Unified Cosmic Mechanics Evolution Theory (II): Cosmic Evolutionary Resources

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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.

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[**This article**] This paper is the Second 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 framework of Information Dynamics evolution theory, this paper introduces the generalized state evolution system (Information dynamics evolution system) [1] and evolutionary resources, jointly demonstrating that standard quantization is the core premise for the system to maintain information distinguishability and evolutionary stability [2]. It clarifies that the basic momentum unit is the only underlying physical reality (evolutionary resource) of the universe, with the dual attributes of static conservation and dynamic transition. This paper constructs three types of deterministic transition mechanisms (A/B/C), strictly proving that physical quantities such as space-time, mass, force, and energy are neither independent entities nor products of probabilistic statistics, but deterministic shaping effects naturally emerged from evolutionary resources under strict vector interactions. Addressing the logical controversy in traditional physics of "replacing physical reality with mathematical probability", it is proposed that there is no randomness in the microcosm, and "probability" is merely a low-resolution approximation of the synthesis of a large number of deterministic vectors in macroscopic observations. The "infinite continuity" assumption of traditional mathematical tools lacks support in a stable and evolvable system [3], but a "discrete-continuous space-time" can emerge based on state evolution carried by discrete evolutionary carriers. This paper clarifies the nature of matter, the nature of space-time, and physical dynamic relationships, improves the interpretation of the mass-energy equation, derives various emergent physical quantities of the basic momentum unit, unifies the evolutionary carrier and driving force, and provides core theoretical support for understanding the underlying power and logic of cosmic evolution.

Keywords: Unified Cosmic Mechanics; Evolution Theory; Origin of Matter; State Evolution; Origin of Time; What is Energy; Unified Field Theory

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1 Introduction

Underlying Dilemmas of Traditional Physics: Fragmentation and Compatibility Issues in the Origin of Multi-domain Dynamics

1.1 Fragmentation of Dynamical Origin Explanations

In the research paradigm of traditional physics, different dynamical origin explanations are given for different physical phenomena: in the field of relativity, the origin of dynamics is attributed to the geometric properties of space-time. Gravitational effects and celestial motion laws are described through the curvature and distortion of space-time structure, material motion is regarded as geodesic evolution in a curved geometric background, and space-time itself becomes the core carrier of dynamics. In the classical mechanics system, the origin of dynamics is characterized by introducing various physical quantities of different dimensions such as energy, potential energy, and Lagrangian. These physical quantities serve as the basis for explaining driven evolution under different mathematical forms (such as Newtonian vector mechanics and analytical mechanics), but the deep ontological connection and unity between various physical quantities have not been clarified at the fundamental level. This coexistence of "geometric drive" and "scalar potential/functional drive" makes macro physical theories present a multi-source parallel feature in their underlying logic.

1.2 Dual Tension Between Mathematical Description and Physical Reality

In the field of quantum mechanics, the physical reality is replaced by a duality of reality, probability, and mathematics, leading to unclear mechanisms. Taking the mainstream Copenhagen interpretation as an example, this theoretical framework presents a dual structure when describing micro-systems: on the one hand, the theory presupposes the basic status of particles as objective physical reality and acknowledges their substantiality in the measurement process; on the other hand, its dynamic evolution process is mainly dominated by the probability wave function (mathematical probability amplitude), and the change of micro-states is expressed as the evolution and collapse of probability distribution.

1.3 Realistic Ontology of Cosmic Physics

All conservative state evolution systems inherently possess a core entity—evolutionary resources (momentum units) [4,5,6]. It is integrated by deterministic evolutionary carriers and state transition driving forces, and is also the only underlying physical reality of the universe. Evolutionary resources not only define the static realistic state representation ability of the system, but also dominate the unified origin mechanism of dynamic space-time state shaping.

Note: This paper only serves as a preliminary logical foundation chapter of this evolution theory framework. Its core task is to qualitatively elaborate on core concepts, build framework logic, define evolutionary resources and their necessary attributes in the evolution system, and has not yet deeply demonstrated the complete dynamic mechanism and dimensional derivation. For relevant dynamic logic and dimensional analysis, see subsequent chapters (especially Chapter 5 "Reconstruction of Dynamic Relationships of Basic Physical Dimensions") [5]. Therefore, the physical dimensions and mathematical expressions involved in this paper are only for the logical understanding of the whole paper; if there is any inconsistency with subsequent chapters, the detailed derivation and final definition of subsequent chapters shall prevail.

2 ntology of Evolutionary Resources: Quantization Foundation and Static Conservation

2.1 Uniqueness Definition of Evolutionary Resources

Evolutionary resources are the core physical carriers of the information dynamics evolution system, and the material and energy foundation for space-time state shaping and causal relationship continuation under rule constraints. Among them, matter is the state representation unit m_0 in the system, energy and force are the driving capabilities for state evolution in the system (the cosmic system has an inertial speed of c). We can collectively refer to the Representational quantity and Driving quantity as Momentum unit or Evolutionary resource. The existing physical theories lack the ontological characterization of evolutionary resources and fail to clarify the underlying evolutionary units. The only underlying evolutionary resource in the universe and the subject of space-time state shaping is the basic momentum unit—it carries all the core attributes of space-time state shaping, encodes evolutionary amplitude, evolutionary frequency, and evolvable direction, is the most fundamental and indispensable quantized input variable entity in group theory, and is also the core carrier of all causal interactions in the universe. This is because any mathematical calculation defaults to standard quantization as the input premise, while the standard model is a mathematical tool for statistical physics.

Core attributes of the basic momentum unit: static conservation (the origin of inertia, cannot independently change the evolutionary state without external rule action, and has the attribute of imper-

ishability), dynamic transition (the origin of evolution, with intrinsic evolutionary ability of the speed of light c, not externally driven), and satisfies the stability constraints of non-space-time overlap and impenetrability (supported by the Pauli exclusion principle).

It is necessary to clearly distinguish: energy is only the evolutionary driving force, has no space-time state recording ability, and cannot carry causal continuation; mass is an emergent quantity of the basic momentum unit, not the underlying unit; information is the representation of the system state, which needs to rely on the carrier to exist and cannot independently serve as the evolutionary subject. None of the three can be used as the underlying evolutionary resource.

2.2 Necessity of Standard Quantization (Core Premise of Evolvability)

1. **Infinite continuity is equivalent to infinite symmetry:** In any evolution system, if for any evolution transformation T, $T(\psi) = \psi$ (ψ is the system state vector) is satisfied, then the state difference $\Delta\psi = 0$, the information entropy $S = 0$, and all state information such as time, space, and energy cannot emerge, making evolution impossible. If the system state space is continuous and infinitely divisible, the system state remains unchanged for any transformation, no distinguishable information is generated, and thus no observable evolution exists.

   The necessary and sufficient condition for information emergence is $\exists T$, $T(\psi) \neq \psi$ (breaking infinite symmetry), and the quantized variables must satisfy the Heisenberg uncertainty principle $\Delta q \cdot \Delta p \geq \hbar/2$, which ensures that the state difference is observable and evolvable. Furthermore, infinite discreteness requires infinite energy drive, which is contrary to the physical fact that the universe has finite energy and is evolvable. Therefore, quantization (l_P, t_P) is the only solution to generate deterministic differences and maintain stable system evolution, and is the core premise of cosmic evolvability [7].

2. **Infinite divisibility is equivalent to infinite energy:** In a relational state evolution system, based on Landauer's principle [8] and the Bekenstein bound [9], information representation is inseparable from carriers and energy drive. If time can be infinitely divided, it means that the system needs to update its state at infinitely dense time points, which will generate divergent information entropy. Since the generation of each bit of information corresponds to a certain energy consumption, infinite information must require infinite energy supply, such as representing 10^{100} eigenstates requiring a corresponding number of energy units. This conclusion (infinite divisibility $\equiv$ infinite energy demand) obviously violates the observational fact of a finite universe, thus falsifying the infinite continuity of space-time [10][11].

3. **Infinite divisibility cannot establish relationships:** In a relational state system, when AB evolutionary carriers establish a relationship, the information dimensions between them cannot be transmitted and mapped one by one. Reference can be made to the causal set theory proposed by Sorkin, R. D. in 1990 in "Causal sets: discrete gravity", which provides external theoretical support for the "discrete space-time" hypothesis in mainstream physics [12].

4. **Infinite divisibility is equivalent to infinite dimensions:** Physically, infinite divisibility means that when we observe a ruler at any point, the ruler can continue to expand in dimensions, not simply subdividing in a single dimension in mathematics. For example, when we observe a snowflake, there may be new edges when observed from any edge. Physically, there is no number that can be completely represented as $1/3$, nor is there an absolute perfect circle for us to directly observe. The reason why we calculate $1/3 + 2/3 = 1$ is that human intelligence skips intermediate representation, summarizes laws, gives new rules, and directly performs new representation. Therefore,

mathematics also defaults to standard quantization as the input premise. The theoretical origin of this quantization constraint can be traced back to the energy quantization theory proposed by Planck in 1901 [13].

Therefore, the standard quantization of evolutionary carriers and driving forces is the core premise of a stable and evolvable relational system. Under the constraint of conservation, this evolutionary carrier naturally emerges discrete-continuous space-time through multiple state transitions [14][15].

2.3 Reciprocal Relationship Between the Speed of Light c and Planck Scale: From Discrete Primitives to Continuous Emergence

Note: Similar derivations have been carried out multiple times in traditional theories, but this theory only aims to establish the emergent relationship between Planck length, Planck time, and the speed of light c. Planck length l_P and Planck time t_P are underlying geometric/time primitives independent of the speed of light c [13]. According to the natural logic of state evolution, the emergence process is derived, and the dynamic origin, physical nature, and intrinsic particle properties of the reduced Planck constant $\hbar$ and gravitational constant G contained in the formula are not discussed.

1. **Independent Definition of Discrete Primitives (First Principles)**

   Based on Planck's quantization theory and gravity-quantum coupling constraints, l_P and t_P are regarded as independent axioms here, whose values are determined by experimental measurement or natural combination of $\hbar$ and G, clearly defining the smallest indivisible unit of cosmic evolution (not relying on the pre-physical definition of c; c in the formula only exists as a dimensional conversion coefficient, not representing physical speed; the real physical speed c_{phys} will emerge through l_P/t_P in Section 2.3.2):

   $$l_P = \sqrt{\frac{\hbar G}{c^3}}, \quad t_P = \sqrt{\frac{\hbar G}{c^5}}$$

   Note: Here, c is only temporarily stored as a dimensional balance parameter, and its physical dynamic meaning (evolutionary rate) will be clarified through subsequent ratio derivation, avoiding logical cycles caused by pre-introducing the physical meaning of c.

2. **Algebraic Ratio Locking: Emergence of Intrinsic Rate**

   The ratio operation of the above two independent primitives reveals their intrinsic geometric relationship, and then the physical meaning of the speed of light c emerges:

   $$\frac{l_P}{t_P} = \sqrt{\frac{\hbar G}{c^3}} \Big/ \sqrt{\frac{\hbar G}{c^5}} = \sqrt{\frac{\hbar G}{c^3} \cdot \frac{c^5}{\hbar G}} = \sqrt{c^2} = c$$

   Thus, the reciprocal relationship coefficient is obtained, clarifying the physical nature of c:

   $$\frac{1}{c} = \frac{t_P}{l_P}$$

   Physical interpretation: $1/c$ is not simply the reciprocal of speed, but the "minimum time cost required for unit space evolution". It locks the strict corresponding relationship between the space grid l_P and the time snapshot t_P: for each l_P of space displacement generated, the system must consume and only consume $1t_P$ of evolution step. The core of this derivation is "ratio locking"—c is determined by the inherent ratio of l_P and t_P, rather than being pre-defined and then substituted for verification, avoiding circular reasoning [16].

3. **Integral Emergence Based on DCI: From Discrete Transition to Continuous Speed of Light**

The speed of light c observed macroscopically is actually a statistical emergent value of micro-discrete transitions under massive accumulation. Using the Discrete-Continuum Integral (DCI) system, a complete derivation chain from micro-actions to macro-constants is constructed, further confirming the emergence of c:

(i) Step A: Define a single deterministic transition (Type A mode)

Assuming that under no external field interference, the displacement vector $\Delta\vec{x}_k$ and time increment Δt_k of the k-th transition of the basic momentum unit $\vec{p}_i$ satisfy:

$$|\Delta\vec{x}_k| = l_P, \quad \Delta t_k = t_P, \quad k \in \mathbb{N}$$

(ii) Step B: Construct DCI accumulation operator (pure counting accumulation, avoiding dimensional contradictions)

The macro total displacement $X(N)$ and total time $T(N)$ are defined as the discrete accumulation of N transitions (i.e., DCI integral, the core is "counting summation", without taking c as the integrand):

$$X(N) = \int_{(\mathrm{DCI})} dx = \sum_{k=1}^{N} |\Delta\vec{x}_k| = N \cdot l_P$$

$$T(N) = \int_{(\mathrm{DCI})} dt = \sum_{k=1}^{N} \Delta t_k = N \cdot t_P$$

Note: The limit $\lim_{N\to\infty}$ is not required here, because for any $N \geq 1$, the ratio is constant, reflecting the inherent attribute of discrete accumulation.

(iii) Step C: Emergence and Convergence of Macroscopic Speed

The macro observed speed v_{obs} is defined as the rate of change of total displacement with respect to total time, which is naturally derived from the above accumulation results:

$$v_{\mathrm{obs}}(N) = \frac{X(N)}{T(N)} = \frac{N \cdot l_P}{N \cdot t_P} = \frac{l_P}{t_P}$$

Combined with the ratio conclusion in Step 2.3.2, we can get:

$$v_{\mathrm{obs}}(N) \equiv c$$

Conclusion: The speed of light c is an exact invariant of the ratio l_P/t_P at any scale, and is a macro emergent quantity after the accumulation of micro-discrete transitions. The macro "continuous uniform motion" is essentially a linear superposition effect of N discrete "jump-wait" processes, breaking the circular logic of "defining c first and then deriving the Planck scale".

4. **Integral Expression of Space-Time Conversion and Momentum Unit Constraints**

Based on the reciprocal relationship $1/c = t_P/l_P$, time can be regarded as the cumulative quantity of the space evolution process without relying on the pre-definition of c:

$$T = \int_{(\mathrm{DCI})} dt = \int_0^L \frac{t_P}{l_P} dx = \frac{1}{c} \int_0^L dx = \frac{L}{c}$$

This formula strictly proves that time is a cumulative quantity of the space evolution process, and $1/c$ is a space-time conversion operator connecting discrete space units and discrete time units. This explains why the macro world presents continuity and the invariance of the speed of light—because they are rooted in the rigid ratio of micro-quantized primitives.

In the above space-time framework, the state evolution equation of the basic momentum unit $\vec{p}_i$ is:

$$\vec{p}_i(t + t_P) = \hat{R}(\vec{p}_i(t)) = \frac{h}{\lambda_i}\hat{e}_i$$

where:

- $\lambda_i = k_i l_P$ is the de Broglie wavelength ($k_i \geq 1$ is the wave number quantum number);
- $\hat{e}_i$ is the unit vector of the evolution direction;

Non-overlapping constraint (geometric expression of the Pauli exclusion principle):

$$\forall i \neq j, \quad \text{supp}(\vec{p}_i) \cap \text{supp}(\vec{p}_j) = \emptyset$$

That is, any two momentum units cannot occupy the same space-time primitive (l_P, t_P), ensuring the discreteness and causal independence of evolutionary resources.

3 Dynamic Activation Mechanism: Three Types of Deterministic Transitions and Space-Time Emergence

3.1 Basic Measurement Axioms: Foundation of Determinism

Space primitive: The maximum space span of a single transition is defined as l_P (Planck length).

Time primitive: The minimum time consumption of a single transition is defined as t_P (Planck time).

Core equation: Static resource (carrier) + Intrinsic transition ability = (l_P, t_P).

Determinism principle: Given the resource state S(t) and the environment state E(t), the state S(t + t_P) at the next moment is uniquely determined, with no branches or random choices.

3.2 Type A Mode: Intrinsic Single-Step Transition (Own State Scale + Intrinsic Ability)

Definition: The standard action performed by evolutionary resources relying solely on their own state scale and intrinsic transition ability without external vector interference.

Micro-mechanism: The input is the resource's own state vector S _0. Within t_P time, the intrinsic ability drives the state to complete an accurate l_P space update along the S _0 direction.

Characteristics: The vector direction remains unchanged, and the modulus is maximum (|Δx |=l_P).

Essence: The benchmark inertial motion of the universe, defining "straight line" and "maximum rate" (i.e., the speed of light c). There is no probability here, only deterministic intrinsic execution.

3.3 Type B Mode: Vector Synthesis Transition (Time Domain Sparsity and Space Domain Cancellation)

Definition Correction: Type B mode is not a reduction in the space scale of a single transition (i.e., there is no "half-step" transition with $\Delta x < l_P$), but a statistical emergent phenomenon where the

effective displacement of the center of mass of a composite evolutionary carrier (composed of multiple basic momentum units) is less than $N \cdot l_P$ due to deterministic interference of internal or associated vectors in a continuous time sequence.

1. **Micro-Mechanism Reconstruction ("Transition-Cancellation" Model)**

   Full-speed intrinsity: Within any single time primitive t_P, the intrinsic transition amplitude of a single basic momentum unit is always l_P. There is no "half transition" or "decelerated" transition in the universe, and the micro-level always maintains full-speed (c) evolution.

   Vector cancellation mechanism (two types of deterministic cases):

   (1) **Case 1 (Time domain sparsity/waiting state):** A particle is composed of multiple momentum units. At a certain t_P moment, some units transition forward by l_P, and other units transition backward (or laterally) by l_P. If the internal vector sum $\sum \vec{p}_i = 0$, the macro center of mass displacement $\Delta X = 0$, which is manifested as "stationary" or "waiting" macroscopically, essentially the mutual complete cancellation of transitions of internal momentum units.

   (2) **Case 2 (Direction domain zigzag/projection state):** The particle as a whole moves along a certain macro direction, but the micro transition direction is not strictly parallel to this direction, but distributed in a zigzag shape (such as a Zig-Zag path). Although the modulus of each micro displacement is l_P, the sum of the projection components on the macro observation axis is less than $N \cdot l_P$. Some transition displacements are canceled due to direction differences, and only the remaining part contributes to the macro displacement.

2. **Emergent Formula of Macroscopic Speed**

   Let the macro observation time be $T = N \cdot t_P$ (N is the number of time primitives), and the number of effective transitions contributing to the macro displacement be k ($0 \leq k \leq N$), then the macro speed is derived as follows:

   $$v = \frac{k \cdot l_P}{N \cdot t_P} = \frac{k}{N} \cdot c$$

   where the ratio $\eta = k/N$ represents the "effective evolution ratio not canceled", and its value directly determines the macro motion state:

   (i) When $\eta = 1$, there is no vector cancellation, and all micro transitions are along the macro direction, showing the speed of light c (i.e., Type A mode);

   (ii) When $0 < \eta < 1$, there is partial vector cancellation, and only part of the transitions contribute to the macro displacement, showing sub-light speed $v < c$ (i.e., Type B mode);

   (iii) When $\eta = 0$, all micro transitions cancel each other, the macro net displacement is 0, showing stationary (mass state).

3. **Essential Conclusion**

   Macro low speed is not because the particle "runs slowly", but the result of the particle "running at full speed but in chaotic directions" or "frequently standing still" at the micro level. The essence of speed v is the "coherence rate" of momentum units in the macro direction, i.e., the effective transition ratio not canceled, which eliminates the logical paradox of "single step length less than l_P" and defends the rigidity of quantized primitives.

   Supplementary Note: The effective displacement of the center of mass of the composite evolutionary carrier is less than $N \cdot l_P$, which is a deterministic result of the accurate mutual cancellation

of its internal or associated vectors, not a "random failure to run at full speed". It is not that the carrier "randomly" runs slowly, but that its internal or associated vectors accurately cancel each other to a certain extent; if all $\{\vec{s}_i\}$ are known, the result is uniquely predictable. It is not called "kinetic energy" here, but only described as "vector synthesis state of intrinsic ability".

3.4 Type C Mode: Interactive Rearrangement Transition (0-l_P Scale State Transition Based on External Field Application)

Definition: Within the micro scale of 0 to l_P, the resource is subject to deterministic vector interference from the state field of the external environment (other resource groups), forcing a change in its transition direction or modulus.

Micro-mechanism: The input is the resource's own state S _0 + the state distribution gradient field Φ_ext of external resources. Within t_P time, the vector potential of the external field is directly superimposed on the resource transition vector: V _new = S _0 + f(Φ_ext).

Characteristics: Deterministic deflection of the transition vector.

Essence: The micro origin of interaction.

Deprobabilistic explanation: There is no "random action of force", only strict vector operations between resource state fields; given the environmental distribution, the deflection angle is uniquely determined. It is not called "potential energy" or "force" here, but only described as "transition rearrangement based on external field vector interference".

3.5 Packaging of Evolutionary Resources and Emergence of Space-Time and Speed of Light c

1. **Mode Packaging: Unification of Static Resources and Deterministic Transitions**

   Conclusion: Everything in the universe is the manifestation of "static resources × deterministic transition ability (l_P/t_P)" under different vector boundary conditions. Evolutionary resources (basic momentum units) are the only emergent quantity of state representation and dynamics in the cosmic system, and no additional multiple driving mechanisms are needed to provide state shaping ability.

2. **Strict Mathematical Verification: Planck Scale is the Emergent Basis of the Speed of Light c**

   From Type A mode, the intrinsic maximum transition rate $v_{\max} = l_P/t_P$. At the macro limit, this deterministic rate is observed as c, i.e., $c = l_P/t_P$, whose value matches exactly, indicating that c is a deterministic geometric attribute of the Planck grid and a macro emergent result of micro-discrete primitives, rather than a pre-existing physical constant.

3. **Emergent Discrete-Continuous Space-Time: Non-reality of Space-Time and Deterministic Flow**

   Emergence of space: The deterministic topological structure of static resource distribution; Emergence of time: The one-way accumulation of deterministic transition sequences of resources ($t = N_t \cdot t_P$, where N_t is the number of rule executions).

   Core Inference: Space-time is not real, but a trajectory record of deterministic transition flow, not an independent entity; space-time cannot provide power, and power comes from deterministic vector interference between resources; there is no absolute static, and resources are always undergoing deterministic updates; stationary is only a special case where the result of vector synthesis is zero.

3.6 Inertial Motion and Vector Superposition Emerge Lagrangian, Potential Energy and Kinetic Energy

Deriving macro physical laws from deterministic micro-mechanisms, it is clear that various physical quantities are emergent results of vector actions of basic momentum units:

Emergence of kinetic energy (T): The deterministic net cumulative amount of the intrinsic transition vector of resources in a specific direction per unit time, deriving the square scaling behavior of the vector synthesis modulus T v^2.

Emergence of potential energy (V): The degree to which the free transition vector of resources is constrained due to deterministic vector interference from external resource groups, deriving the spatial distribution of interference gradient V 1/r.

Ultimate emergence of Lagrangian (L): In deterministic evolution, the system naturally follows the optimal accumulation principle of vector paths (the actually occurring path is the only remaining most stable path after vector interference). Therefore, L=T-V is the macro mathematical expression of deterministic vector game, and the principle of least action is an inevitable result of deterministic dynamics, not probabilistic variation.

4 Mathematical Adaptation: Discrete-Continuum Integral (DCI) System

4.1 Discussion on the Physical Adaptability of Traditional Calculus and Probability Theory

Traditional calculus assumes infinite continuity, and probability theory assumes intrinsic randomness, both of which have limitations in adapting to discrete deterministic reality. The core limitation of traditional integral is that it presupposes "continuous intervals exist prior to discrete units", relies on limit operations ($\Delta x \to 0$, $n \to \infty$), the differential dx has no real physical correspondence, and infinite division requires infinite energy drive, which is inconsistent with the physical nature of the universe; while describing micro-particles with probability density functions fails to fully reveal the underlying deterministic vector mechanism, and has the limitation of "replacing physical reality with mathematical probability".

4.2 Construction of DCI: Deterministic Accumulation Based on Natural Number Counting

The Discrete-Continuum Integral (DCI) takes "discrete unit accumulation and emergent continuous representation" as the core, abandons infinite division mathematically, conforms to the core logic of quantized evolution and the correlation between the speed of light and Planck scale, and is a mathematical mapping consistent with cosmic physical facts (refer to the construction of time scale calculus theory); it corrects the dimensional contradiction of the original definition, with the core of "pure counting accumulation" without taking c as the integrand to ensure dimensional unity [17].

1. **Strict Definition (One-Dimensional Core, Adapting to "Cancellation" Logic)**

   Physical essence of DCI: DCI is no longer just a simple counting accumulation, but an accumulation operator of effective net displacement, which is mainly adapted to the "transition-cancellation" logic of Type B mode, not only maintaining the rigidity of micro-quantization, but also explaining the emergence of macro continuous speed.

   Corrected integral expression: Let the micro transition vector of the particle in the i-th time step t_P be $\vec{\delta}_i$ (strictly satisfying $|\vec{\delta}_i| = l_P$ to ensure that a single transition must be the minimum scale), and the unit vector of the macro observation direction be $\hat{n}$, then the macro displacement X is defined as:

$$X(N) = \int_{\text{DCI}} (\vec{\delta}(i) \cdot \hat{n})\, dN = \sum_{i=1}^{N} (\vec{\delta}_i \cdot \hat{n})$$

Key Notes:

(1) The differential symbol dN represents "a single time step" ($dN = 1$), has no meaning of "infinitesimal", and is only a counting identifier of the time primitive;

(2) $(\vec{\delta}_i \cdot \hat{n})$ is the effective projection of a single full-speed transition in the macro observation direction, whose value is determined by the angle between the micro transition direction and the macro observation direction:

- If the micro transition direction is completely the same as the macro observation direction, the projection is l_P (no cancellation, effective contribution);
- If the micro transition direction is completely opposite to the macro observation direction, the projection is $-l_P$ (complete cancellation, negative contribution);
- If the micro transition direction is perpendicular to the macro observation direction, the projection is 0 (lateral cancellation, no contribution);

(3) No limit operation is needed, and the sum is the macro displacement result, avoiding the physical contradiction of infinite division;

(4) The macro speed is derived from the ratio of effective net displacement to total time: $v = \dfrac{X(N)}{T} = \dfrac{\sum_{i=1}^{N} (\vec{\delta}_i \cdot \hat{n})}{N \cdot t_P}$, which fully corresponds to the macro speed emergence formula in Section 3.2, realizing logical closure.

Logical Closure Verification

This definition strictly ensures the self-consistency of the theory and eliminates logical contradictions:

(i) Micro absoluteness: The $|\vec{\delta}_i|$ input each time is always l_P, maintaining the rigidity of quantized primitives and adhering to the core axiom of "minimum unit indivisibility";

(ii) Macro continuity: By changing the direction distribution of $\vec{\delta}_i$ (i.e., changing the degree of cancellation), $\sum_{i=1}^{N} (\vec{\delta}_i \cdot \hat{n})$ can take any value between 0 and $N \cdot l_P$, thus emerging continuous macro speed $v \in [0, c]$;

(iii) No logical loopholes: Abandon the wrong assumption of "single step length less than l_P", all macro low speeds originate from vector cancellation of micro full-speed transitions, which is completely consistent with the Type B mode and quantization axiom mentioned earlier.

Let the core constraints of cosmic evolution be: minimum time unit $\tau = t_P$, minimum space unit l_P, evolution event count $N \in \mathbb{N}$ (finite natural number), event function $f : \mathbb{N} \to \mathbb{R}$ (describing physical quantities of the N-th evolution event, such as displacement, time), then the definition of DCI is:

$$\int_{\text{DCI}} f\, dN \triangleq \sum_{i=1}^{N} f(i)$$

Key Notes: (1) The differential symbol dN represents "a single evolution event" ($dN = 1$), has no meaning of "infinitesimal", and is only a counting identifier; (2) No limit operation is needed, and the sum is the integral result, avoiding the physical contradiction of infinite division;

(3) Macro continuous physical quantities emerge from discrete accumulation: space displacement $X = \int_{\text{DCI}} l_P \, dN = N \cdot l_P$, time $t = \int_{\text{DCI}} \tau \, dN = N \cdot \tau$, speed $v = X/t = l_P/\tau = c$, with strictly unified dimensions ([length]/[time] = [speed]); (4) If $f(i)$ is a speed-related quantity, the integral result is displacement, without additional multiplication by τ, avoiding dimensional redundancy.

2. **Core Properties**

(1) **Linearity:** For any constants a, b, and any event functions $f_1(N), f_2(N)$,

$$\int_{\text{DCI}} (af_1 + bf_2)\, dN = a \int_{\text{DCI}} f_1 \, dN + b \int_{\text{DCI}} f_2 \, dN.$$

(2) **Interval additivity:** For any $N_1 < N_2 < N_3$,

$$\int_{N_1}^{N_3} f \, dN = \int_{N_1}^{N_2} f \, dN + \int_{N_2}^{N_3} f \, dN.$$

(3) **Discrete version of the fundamental theorem of calculus:** Let $\vec{r}(N) = \int_0^N \vec{v}(i) \, dN$ ($\vec{v}(i)$ is the evolution speed of the i-th event), then $\Delta\vec{r} = \vec{v}(N)$, corresponding to the minimum evolution step (l_P) of the basic momentum unit, which is consistent with the micro evolution logic and has no dimensional contradictions.

4.3 Essential Differences Between DCI and Traditional Integral

The two are different mathematical structures adapted to different physical assumptions: traditional integral is a mathematical model adapted to the continuity assumption, starting from continuity and relying on limits, which has limitations in adapting to the quantized nature of the universe; DCI starts from discrete event counting, does not require limits, the differential corresponds to real physical processes (single evolution event), and continuity originates from the macro effect of discrete unit accumulation, which can more accurately describe the integral process of cosmic quantized evolution.

4.4 Reconstruction of the Correlation Between Speed of Light and Planck Scale Based on DCI

DCI definition of the speed of light (core breakthrough, avoiding cycles): Based on the pure counting accumulation characteristics of DCI, the integrals of space displacement and time are X = _(DCI) l_P dN and t = _(DCI) dN respectively, so the speed of light c = X/t = l_P/ . When N=1, X=l_P, t= =t_P, i.e., c=l_P/t_P, without taking c as the integrand, solving the cycle problem of "lambda_P = c • tau" in the original definition.

DCI derivation of the reciprocal relationship (exact without approximation): $1/c = \tau/\lambda_P = \int_{\text{DCI}} \tau dN|_{N=1} / \int_{\text{DCI}} \lambda_P dN|_{N=1}$; in natural units (l_P=1), it simplifies to $1/c = \tau = \int_{\text{DCI}} \tau dN|_{N=1}$, indicating that 1/c is the inherent time imprint of a single evolution event, forming a logical closure with quantized evolution logic and unified dimensions.

5 Essential Distinction Between Momentum and Energy (Logical + Mathematical Verification)

In traditional theories, the definition of energy and momentum is not clear enough, and there are even discussions about taking energy as the evolutionary subject. In fact, the two have essentially different functions. Energy cannot be the evolutionary subject nor exist alone, but at the statistical level of action

state quantities, force, energy, and momentum are completely equivalent. For specific derivation, see the chapter "Reconstruction of Dynamic Relationships of Basic Physical Dimensions" in this evolution theory framework [5].

Core Logic: Energy is only the evolutionary driving force, has no space-time state recording ability, and can only record the magnitude of the driving force; if there is pure energy in the cosmic system, it cannot directly correlate causal relationships, and can only appear in specific processes that do not directly affect space-time state shaping. The basic momentum unit has state invariance, can completely record the causal state of space-time evolution, and is the only evolutionary subject.

Mathematical Verification:

1. State invariance of momentum: Without external rule action,

$$\frac{\mathrm{d}\vec{p}_i}{\mathrm{d}t} = 0,$$

i.e., $\vec{p}_i(t) = \vec{p}_i(0)$, indicating that the basic momentum unit has imperishability and can carry causal continuation.

2. Definition and limitations of energy: Energy is the total momentum change of space-time evolution shaping in the time interval Δt, defined as $E = \int_{t_1}^{t_2} |(d\vec{P})/dt|dt = \int_{t_1}^{t_2} |\vec{F}|dt$ ($\vec{P} = \sum \vec{p}_i$ is the total momentum, $\vec{F} = (d\vec{P})/dt$ is the force); energy is a scalar, only recording the magnitude of the driving force, not including the evolution direction and frequency, and cannot carry causal continuation.

3. Dimensional comparison: The dimension of momentum [p] = MLT ^{1}, and the dimension of energy [E] = ML^{2}T ^{2}. The two can be related through $E = \int \vec{F} \cdot d\vec{r} = \int (d\vec{p})/dt \cdot d\vec{r}$, but cannot replace each other. Energy lacks the direction and state coding of momentum, which is the core mathematical basis for it to be unsuitable as an evolutionary subject.

6 Improved Interpretation and Mathematical Derivation of the Mass-Energy Equation (Correcting Logical Leaps)

The traditional interpretation of the mass-energy equation E=mc^2 has two deficiencies: first, some interpretations directly equate photon energy with mc^2, failing to fully consider the evolutionary attributes and dimensional matching of photons; second, interpreting mc^2 as "static energy" makes it difficult to explain the continuous evolutionary characteristics of photons after matter-antimatter annihilation. In fact, mc^2 represents "sustained evolutionary potential" rather than static energy, and the evolutionary expression of photons should be "mass $\times$ evolutionary three-dimensional amplitude c $\times$ evolutionary frequency c"; the mass-energy equation is essentially the limit time and space state shaping equation in the cosmic system, and the speed of light is the macro state evolution rate (statistical average result of discrete evolution steps of a large number of basic momentum units).

Complete Mathematical Derivation (Clearly Distinguishing Vector Sum and Scalar Sum, Correcting Logical Leaps):

Step 1: Correct rule expression — The cosmic evolution rule is essentially a mapping relationship $\hat{R} : P \to S$ in group theory, where P is the set of basic momentum units (evolutionary resources), S is the set of system states, and the core of the mapping is "basic momentum units perform state reconstruction according to rules".

Step 2: Correlation between the number of mapping executions and time — Each execution of the mapping $\hat{R}$ corresponds to a time snapshot (t_P); let the number of mapping executions per unit time be f=1/t_P, and the total number of executions be N_t = t/t_P, then time t = N_t $\bullet$ t_P, which is consistent with the time definition mentioned earlier.

Step 3: Mathematical expression of energy consumption — Energy E = $\Phi \bullet$ N_t, where Φ is the mapping intensity (total contribution of basic momentum units participating in evolution in a unit event).

Step 4: Core derivation of mc² (sustained evolutionary potential, correcting logical leaps) — Clearly distinguish between "vector sum" and "scalar sum" of basic momentum units:

1. Vector sum: $\vec{P} = \sum_{i=1}^{n} \vec{p}_i$, corresponding to macro observable momentum; for a stationary particle, internal momentum vectors cancel each other, |P |=0;

2.Scalar sum: $\sum_{i=1}^{n} |\vec{p}_i|$, corresponding to the total intrinsic evolutionary potential of the particle, directly related to the rest mass, and not affected by vector cancellation;

3. Core correlation: The evolutionary amplitude of the basic momentum unit is the three-dimensional speed of light c, and the evolutionary frequency is also c; assuming that the particle is encapsulated by n Planck momentum units, the size of a single momentum unit is p_P = /l_P, and the relationship between the rest mass m of the particle and the scalar sum of basic momentum units is $\sum_{i=1}^{n} |\vec{p}_i| = mc$ (this is the core correlation between intrinsic potential and mass, not macro momentum);

4. Derivation of mapping intensity (sustained evolutionary potential):

$$\Phi = \sum_{i=1}^{n} |\vec{p}_i| \cdot c = mc \cdot c = mc^2$$

.

Physical Meaning: mc² is the maximum driving amount that the basic momentum units encapsulated in the particle can release each time the rule mapping is executed; mc² is the limit continuous evolution state representation quantity, and mass m is an emergent quantity of the scalar sum of basic momentum units. Both are essentially emergent quantities of momentum. Through the vector cancellation effect, the basic momentum unit realizes the switching between two states: static (vector sum is 0) and limit continuous evolution (vector sum is maximum), solving the logical leap of "deriving mc² when the momentum vector sum of a stationary particle is 0" in the original derivation.

Step 5: Connecting the observed photon energy h — A photon is encapsulated by n_j Planck momentum units, and its sustained evolutionary potential $E_{potential,\gamma} = m_\gamma c^2$ (m_γ is the equivalent evolutionary mass of the photon); the observed energy h of the photon is the potential released per unit time, i.e., $h\nu = mc^2 \cdot \nu t_P$, which holds true after substituting relevant physical constants for simplification, perfectly connecting theory and observation.

Step 6: Verification of the evolutionary stability of photons — Without any interaction, the basic momentum units of photons satisfy$(d\vec{p}_\gamma)/dt = 0$, so they can move in a straight line at the speed of light forever, confirming the core attributes of basic momentum units; at the same time, mc² cannot express the total energy of photons over infinite time, further indicating that mc² is "sustained evolutionary potential".

7 Emergent Physical Quantities of Basic Momentum Units (Logical + Mathematical Expressions)

Note: In essence, force, energy, mass, momentum, entropy, information, time, and space are all the number of evolutionary carriers N in a single Planck time snapshot. When the state transitions, energy = force = momentum = mv = mc (limit state). For details, see the chapter on physical dimension reset in this evolution theory framework, but the following continues the traditional physical dimensions [5].

The basic momentum unit is the only evolutionary resource in the cosmic system, encoding a single state three-dimensional transition scale of l_P. The speed of light c (evolution rule) naturally emerges under multiple discrete transition events t_P; the vector sum of multiple basic momentum units can emerge all observable physical quantities in the universe. The specific mathematical definitions are as

follows (combined with the rule constraint$\hat{R}$, $\vec{P} = \sum_{i=1}^{n} \vec{p}_i$ is the vector sum of basic momentum units):

1. Evolutionary speed: $\vec{v} = \vec{P}/M$, where M is the emergent mass, satisfying 0 $|\vec{v}|$ c;

2. Force: The amount of momentum change within a unit time snapshot,

$$\vec{F} = (\Delta\vec{P})/\Delta t = (\vec{P}(t + \Delta t) - \vec{P}(t))/t_P$$

;

3. Inertia: Inertial mass $M_I = |\vec{F}|/|\vec{a}|$, where $\vec{a} = (\Delta\vec{v})/\Delta t$, determined by the state invariance of the vector sum of basic momentum units;

4. Mass (evolutionary state blocking quantity):

$$M = 1/c \sum_{i=1}^{n} |\vec{p}_i|$$

(defined based on scalar sum, consistent with the correction logic in Chapter 6);

5. Energy (free unlocking quantity): Combined with the previous definition of "sustained evolutionary potential" and the work-energy theorem, it is simplified to $E = \int F \cdot vdt$, where $(d|\vec{P}|)/dt$ is the magnitude of force, and $(|\vec{P}|)/M$ is the magnitude of speed, with a more intuitive physical meaning

;

6. Time (number of evolutionary states): $t = N_t \cdot t_P$, where N_t is the number of rule executions;

7. Space (evolutionary state dimension): $\vec{r} = \sum_{i=1}^{N_t} \vec{v}(i) \cdot t_P$, three-dimensional space emerges from the three orthogonal components of the evolution direction of basic momentum units;

8. Heat (disordered evolvable state quantity):

$$Q = \sum_{i=1}^{n} |\vec{p}_i - \vec{p}_{avg}|$$

($\vec{p}_{avg} = 1/n \sum_{i=1}^{n} \vec{p}_i$ is the total direction deviation of basic momentum units);

9. Temperature (degree of disordered evolvability): $T \propto Q/n$;

10. Entropy (locally lost heat):

$$S = \int dQ/T$$

, caused by the increase in the disorder of basic momentum units, consistent with the second law of thermodynamics [18];

11. Kinetic energy:

$$E_k = |\vec{P}|^2/(2M)$$

, which is the inertial motion tendency energy in the direction of net momentum deviation;

12. Potential energy:

$$E_p = -\int \vec{F} \cdot d\vec{r}$$

, which is the tendency energy under the action of a potential well;

13. Causal continuity: $\vec{P}(t + \Delta t) = \hat{R}(\vec{P}(t))$, and $\hat{R}$ is reversible (unitary transformation);

14. Information: Information entropy $S = -\sum_{i=1}^{m} p_i \ln p_i$, where p_i is the probability of the i-th momentum unit vector combination, and m is the number of evolvable states. Note: The information in this paper refers to the intrinsic state information of state evolution in the cosmic physical system, not the new combined information that emerges (for example, tens of thousands of pixels on computer software can be combined into a variety of new information; essentially, this information emerges from the

interaction and observation of new logical causal systems, not the intrinsic state information of physical causal evolution) [19,20].

Note: The above mathematical formulas only help to understand which physical dimensions can be directly emerged by the momentum unit (i.e., evolutionary carrier) based on state evolution. The above expressions are comprehensive basic expressions combined with traditional theories; for further logic, see the article on reconstructing physical dimensions in this evolution theory framework. Among them, the logic of system self-organization and order maintenance refers to the self-organization order theory proposed by Kauffman, S. A. in 1993 in "The Origins of Order: Self-Organization and Selection in Evolution" [21].

Conclusion: Evolutionary resources are the core foundation of a state evolution system. They are the main body of state space shaping and representation. Multiple resources emerge as mass, and the stability of resources emerges as conservation. In the cosmic system, evolutionary resources are momentum units, which have the intrinsic evolutionary ability of the speed of light c and are not externally driven [22]. Therefore, they are the only emergent quantity of state representation and dynamics in the cosmic system. The standard quantization of evolutionary resources is the premise for the stability of any complex state evolution system.

8 Conclusions

1. Standard quantization is the premise for the stable evolution of a state evolution system. Only when quantized into standard variables and input into the rule function can a one-to-one corresponding causal set be stably emerged, realizing the evolvability of the universe.

2. Physical reality emerges from the conservation of evolutionary carriers and the stability of rules. It is an objective existence formed by evolutionary resources (basic momentum units) and their driving forces, and cannot be replaced by mathematical probability; basic momentum units are the only underlying evolutionary resources of the universe, with dual attributes of static conservation and dynamic transition, undertaking the core functions of space-time state shaping and causal continuation, without the need for multiple types of dynamic driving forces.

3. Based on three types of deterministic transitions, vector superposition ability, and causal inertia maintenance ability, evolutionary resources emerge all observable physical quantities such as discrete-continuous space-time, energy-momentum, state quantities, force, and Lagrangian, realizing the unification of evolutionary carriers and driving forces.

4. The Discrete-Continuum Integral (DCI) system effectively replaces the traditional infinite subdivision integral. After correcting dimensional contradictions, it realizes the seamless derivation from deterministic micro-dynamics to macro-physical laws, which is consistent with the nature of cosmic quantized evolution; the essence of the mass-energy equation $E = mc^2$ is the cosmic limit time and space state shaping equation. mc^2 represents the sustained evolutionary potential of basic momentum units, and a physical dynamic mechanism is provided after clearly distinguishing between vector sum and scalar sum.

5. In any state evolution system, evolutionary carriers, driving forces, and material foundations are essentially the same, collectively referred to as "evolutionary resources". This resource is the only core intrinsic quantity for the generation and evolution of the internal space-time structure of the system. Its distribution shapes the space-time state structure, and it is the only reality of matter and energy in the evolution system.

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