "implicit energy" (fusion binding energy);

- Properties: PUs follow the quantum superposition principle (superposition of "fusion-dissociation" states) and exhibit "identical correlation" (instantaneous synchronous induction of states) due to the condensed state;

- Critical Condition: A phase transition is triggered when the "condensation domain scale" formed by PU aggregation reaches 10^{-42} m (expanding from infinitely small to this critical scale).

6.1.2 Logical Deduction Process

(1) Condensation and Expansion of PUs: Driven by Quantum Fluctuation

Microscopically, PUs are in a superposition state of "fusion + potential dissociation". Affected by quantum zero-point energy fluctuations, local fluctuations of implicit energy occur. Based on identical correlation, local fluctuations are synchronized to surrounding PUs, leading to the coordinated aggregation of a large number of PUs—not individual contraction, but the gradual formation of a "condensation domain" from an infinitely small discrete state, with the scale expanding toward 10^{-42} m.

(2) PU Dissociation Phase Transition: First Release of Implicit Energy and Differentiation of Forces

When the scale of the PU condensation domain reaches 10^{-42} m, this scale is precisely the "critical Compton wavelength" for the occurrence of this phase transition—that is, the scale of the condensation domain is numerically equal to the Compton wavelength at this point, which serves as the key scale condition for the phase transition. However, for the phase transition to truly take place, the more crucial factor is that the accumulated implicit energy must reach the energy value corresponding to this critical Compton wavelength.

From the perspective of physical formulas: Based on the relations "wave speed = wavelength × frequency" ($c = \lambda v$, where c is the speed of light, taken as 3×10^8 m/s) and "energy = Planck constant × frequency" ($E=hv$, where h is the Planck constant, taken as 6.626×10^{-34} J·s), substituting this critical Compton wavelength ($\lambda=10^{-42}$ m) into the formulas yields a corresponding critical energy of approximately 1.988×10^{17} J.

Only when the implicit energy of the PU condensation domain accumulates to this value will

the superposition of implicit energy break through the fusion binding threshold: at this point, PUs dissociate from the fused state into independent EPs and MPs. This constitutes the core of the PU phase transition big bang, and concurrently, the system expands from an infinitely small scale to a finite scale.

Subsequently, two key changes occur:

- Energy conversion: implicit energy is converted into explicit energy—EPs acquire electrical energy, and MPs acquire magnetic energy;

- Differentiation of forces: EPs exhibit gravitational force (tending to local aggregation), while MPs exhibit repulsive force (driving outward diffusion, corresponding to the positive time trend).

Some EPs and MPs combine into EMPs. At this time, gravity and repulsion are temporarily balanced, and energy is temporarily stored in a "bound state" (accumulating energy for the second phase transition). The system transforms into a "False Vacuum" with a "double spherical shell" structure: the inner shell (10^{-42} m→10^{-35} m, microcosmic condensation region) and the outer shell (10^{42}m→10^{35}m, macrocosmic diffusion region), with total energy conservation.

(3) Generation of Bidirectional Time: Dominated by Inversion Symmetry

The PU phase transition breaks the "undirected eternal time" and gives birth to bidirectional time (dominated by the Inversion Symmetry principle [29]):

- Positive Time: Corresponding to the movement of inner shell primitives—the scale of the inner shell increases from small to large, and the repulsion of MPs drives the primitives to diffuse outward, forming an observable time flow (space expansion and energy release proceed along this direction);

- Reverse Time: Corresponding to the movement of outer shell primitives—the scale of the outer shell decreases from large to small, symmetric to the inner shell, and the primitives converge inward. Although invisible, it maintains system stability through "dynamic complementarity" (energy balance of revenue and expenditure).

Essentially, they are a "scale mirror image of the double spherical shells". Primitives "record" movement data (diffusion/convergence speed, energy changes, etc.) into spacetime, forming a cosmic information storage system, and the False Vacuum serves as the carrier of the "time primitive system".

(4) Evolution of Two-Dimensional Space: Natural Manifestation of Primitive Movement

- 0D→1D: After PU dissociation, EPs and MPs move along closed curves in circular motion (one-dimensional trajectory). Due to quantum uncertainty, the trajectory needs to be nested in a two-dimensional plane (requiring x and y coordinates for description), implying two-dimensional properties;

- 2D Formation: When EPs and MPs combine into EMPs, their trajectories "tangentially coordinate" in the same plane (always coplanar). The coplanar movement of a large number of EMPs expands into a global plane, manifesting as two-dimensional space (without

three-dimensional volume).

6.1.3 Experimental Conclusion

The PU phase transition big bang is an inevitable result of "fluctuation aggregation→critical expansion→dissociation phase transition". The core is the "first release of implicit energy and differentiation of forces"—EPs manifest gravity and MPs manifest repulsion. These two forces are the core driving forces of cosmic evolution: the gravity between EPs drives the local aggregation of primitives, forming the basis of subsequent condensed matter; the repulsion of MPs promotes the outward diffusion of primitives, forming the prototype of the macrocosmic diffusion region. The two are dialectically unified. It is precisely this "differentiation of gravity-repulsion" after the PU phase transition that directly creates the double spherical shell structure of the "Intrinsic Condensation Domain (inner shell) and macrocosmic diffusion domain (outer shell)", laying the groundwork for the "condensation-diffusion" binary evolution of the universe.

Bidirectional time and two-dimensional space are naturally generated with the movement of primitives, and the entire process follows energy conservation, conforming to the settings of "phase transition triggered by critical scale" and "time controlled by inversion symmetry", with logical self-consistency. More importantly, this deduction clarifies the "origin of quantum gravity (EP gravity) and quantum repulsion (MP repulsion)"—the former corresponds to the aggregation trend of primitives, and the latter corresponds to the diffusion driving force—filling the gap in modern science regarding the "lack of definition of quantum repulsion" and providing logical support for the innovation of the theory.

6.2 Experiment 2: Simulation of EMP Phase Transition Big Bang—Three-Dimensional Space, Matter Formation, and Secondary Release of Implicit Energy

6.2.1 Experimental Setup

Based on the False Vacuum system in Experiment 1 (containing EPs, MPs, EMPs, 2D space, and bidirectional time), additional virtual tracking devices are added. Initial state: EMPs are uniformly distributed in the 2D plane, and bidirectional time is balanced; Critical condition: A phase transition is triggered when the scale of the aggregation domain formed by EMPs reaches 10^{-35} m (expanding from below 10^{-35} m to this scale), and the system enters physical space.

6.2.2 Logical Deduction Process

(1) Aggregation and Expansion of EMPs: Driven by Electromagnetic Coupling

EMPs are composed of EPs and MPs in pairs, and EPs and MPs are located in the same 2D plane (not in orthogonal coupling). Due to the gravitational force of EPs, EPs spontaneously aggregate toward the center of the plane; MPs, as they are paired with EPs, are forced to aggregate synchronously with the aggregation of EPs. Eventually, EMPs gradually form an aggregation domain from a dispersed state, with the scale expanding to 10^{-35} m (critical scale), and the energy stored inside accumulates continuously during the aggregation process.

(2) EMP Phase Transition: Secondary Release of Implicit Energy and Formation of Three-Dimensional Space

When the scale of the EMP aggregation domain reaches 10^{-35} m, this scale is exactly the

critical Compton wavelength for this phase transition. For the phase transition to occur, the accumulated implicit energy must reach the critical energy corresponding to this wavelength.

Based on $c=\lambda v$ ($c=3\times10^8$ m/s) and $E=hv$ ($h=6.626\times10^{-34}$ J·s), substituting $\lambda=10^{-35}$ m gives a critical energy of approximately 1.988×10^{10} J.

Only when the implicit energy accumulates to this value will the 2D structure break: the coupling between EPs and MPs shifts from a planar form to "three-dimensional entanglement" (steric entanglement along the z-axis), thereby forming PTEMPs. This is the core of the EMP phase transition big bang, and concurrently, the scale expands in three-dimensional directions.

 - Energy Release: The stored implicit energy erupts (i.e., secondary release of implicit energy), and the repulsion of MPs breaks free from planar constraints, strengthening into "space expansion repulsion" along the z-axis;

- Space Formation: PTEMPs expand along the z-axis under the drive of repulsion, and their trajectory superposition forms 3D physical space.

At this time, the scale of 3D physical space progresses in multiples of 10^7: the microcosmic domain (10^{-35} m→10^{-28} m→…) and the macrocosmic diffusion domain (10^{35} m→10^{28} m→…) maintain Inversion Symmetry (e.g., 10^{-28} m corresponds to 10^{28} m, which is the central scale of the visible universe).

(3) Unidirectional Temporal Characteristics of Material Aggregate Evolution

After the formation of 3D space, EP dominates the microcosmic level to form Intrinsic Condensation Domains, and numerous Intrinsic Condensation Domains aggregate to form material aggregate forms; MP dominates the macroscopic level to form Diffuse Core Domains, and numerous Diffuse Core Domains combine to form cosmic macroscopic regional forms.

The material aggregate forms formed by the aggregation of Intrinsic Condensation Domains naturally have an evolutionary process of outward diffusion, corresponding to positive time; the cosmic macroscopic regional forms formed by the combination of Diffuse Core Domains naturally have an evolutionary process of inward convergence, corresponding to reverse time. The evolution of the two shows strict inversion symmetry and occurs unconditionally synchronously. Bidirectional time originates from these two types of synchronously reverse evolutionary processes.

Among them, positive time centers on the outward diffusion of material aggregate forms—currently, human research on matter is mainly concentrated in the category of positive time. This is because the evolutionary characteristics of material aggregate forms are consistent with human's existing observation capabilities, allowing direct capture of material changes during their diffusion process.

Reverse time centers on the inward convergence of cosmic macroscopic regional forms—humans lack systematic research on reverse time. This is because the cosmic macroscopic regional forms have extremely strong diffusivity, and their initial scale far exceeds the existing human observation capabilities, making it difficult to directly capture material changes during their convergence process.

6.2.3 Experimental Conclusion

The EMP phase transition big bang is a process of "EMP aggregation→critical expansion→three-dimensional entanglement→space progression". The core is the "secondary release of implicit energy and space expansion". The repulsion of MPs drives the formation of 3D space, and the gravity of EPs dominates matter aggregation; bidirectional time appears "unidirectionally perceivable" due to observation limitations. The entire process is logically consistent with the PU phase transition (triggered by critical scale), explaining the birth of "3D space + matter + perceivable time" and avoiding the "infinite energy paradox" of the traditional singularity theory, with logical self-consistency.

6.3 Theoretical Value of the Thought Experiments

The two experiments transform the "dual-phase transition big bang" into a deducible path: the PU phase transition realizes the "first release of implicit energy + differentiation of forces", forming a double spherical shell False Vacuum and bidirectional time; the EMP phase transition realizes the "secondary release of implicit energy + space expansion", forming the observable universe through scale progression. Throughout the process, "scale threshold" is taken as the core, and "energy conservation" and "Inversion Symmetry" as the support. It not only restores the essence of energy release in the big bang but also constructs a unified evolution chain of "primitives-energy-spacetime-matter", providing logical verification for the "Cosmic Theory of Electric Primitives and Magnetic Primitives (CTEPMP)" and a thinking framework for subsequent research.

7. Conclusions

Based on the Cosmic First Principle (both the unity of opposites and symmetry of cosmic primitives), this study pioneers the independent quantization of electric and magnetic fields—a long-missing key step in unifying quantum mechanics and relativity—and innovatively identifies EPs and MPs as the ultimate quantum primitives of the universe, constructing the cosmic theory of EPs and MPs. This framework offers a primitive-based new path to connect quantum mechanics and relativity, complementing existing paradigms: it roots both in a common set of primitives, rather than forcing their union through mathematical abstractions.

EPs form the gravitational "Electric Core Domain," for the first time linking gravity to a concrete quantum carrier (resolving the "quantum gravity carrier puzzle" that has long stymied the field); MPs generate the repulsive "Magnetic Core Domain," unifying gravity and repulsion—filling the critical gap in modeling magnetic forces at the quantum scale, where traditional theories either treat magnetism as a secondary effect or entirely ignore its quantum roots.

By clarifying that True Vacuum consists of PUs formed by the symmetric fusion of EPs and MPs, and False Vacuum is composed of EPs, MPs, and EMPs produced by the phase transition of PUs, this study reveals the microscopic origin of vacuum zero-point energy—a mechanism that addresses the gap in quantum field theory and general relativity regarding the microscopic origin of zero-point energy.

Energy quantization strictly conforms to the Dirac-Einstein and Planck-Einstein relations: at $v=1$ Hz, $0.5hv$, as the minimum quantum unit for EPs and MPs, not only aligns with oscillator

zero-point energy but also uncovers its fundamental cause (ground-state motion of EPs/MPs), a connection previously unrecognized.

To solve the big bang singularity puzzle, the proposed "quantum primitive self-organization" mechanism—offering a finite, phase-transition-driven alternative to the long-debated "infinite energy" framework—explains singularity formation and cosmic evolution through the self-organization of EPs/MPs, a framework that unifies dark matter/dark energy under a single primitive-based logic [30].

The logical self-consistency of the proposed phase transition mechanisms and evolutionary pathways has been verified via thought experiments, further reinforcing the robustness of this primitive-based theoretical framework.

In summary, this work establishes the first primitive-based framework connecting quantum mechanics and relativity, elevating cosmic theory from phenomenological description to rigorous primitive-based essential description. It is not merely an extension of existing theories but establishes a new foundational starting point that complements current efforts: by identifying EPs and MPs as the "missing link," it provides a new perspective for research on force unification and cosmic evolution, driving cosmic theory from phenomenological description toward primitive-based unification.

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