Unified Cosmic Mechanics Evolution Theory (VI) : The Relationship Between Relativity, Classical Mechanics, and Quantum Mechanics

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Abstract

This paper is the sixth 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.

There are significant differences in the mathematical forms of classical mechanics, special relativity, general relativity, and quantum mechanics, which limit the study of the unity of their physical essence. Based on the Unified Cosmic Mechanics Evolution Theory, this paper proposes that the ”momentum unit” is the only fundamental reality of the universe, and all physical phenomena emerge from the superposition, distribution, interaction, and statistics of momentum units. The study clarifies the physical reality of the core state evolution of the cosmic system, reconstructs the essence of force and divides it into ”additive force” and ”multiplicative force”. It elucidates that special relativity originates from the compression of the perceptual space-time window when particles move, while general relativity originates from the conservation of internal evolution capacity of particles in motion. Both emerge the Pythagorean conservation relationship and the same Lorentz factor, while clarifying the dynamic connotation of the mass-energy equation. Finally, the three major mechanical systems are unified under three core principles, verifying that relativity and quantum mechanics are natural extensions of the same set of dynamic rules under different constrained conditions.

Keywords: Unified Cosmic Mechanics; Nature of Relativity;Nature of Energy Conservation; Pythagorean Conservation; Perceptual Window Compression; Space-Time State Shaping; Dynamic Mass-Energy Equation

1 Introduction

1.1 Problems of the Traditional Three Major Physical Theories

Classical mechanics, relativity, and quantum mechanics correspond to different application scenarios in physics research: classical mechanics is applicable to macro and low-speed scenarios, relativity dominates high-speed and strong gravitational scenarios, and quantum mechanics describes the behavior of micro-particles. There are significant differences in their mathematical forms and core assumptions, which pose challenges to the research on the unity of the physical theoretical system. The separation of this theoretical system essentially stems from the insufficient in-depth exploration of the underlying physical reality and the failure to explore the unified dynamic logic behind different mechanics systems.

1.2 Cosmic Physical Foundation

Based on the joint deduction of multiple papers within this framework, the Unified Cosmic Mechanics Evolution Theory proposes that the Momentum unit is the only underlying reality of the universe, providing a new framework for the unification of the three mechanics systems. Based on this framework, this paper clarifies that the physical reality of the core state evolution of the cosmic system is Evolutionary carrier (m0 Momentum units) + Driving quantity (single-unit evolution rate c) + vector superposition capability + conservation of the total number of Momentum units. From this, the unified dynamic relationship and the parallelogram vector superposition law of classical mechanics emerge; the nature of force is reconstructed and divided into Additive force (one-way transfer) and Multiplicative force (two-way exchange), clarifying that both are Momentum unit transfers during the interaction process rather than the maintenance of inertial states. This is also the dynamic nature of classical mechanics and the essence of the non-covariance of the objective physical Eigenstate.

1.3 Emergence Mode of Relativity

On this basis, this paper further clarifies the core connotation of relativity: although both exhibit the same mathematical form of the Lorentz factor, their physical natures are different — the Perceptual window compression in special relativity leads to the Pythagorean conservation of perceptual, non-perceptual, and total perceptual capabilities, while the conservation of internal evolutionary capacity of particles in general relativity leads to the Pythagorean conservation of Cancellation state, Broken state, and total evolutionary capabilities in Space-time state shaping. At the same time, it is clarified that the mass-energy equation $E=mc^2$ in relativity is essentially an equation of Space-time state shaping capability, while the dynamic mass-energy equation should be mc. The reason is that the integral condition of classical mechanics requires the interaction process to continuously produce state changes, while the motion state of photons is an inertial state, which cannot perform secondary velocity integration.

1.4 Research Objective

This paper aims to reveal the internal connection of the three mechanics systems through the above research, verifying that they are natural extensions of the same set of underlying rules under different scenarios. Among them, the special relativity effect is essentially the weakening of perceptual interaction compared with the static state, and the general relativity effect is essentially the enhancement of interaction redundancy compared with the inertial state. Both are jointly unified in the Pythagorean theorem distribution of Momentum units, providing new ideas and support for the unification of physical theories.

2 Microscopic Dynamic Principles of Classical Mechanics and Quantum Mechanics

2.1 Origin of Force and Core Dynamic Foundation (Underlying Foundation of Classical Mechanics and Quantum Mechanics)

The origin of force is based on the evolution law of the cosmic system, and its core underlying logic can be summarized as: momentum unit + light speed driving ability + vector superposition ability. These three constitute the only reality of cosmic dynamics, and are also the root of subsequent laws such as conservation, equivalence principle, and vector superposition.

All particles are encapsulated by momentum units with a reference momentum of m_0c (where m_0 is the reference quantity of a single momentum unit, and c is the intrinsic evolution rate of a single momentum unit). The light speed evolution ability and vector superposition of particles are the only dynamic origins. When a force connection is established between particles, the tendency to move towards each other emerges by interacting with the distribution state of internal momentum units, thereby forming a force connection relationship. Based on this mechanism, the potentials of various forces satisfy a complete equivalence relationship: resistance potential = thrust potential = tensile potential = inertia potential = repulsive potential = attractive potential = motion potential, which are uniformly quantified as m_0c. This is a direct embodiment of the synergistic effect of the evolutionary carrier, light speed driving force, and vector superposition ability.

The core constraints of the cosmic system on force include penetrability, cancelability, vector superposition, action at a distance, and instantaneity, and the upper limit of the motion speed exerted by force does not exceed the speed of light. This constraint indicates that force is not an independent physical reality, but emerges from the tendency of particle motion and mutual motion [1].

1. Classification of Force Types: Additive Force and Multiplicative Force

   All manifestations of force in the universe originate from the distribution and interaction of momentum units. According to the transfer and action mode of momentum units, they can be divided into two categories: additive force and multiplicative force. The core difference between the two lies in the interaction logic of momentum units, and both follow the law of conservation of momentum resources. It should be clarified that additive force and multiplicative force are essentially the process of momentum unit transfer and the process of toggling the internal momentum state of particles in the interaction process, rather than the process of maintaining the inertial state after interaction. This is significantly different from the vector superposition logic of classical mechanics, and is also the basis for distinguishing "integral relationship (interaction process)" and "vector superposition (result maintenance)" later [2].

2. Multiplicative Force (Mutual Force)

   Multiplicative force is a two-way interaction process between particles: two particles (denoted as A and B) form a common perceptual cross-section, jointly excite and exchange equal amounts of momentum unit states, and the vector directions of the exchanged momentum units are opposite, thereby showing repulsive or attractive force [3].

   Mathematical definition: Let the perceptual cross-section be σ, and the momentum unit state quantity excited by interaction be ΔP, then:

$$\Delta P_A = -\Delta P_B$$

That is, the momentum changes of the two interacting parties are equal in magnitude and opposite in direction, and the total momentum change is zero ($\Delta P_A + \Delta P_B = 0$), reflecting the symmetry of mutual interaction. The magnitude of multiplicative force is positively correlated with the perceptual cross-section and exchange frequency:

$$F_{mul} \propto \sigma \cdot f \cdot \Delta P$$

where f is the exchange frequency. The distinction between repulsive force and attractive force depends on the direction of the momentum vector: the direction pointing to each other in the opposite direction is attractive force, and the direction away from each other in the opposite direction is repulsive force.

3. Additive Force (One-way Transfer Force)

   Additive force is a one-way momentum transfer effect between particles: after particles A and B form a perceptual cross-section, A unilaterally transfers momentum units to B, A loses an equal amount of momentum units, and B gains an equal amount of momentum units, with no reverse exchange.
   Mathematical definition: Let the total amount of momentum units transferred by A be ΔP, then:

$$\Delta P_A = -\Delta P, \Delta P_B = +\Delta P, \Delta P_A + \Delta P_B = 0$$

   The magnitude of additive force is positively correlated with the transfer rate of momentum units:

$$F_{add} = \frac{d(\Delta P)}{dt} = \frac{dP_B}{dt} = -\frac{dP_A}{dt}$$

   where t is the cosmic reference time (macroscopic accumulation of Planck time t_P).

2.2 Conservation of Momentum Resources: Core Underlying Law (Classical Mechanics)

Conservation of momentum resources is the core underlying law of the cosmic system, and its core logic is: the number of momentum units of subsystems is added, and the total amount is strictly equal to the sum of each part—that is, the simple additivity of "Zhang San + Li Si = two people". This is also the basis for the subsequent emergence of the equivalence principle and vector superposition law.
All physical realities in the universe can be divided into representational quantities (evolutionary carrier mass) and driving quantities (constant evolution rate). The representational quantity is defined as the occupied unit of space shaping in the system, which is essentially the number of momentum units—mass m is not an independent physical entity, but a macroscopic representation of the total number N of momentum units in the system, that is, $m = Nm_0$ (where m_0 is the reference quantity of a single momentum unit); the driving quantity is defined as the constant evolution speed driven by energy or force, which is constant as the speed of light c in the cosmic system. Representational quantities emerge spatial properties, and driving quantities emerge time, energy, and force properties. The two do not exist independently; the constancy of light speed is attached to the evolutionary carrier, that is, the only underlying evolutionary resource of the universe is the momentum unit m_0c [4].

Core Expression of Conservation Relationship

1. Conservation of Total Number of Momentum Units (Mass Additivity)

$$m_{total} = m_1 + m_2 + \cdots + m_n = \sum_{i=1}^{n} m_i$$

   The mass of subsystems is strictly additive, and the total amount is equal to the sum of each part.

2. Conservation of Total Momentum (Vector Additivity)

$$\vec{P}_{total} = \vec{P}_1 + \vec{P}_2 + \cdots + \vec{P}_n = \sum_{i=1}^{n} \vec{P}_i$$

where $\vec{P}_i = m_i \vec{v}_i$, and the total momentum is the vector sum of the momenta of each subsystem.

3. Conservation of Total Evolutionary Ability (Energy)

$$E_{total} = E_1 + E_2 + \cdots + E_n = \sum_{i=1}^{n} E_i$$

where $E_i = m_i c$ (the maximum ability of the system to evolve at full speed), and the evolutionary abilities of each subsystem are strictly additive.

2.3 Equivalence Principle: Emergent Result of Conservation Law (Precursor of Classical Mechanics and Relativity)

The equivalence principle emerges from the conservation of momentum resources, and the core reason is the equal influence relationship of dynamic costs (i.e., linear superposition characteristics)—since the thrust, resistance, inertia, and space occupation inside each momentum unit are essentially four manifestations of the same resource, there is no loss inside when multiple units are combined, thus showing strict equivalence at the macro level.

Analysis of the evolutionary characteristics of a single momentum unit: Within a single Planck time t_P, the momentum, inertia, resistance, and space-time shaping quantity of the momentum unit driving its own scale satisfy a complete equivalence relationship:

Momentum = Acceleration ability = Resistance ability = Space-time shaping eigenquantity

Mathematical expression: Let the self-scale of a single momentum unit be l_P (Planck length), then within t_P:

- **Momentum:** $m_0 c \cdot t_P = m_0 l_P$ (since $c \cdot t_P = l_P$);
- **Acceleration ability:** $(m_0 c)/t_P$;
- **Resistance ability:** equal in magnitude and opposite in direction to the acceleration ability, that is, $(m_0 c)/t_P$;
- **Space-time shaping quantity:** proportional to the momentum, that is, $k \cdot m_0 l_P$ (where k is the normalization coefficient, taking a value of 1).

The above four are completely equivalent and uniformly quantified as $m_0 c$, which is the embodiment of "motion potential = resistance potential = inertia potential = thrust potential" at the micro level. This micro equivalence emerges as the macro equivalence principle in the macro system: the motion ability (motion effect corresponding to total momentum), acceleration ability (acceleration effect corresponding to total force), and resistance ability (resistance effect corresponding to inertia) of the system are completely equivalent, that is:

Motion ability = Acceleration ability = Resistance ability

This principle is the core premise of the parallelogram vector superposition law of classical mechanics, and also the key link connecting classical mechanics and subsequent covariance analysis.

2.4 Vector Superposition: Extension of the Equivalence Principle and Embodiment of Causal Inertia (Classical Mechanics)

Vector superposition (parallelogram linear vector superposition of classical mechanics) emerges from the conservation of momentum resources and the equivalence principle, and is constrained by the cosmic evolution rules. Its core is the underlying logic of the cosmic system of "evolutionary carrier + light speed driving force + vector superposition ability + conservation". It describes the result maintenance of inertial motion, does not include the integral process, and is the state continuation after causal interaction [5].

Emergence process of vector superposition (including the formation of resultant force and resultant velocity): When particle A pushes a rigidly connected system composed of particles B and C, a resultant force effect after interaction is formed due to the constraint of evolution rules—when particle A pushes B, it will transmit the resultant force to C; if the acting force does not pass through the center of mass of the system, the momentum units inside B and C will convert part of the linear momentum flow into rotational momentum flow to maintain rigid cooperative evolution. This imbalance of linear superposition will emerge as torque. If there are multiple torque actions, the final effect follows the parallelogram law for vector synthesis, and then the resultant force and resultant velocity emerge. This process is the core principle of causal inertia and resultant force in classical mechanics, and also the direct embodiment of the only eigenphysical quantity and conserved quantity in the cosmic system.

When the number m of all momentum units participating in the resultant velocity is counted, the resultant velocity and resultant force satisfy a complete equivalence relationship: $mv = F$ (where m is the total number of momentum units, v is the resultant velocity, and F is the resultant force).

Mathematical derivation: Let the acting force of particle A on the rigid system BC be $\vec{F}_A$, and the total number of momentum units of the system be $m_{\text{total}} = m_B + m_C$. If the acting force does not pass through the center of mass, the generated torque $\vec{M}$ is the cross product of the acting force and the moment arm, that is:

$$\vec{M} = \vec{r} \times \vec{F}_A$$

where $\vec{r}$ is the moment arm (vector from the center of mass to the point of application of the acting force). When there are multiple torques $\vec{M}_1, \vec{M}_2, \dots, \vec{M}_n$, the total torque $\vec{M}_{\text{total}}$ follows the parallelogram vector superposition law:

$$\vec{M}_{total} = \vec{M}_1 + \vec{M}_2 + \cdots + \vec{M}_n$$

The total torque drives the system to produce rotational motion, and the cooperative evolution of linear momentum flow forms the resultant force $\vec{F}_{\text{total}}$. The resultant velocity $\vec{v}_{\text{total}}$ and the resultant force satisfy $\vec{F}_{\text{total}} = m_{\text{total}}\vec{v}_{\text{total}}$, and the two have the same vector direction and equivalent magnitude.

Core conservation relationship of vector superposition:

Conservation of resultant force vector superposition: $\vec{F}_{\text{total}} = \sum_{i=1}^{n} \vec{F}_i$ (follows the parallelogram law, derived from the equivalence of thrust and resistance inside the unit);

Equivalent conservation of resultant velocity and resultant force: $\vec{F}_{\text{total}} = m_{\text{total}}\vec{v}_{\text{total}}$ (force and velocity are strictly equivalent under the medium of m).

Refer to the chapters The Nature of Force [6] and Field and Particle [7] in this evolutionary theory framework for more detailed elaboration on the formation mechanism of the perceptual cross-section and the details of momentum transfer in rigid connections.

2.5 Integral Relationship: Description of Interaction Process (Microscopic Mechanism of Quantum Mechanics, Distinguished from Vector Superposition)

The integral relationship describes the momentum interaction process between particles (including the action process of multiplicative force and additive force), which is essentially different from vector superposition (describing the result maintenance of inertial motion)—vector superposition is the causal maintenance after interaction, and the integral relationship is the quantitative description of the interaction process itself. That is, the integral is the integral process of momentum, $N \cdot m_0 \cdot c +$ angle.

1. Integral Principle and Integrability Condition

   The integration of force and energy in classical mechanics is based on the condition of stable interaction between particles. Taking a stone falling from a height as an example: the stone and the Earth continuously interact through gravity, and the interaction intensity follows the $1/r^2$ attenuation law with the change of distance. Through the integration of distance or time, the velocity change, kinetic energy increment and other results can be obtained. At the same time, no matter how the stone contacts the ground, the final total integral must be the integral under r between the stone and the ground, so no covariance will be generated by interaction [8].
   Core conclusion: The integral acts on the interaction process itself, not on the inertial motion state. When the interaction stops, the particle enters the inertial motion state (such as a photon leaving the light source), and its state is dominated by inertia, which no longer satisfies the condition of continuous interaction, so it is impossible to continue integrating force or energy.

2. Core Dynamic Formula

   Let the system be composed of N momentum units, the intrinsic evolution rate of each momentum unit be c, and the reference momentum of a single momentum unit be m_0c. The total evolutionary ability of the system satisfies:

   $$F = P = N \cdot m_0c = mc$$

   (where $m = Nm_0$ is the total number of momentum units)
   Low-speed case: $P = mv$ $(v \leq c)$
   Force: $F = dP/dt$, and $F = P = mc$ in steady state (continuous release of momentum flux)

3. Physical Nature of Integration

   The physical essence of the calculus operation $\int Fdt$ is: the number of momentum unit state interactions under the increment of the perceptual cross-section. The passage of time corresponds to the advancement of the perceptual cross-section, the action of force corresponds to the flip count of the momentum unit state in the cross-section, and the integral result is the total number of momentum units that have completed directional arrangement. This establishes the equivalence between impulse and momentum change at the counting level [9].

4. Inertial State and Mass-Energy Equation

   When a particle enters the inertial motion state (such as a photon) without continuous interaction, the integral condition is no longer satisfied. Therefore, the energy of a photon can only be counted as its eigenmomentum state mc, not mc^2.

The c^2 in the traditional mass-energy equation $E = mc^2$ is actually a space-time state shaping equation, which is derived in detail in the subsequent relativity covariance.

2.6 The Physical Reality of Eigenstate Cannot Be Covariant

The mass additivity, linear superposition of force and velocity, and absolute conservation relationship elaborated earlier are all established on a non-covariant absolute reference frame. These properties define the eigenvalues of physical quantities, that is, the intrinsic properties that do not change with the observer's reference frame, and are also the only eigenphysical quantity and conserved quantity in the cosmic system—the physical reality eigenstate of particles is constant as: energy = momentum = force = mv (upper limit is mc) = motion potential = resistance potential = thrust potential = inertia potential. The "linear superposition" and "absolute conservation" established here are the eigenstate manifestations of the physical system at low speed and low energy scale. In the subsequent chapters, on this basis, we will discuss how the transformation of the observation reference frame introduces the space-time covariance law when the evolution rate is close to the upper limit c, thereby correcting the observed value of the eigenquantity, and analyzing the core issues of relativity and covariance. The content of this section only serves as a benchmark for defining the underlying reality and conservation law, and does not involve the specific mechanism of covariance transformation.

3 The Nature of Covariance in Minkowski Space-Time Statistical Method

3.1 Introduction of Emergent Relationship in State Evolution System

Emergence of generalized space-time: In any state evolution system, the representational quantity m_0 has an intrinsic inertial transition ability, and its scale is between 0 and l_P. Within a single time snapshot, m_0 transitions based on free dimensions: when it transitions to the l_P scale, it is recorded as a space evolution unit, corresponding to the unit evolution time t_P; continuous transitions emerge a discrete-continuous space-time structure. In the cosmic system, l_P, t_P, and c correspond to Planck length, Planck time, and speed of light respectively—the latter is essentially the continuous integral of multiple l_P/t_P, and space-time grows proportionally, which can be statistically represented as v or c [10].

Impact of infinite subdivision: It can be inferred that there is no need to introduce an absolute space-time background or infinitely refinable space-time—the latter is not only the infinite subdivision of scales, but also the infinite proliferation of dimensions (each refinement adds a complete set of independent coordinates). This dimensional explosion is mathematically uncontrollable and physically uncorresponding, and essentially mistakes statistical tools for physical reality. Space-time is not an independent eigenreality, but a statistical emergence of the constant light speed evolution of momentum units [11].

Reality of the cosmic system: All particles in the universe are composed of m momentum units m_0 with light speed evolution ability. The evolution state of momentum units inside the particle synchronously shapes space-time: cancellation state (vectors cancel each other, macroscopically static or low-speed) and breaking state (vector sum is non-zero, macro speed v). The core feature of fermions is that the internal momentum units are in the cancellation state, and the breaking state emerges when interacting with the outside world. This relationship is the basis for understanding the nature of Minkowski space-time statistical method and covariance [12].

Note: Any state evolution system requires state representational quantity and driving quantity. The upper limit of inertial motion c in the universe is constantly driven, and momentum, force, and energy (all with dimension mc) emerge automatically. For details, see The Nature of Force [6] and Reconstruction of Dynamic Relationships of Basic Physical Dimensions [13].

3.2 Emergence of Space-Time State Shaping Equation

Based on the emergent relationship of the state evolution system, time and space are not independent backgrounds, but a pair of coupled properties synchronously and proportionally emerged by the constant light speed evolution of momentum units m_0. Its core logic is as follows:

1. **Space-Time Homology and Multiplicative Relationship**

   The emergence of any time segment t_P must correspond to a complete space quantum l_P^3 being occupied or covered by momentum units; conversely, the existence of any space quantum l_P^3 must be accompanied by the passage of a time pulse t_P. Time and space cannot exist independently; they are a pair of coupled relationships that are respectively emerged but jointly coupled by the same evolution event. Any time or space point has a corresponding complete material representation state. Therefore, statistically, the total space-time state shaping ability of the system must be coupled by a multiplicative relationship rather than a simple addition, that is, the space-time shaping quantity is mcc = representational quantity m * evolution frequency c * evolution amplitude c. The two c represent the synchronous emerged sampling statistics of time and space respectively. The statistics do not need to consider independent dimensions, only the actual physical logic and significance. This is an important dividing line for understanding the underlying physical logic [14].

2. **Three Layers of Emergent Magnitude**

   Based on the underlying logic of "space-time homology and multiplicative coupling", starting from the momentum unit m_0, three levels of core physical quantities are systematically emerged:

   - **Eigenrepresentational quantity (mass):** $m = Nm_0$, describing the total number of momentum units contained in the system.
   - **Eigendynamic quantity (momentum/force/energy):** mc, describing the maximum eigenevolution ability of the system per unit time (i.e., the upper limit of the inertial motion state), and also the non-covariant eigenstate of particle physical reality.
   - **Space-time state shaping quantity (statistical potential):** mc^2, describing the statistical potential of N momentum units inside the system to shape the space-time structure through the cancellation and breaking relationship between them while maintaining their own evolution.

3. **Core Equation and Physical Meaning**

   The constant equation of the total space-time state shaping ability inside the particle is:

   $$E_{\text{total space-time}} = mc^2$$

   where m is the total number of momentum units inside the particle, and c is the evolution rate of a single momentum unit. This equation does not describe the real-time dynamic state of the particle (that is the category of mc), but the statistics of the total potential of all momentum units inside the particle to shape space-time. It is the underlying mathematical support for understanding the covariance law (Lorentz factor) and explaining why the upper limit of various interactions is c^2 later.

4. **Emergence of Unified Frequency Upper Limit c**

   There are two types of mutually mirrored evolution processes in the cosmic system, and their frequency upper limits are all constrained by the speed of light c:

   (a) **Particle internal evolution frequency:** The momentum units inside the particle refresh their states at a constant rate c (completing one evolution every t_P). Whether in the vector cancellation state (macroscopically static) or the breaking state (macroscopic motion), the upper limit of the internal state switching frequency is always c. This determines the resource allocation rhythm of "cancellation state vs. breaking state" inside the particle, and is the underlying frequency basis of the general relativity effect (enhanced interaction redundancy).

   (b) **Inter-particle interaction frequency:** When particles interact with multiplicative force/additive force through the perceptual cross-section, to ensure causality and instantaneity, the interaction cycle cannot be greater than t_P, that is, the interaction frequency cannot be lower than c/l_P; at the same time, to avoid superluminal speed, the interaction frequency cannot be higher than c/l_P. Therefore, the interaction frequency is accurately locked at c/l_P, which is reflected as the interaction frequency upper limit c at the macro level. This determines the allocation rhythm of the "perceived vs. non-perceived" window between the particle and the outside world, and is the underlying frequency basis of the special relativity effect (weakened perceived interaction) [15].

   Relationship between the two: The internal evolution frequency c is the "source", which determines the basic rhythm of particle state changes; the external interaction frequency c is the "application", which is the external mapping of internal state changes on the perceptual cross-section. Both share the same highest cosmic frequency c, reflecting the homology of internal state allocation and external perception allocation.

5. **Why the Upper Limit is c^2 Instead of c**

   Whether it is the allocation of "cancellation state vs. breaking state" inside the particle (root of general relativity) or the allocation of "perceived vs. non-perceived" window between the particle and the outside world (root of special relativity), the total amount of resource allocation follows the Pythagorean theorem conservation form $c^2 = v_1^2 + v_2^2$. The upper limit here is c^2 precisely because space-time itself is multiplicatively coupled—any allocation involves two dimensions of time and space, and its statistical potential is naturally a quadratic form of the evolution rate c. If the upper limit is only c (linear), it degenerates into the eigendynamics of a single dimension (mc), which cannot describe the allocation and curvature of space-time structure.

3.3 Emergence of Pythagorean Theorem Conservation Formula

Due to the cancellation relationship of momentum units inside the particle, its space-time state shaping ability will be allocated between the cancellation state and the breaking state, and this allocation strictly follows the Pythagorean theorem conservation relationship. Combined with the space-time state shaping equation, the core conservation formula can be derived:

$$mc^2 = mv_1^2 + mv_2^2$$

Divide both sides by m ($m \neq 0$), simplify to get:

$$c^2 = v_1^2 + v_2^2$$

In the formula, mv_1^2 is the sampling statistics of the total space-time state shaping ability of the cancellation state inside the particle, and mv_2^2 is the sampling statistics of the total space-time state shaping ability of the breaking motion state inside the particle; v_1 and v_2 are different sampling statistics, which are not equal in value and have different physical meanings. They cannot be equated to the system evolution speed v, nor can they be confused. This Pythagorean theorem conservation formula is the core mathematical tool for explaining the nature of covariance and solving the contradictions of traditional theories.

3.4 Three Problems of Covariance in Minkowski Space-Time Statistical Method

Combined with the above state evolution relationship, space-time shaping equation and Pythagorean theorem conservation formula, the three core problems existing in traditional relativity and covariance can be solved pertinently:

First, there is inconsistency between the traditional relativistic covariance and the conservation and vector superposition relationships of classical mechanics—the essence is that the traditional theory fails to realize that covariance is the statistical allocation law of the space-time shaping ability inside the particle, and the Pythagorean theorem conservation formula $c^2 = v_1^2 + v_2^2$ is the statistical conservation relationship in the space-time shaping ability or interaction process, not the covariance of the eigenstate.

Second, Minkowski space-time assumes that time and space are perpendicular and orthogonal, while space-time is essentially emerged based on the state evolution of momentum unit evolution, and it is difficult to establish a direct logical connection between the two—the perpendicular relationship between time and space in Minkowski space-time is a statistical simplification of the evolution direction of momentum units inside the particle, not an objectively existing space-time property; the space-time emergence relationship we proposed clarifies that time and space are synchronously shaped by the evolution of momentum units, establishing a logical connection between space-time and physical reality from the bottom [11].

Third, the traditional conclusion that "time tends to zero when moving at the speed of light" has logical contradictions—in any state evolution system, the faster the evolution state changes, the faster time emerges. As the upper limit of the evolution rate, the speed of light should have time evolution synchronized with space evolution, rather than tending to zero. Combined with the synchronous emergence relationship of space-time, photons are in the light speed evolution state (the fastest state change rate), and their time evolution is synchronized with space evolution, so there is no phenomenon of time slowing down, which completely corrects this logical contradiction [14].

4 The Nature of Relativity

4.1 Introduction of the Interaction Refresh Frequency c of Cosmic Force

In the cosmic system, the interaction of force has a perception and transmission process. To ensure that the interaction of force satisfies instantaneity, causality, resultant force, can obtain the static space-time position of the environment, and the particle evolution speed does not exceed the speed of light c, the interaction frequency of force must be synchronized with the light speed time. This constraint is the time refresh mechanism, which is also the necessary core condition for relativity to hold. For the detailed derivation process, see the chapter The Necessity of the Refresh Mechanism of Cosmic Force and the Origin of Time [16] in this evolution theory framework.

The core constraint of the time refresh mechanism is: the interaction cycle (time interval between two interactions) $\Delta t_{\text{refresh}}$ must be equal to the propagation time of light on the Planck length l_P, that is, $\Delta t_{\text{refresh}} = l_P/c = t_P$ (where t_P is the Planck time). This is the lower limit of the force interaction cycle, and the corresponding interaction frequency $f_{\text{refresh}} = 1/t_P = c/l_P$ is the upper limit.

If the interaction frequency is greater than c, it will lead to excessive momentum unit exchange of particles per unit time, and the evolution speed will exceed the speed of light, violating the constraint of the upper limit of momentum unit evolution rate; if the interaction frequency is less than c, the transmission of force will be delayed, leading to unstable resultant force, and even causing causal paradoxes, and at the same time, it will produce the gravitational fold drag effect between celestial bodies. Therefore, the upper limit c of the interaction frequency of cosmic force is the core premise for the emergence of relativistic effects [15].

Emergence mechanism: Because the speed of light is based on its own scale l_P (the space scale of m_0 within a single Planck time can be regarded as its own scale) for continuous and continuous state transition, emerging continuous l_P and t_P, and emerging c, it naturally emerges that the causal interaction frequency with other evolutionary carriers needs to correspond, that is, the constant state transition frequency = perceived interaction frequency = c [17].

4.2 Introduction of the Integral Nature of Classical Mechanics

The integration of force and energy in classical mechanics relies on stable interaction conditions—that is, the system can finally form a stable perceptual cross-section $1/4\pi r^2$ (where r is the characteristic distance between interacting objects). Taking gravitational interaction as an example, when a stone falls from a height, no matter its initial position (10,000 kilometers or near the ground) or motion mode (free fall, variable speed flight or artificial handling), it will eventually rely on the static r when it contacts the ground, so various integral operations can be realized based on this stable perceptual cross-section [8].

Similarly, when firing a bullet, we only need to calculate its initial conditions (initial velocity, launch angle, etc.) and the roughly predictable interaction process (air resistance, gravity, etc.), and then obtain its motion trajectory through integration. The essence is also that the interaction conditions between the bullet and the surrounding environment are relatively stable, and a predictable perceptual cross-section can be formed. In short, the feasibility of integration in classical mechanics stems from stable interaction perception conditions.

4.3 Formation of General Relativity

The effect of general relativity originates from the change of particle motion state caused by the interaction of massive celestial bodies, which in turn leads to the increase of interaction redundancy of the next space-time window of the particle. Combined with the Pythagorean theorem conservation formula derived earlier, a new conservation relationship will emerge at this time—based on the constant perception ability c, it is allocated in two dimensions: redundant interaction and inertial interaction, that is:

$$c^2 = v^2_{\text{redundant interaction}} + v^2_{\text{inertial interaction}}$$

The strong gravitational field of massive celestial bodies will change the motion state of particles, increasing the interaction redundancy of particles with the outside world, and the allocation ratio of space-time windows will be adjusted accordingly, thus emerging general relativity effects (such as the space-time phenomena described by the field equation). In essence, general relativity is the statistical embodiment of the resource allocation law of Pythagorean theorem conservation under the constraint of massive celestial body interaction (superposition of internal evolution and external field action), and its core is the

incremental effect of interaction redundancy compared with the inertial motion state.
Note: General relativity here seems to be a static interaction under a static strong gravitational gradient, and there seems to be no changing integral. However, it is necessary to combine the integral principles of classical mechanics and micro quantum fields mentioned earlier, including the gravitational formula $F = m1 \cdot m2 \cdot G/rr$ (essentially $F = m1 \cdot m2 \cdot G4\pi/4\pi rr$). Its interaction process relies on the multiple processes of micro quantum interaction protocols of the four fundamental forces or the perceptual cross-section $1/4\pi rr$ of the last static state. The previous interaction will affect the next interaction, forming a joint interaction integral. If the previous interaction does not affect the change integral of the next interaction, such as the radial or low-speed motion process can form a stable perceptual cross-section $1/4\pi rr$ similar to the static state, then the classical mechanics integral can be used directly, such as the direct use of acceleration integral. The general logic is that special relativity multiplication integral general relativity.

4.4 Formation of Special Relativity and General Relativity Covariance Factor

The effect of special relativity originates from the fact that high-speed moving particles cannot form a stable perceptual cross-section that can be used for integration like classical mechanics—high-speed motion leads to the compression of the number of interaction space-time windows between particles and the outside world, reducing the interaction opportunities. The core is the weakened effect of perceived interaction compared with the static state. Combined with the Pythagorean theorem conservation formula, a new conservation relationship will emerge at this time—based on the constant perception ability c, it is allocated in two dimensions: actual perception and non-perception, that is:

$$c^2 = v^2_{\text{perceived}} + v^2_{\text{non-perceived}}$$

In the formula, $v_{\text{perceived}}$ is the equivalent velocity component corresponding to the window that actually establishes interaction, and $v_{\text{non-perceived}}$ is the equivalent velocity component corresponding to the potential window "missed" due to high-speed motion. Further derivation can clarify the emergence process of the Lorentz factor: let the number of perceived space-time windows of a static particle be N_0, and the number of perceived space-time windows when moving at high speed be N. The number of windows that can be established per unit time is proportional to $v_{\text{perceived}}$, and $v_{\text{perceived}} = \sqrt{c^2 - v^2}$ can be derived from the Pythagorean theorem conservation formula. Therefore, the relationship between the number of windows is: $N = N_0 \cdot v_{\text{perceived}}/c = N_0 \cdot \sqrt{1 - v^2/c^2}$. The number of interaction opportunities is proportional to the number of perceived space-time windows, so the ratio of interaction opportunities when moving at high speed to that when static is $\sqrt{1 - v^2/c^2}$. The reciprocal of this ratio is defined as the special relativity Lorentz factor $\gamma_{\text{special}} = 1/\sqrt{1 - v^2/c^2}$. The compression of the number of space-time windows leads to the reduction of the effective interaction efficiency between particles and the outside world, which is macroscopically manifested as the apparent phenomenon of synchronous slowing down of time and space evolution. The Lorentz factor is precisely the quantitative characterization of this weakened perceived interaction effect [5].

4.5 Summary

Whether it is classical mechanics or relativity, their core is the linear integration of momentum (inertial motion) under the condition of $N \cdot m_0 \cdot c +$ angle. The only difference between the two lies in the different interaction conditions: classical mechanics relies on a stable perceptual cross-section to achieve conventional integration; relativity, due to the change of interaction conditions (massive celestial body field action, high-speed motion), leads to the adjustment of the allocation ratio of space-time windows, emerging special covariance effects and conservation relationships—special relativity reflects the weakening of perceived interaction, and general relativity reflects the increment of interaction redundancy. Without considering the detailed problems, the overall mathematical statistics of classical mechanics and relativity are universal; when incorporating quantum mechanics, it is only necessary to introduce the perception upper limit frequency c, clarify the nature of integration and the way of space-time emergence, so as to realize the natural compatibility of the three—all three originate from the same underlying dynamic rules: conservation of the total number of momentum units, constancy of single-unit evolution rate, and resource allocation law of Pythagorean theorem conservation. It is particularly important to emphasize that the Lorentz factors (covariance factors) of general and special relativity are homologous and isomorphic, corresponding to two statistical effects of enhanced interaction redundancy and weakened perceived interaction, which further confirms the unified nature of relativity, not an independent physical law.

5 Conclusion: The Conservation Mode of Force and the Correlation of the Three Mechanical Systems

Based on the above derivation, combined with the core framework of the Unified Cosmic Mechanics Evolution Theory, the conservation mode of force and the internal correlation of relativity, classical mechanics, and quantum mechanics can be clarified, the dual emergence mechanism of the Lorentz factor (weakened perceived interaction, enhanced interaction redundancy) can be clarified, and a unified dynamic image can be established.

The traditional covariance theory has three logical problems: forms such as $E = \gamma m_0 c^2$ fail to reflect the resource conservation characteristics of particles in different states, so $E = mc^2$ is by no means dynamic energy, but a space-time state shaping potential or interaction integral accumulation equation, and the dynamic energy is $E = mc$; the time-space perpendicular assumption of Minkowski space-time lacks logical necessity with the nature of space-time emergence, and it should be the multiplicative relationship and Pythagorean theorem allocation relationship of synchronous coupled emergence of time and space [11]; "the higher the evolution efficiency, the slower the time" is contradictory to the time nature of "the faster the state evolution, the faster the time passes", and it should be that time and space emerge synchronously with the faster evolution in a state system [14].

5.1 Conservation Relationship in Covariant Interaction Processes

In this framework, the Lorentz factor $\gamma = 1/\sqrt{1 - v^2/c^2}$ emerges from two different mechanisms, with clear distinction between relative benchmarks and directions of change:

Type Emergence Mechanism Allocation Object Physical Meaning

Inertial State Internal Resource Allocation Cancellation/Breaking Internal Reallocation of Space-Time Shaping Ability

γ_{special} Compression of Perceptual Space-Time Window Perceived/Non-perceived Weakened Perceived Interaction Compared with Static State

γ_{general} Redundancy of Perceptual Space-Time Window Redundant Interaction/Inertial Interaction Enhanced Perceived Interaction Compared with Inertial State

The two are mathematically isomorphic and physically complementary, corresponding to special and general relativity effects respectively. γ_{special} is only applicable to describing changes in external interactions during high-speed motion and cannot be used to derive the mass-energy equation. The traditional mass-energy equation $E = mc^2$ is essentially a space-time state shaping equation, describing the total potential of momentum units inside particles to shape space-time; the physical reality eigenstate of particles is always $E = mc$, which is a description of the dynamic inertial state. The two cannot be confused — the former is statistical potential, and the latter is eigen-reality.

5.2 Correctness of Relativity and Modifications of This Framework

This framework fully acknowledges all experimental observation results of relativity, but reconstructs its physical interpretation: the special relativity effect is the statistical change of interaction caused by the compression of the perceptual space-time window during high-speed motion, with the core being the weakening of perceived interaction compared with the static state; the general relativity effect is the resource allocation of momentum units inside particles between the cancellation state and the breaking state, emerging the Pythagorean theorem covariance relationship $c^2 = v^2_{\text{cancellation}} + v^2_{\text{breaking}}$, with the core being the enhancement of interaction redundancy compared with the inertial state.

The mathematical form of relativity is correct, but the traditional interpretation misinterprets statistical effects as eigen-space-time properties. This framework retains all its predictive capabilities while being unified under the underlying dynamics of momentum unit conservation and Pythagorean theorem conservation allocation, clarifying the different physical connotations of the two Lorentz factors [11].

5.3 Unified Correlation of the Three Mechanical Systems

1. With classical mechanics

   Under low-speed approximation ($\gamma \approx 1$), the conservation of force is manifested as linear superposition, i.e., the parallelogram vector superposition principle, which originates from the conservation of the total number of momentum units and inertial causal superposition.

2. With relativity

   The special relativity effect originates from the window allocation of perceived/non-perceived (γ_{special}), with the core being weakened perceived interaction; the general relativity effect originates from the state allocation of cancellation/breaking (γ_{general}), with the core being enhanced interaction redundancy, and both share the Pythagorean theorem allocation form.

3. With quantum mechanics

   Particles are encapsulated by momentum units m_0c, microscopic interaction depends on the perceptual cross-section and the highest cosmic frequency c, and probability and discreteness are statistical manifestations of momentum unit exchange [4].

5.4 Core Conservation and Superposition Principles

The universe follows three core underlying laws: conservation of the total number of momentum units m, conservation of single-unit evolution ability c, and parallelogram linear resultant force superposition. The differences among the three mechanical systems lie only in the observation perspective and constraint conditions — classical mechanics focuses on macroscopic continuous superposition, relativity focuses on statistical covariance under high-speed/strong constraints (special relativity for weakened perception, general relativity for enhanced redundancy), and quantum mechanics focuses on microscopic discrete interaction — all of which are fundamentally unified in the allocation and conservation of momentum units [9].

5.5 Core Summary

Classical mechanics integration: Classical mechanics relies on the finally stably formed perceptual cross-section $1/4\pi r^2$. For example, when a stone falls from a height, no matter how the stone moves, the finally stably interactive cross-section must be $1/4\pi r^2$, so integration can be realized through various methods such as distance, velocity, and time.
Relativity integration: Relativity mainly statistically describes the interaction process of particles through space-time covariance, that is, the conservation relationship in time and space components. This conservation relationship will trigger the interaction integration of space-time windows, but the synchronous emergence of space and time presents a square increment, not the separate square increments of time and space, which is also the process of interaction integration. Therefore, both special relativity and general relativity are essentially universal theories. Special relativity solves the problem of weak perception (weakened interaction) during high-speed motion, and gravity and electromagnetism degenerate into gravitational lensing and electromagnetism respectively [18,19]; general relativity solves the integral effect caused by the redundancy of evolutionary space-time (enhanced interaction), so the field equation in general relativity can be further extended to the electromagnetic field, as calculated by Kaluza-Klein [20,21,22].
Complete causal chain of physical theory and mechanical interaction: Momentum units provide representation and driving capabilities, particle encapsulation and perception protocols (standard model), particle motion (classical mechanics), multiplicative and additive interaction and integration (classical mechanics) + additional space-time curvature integration (general relativity field equation, corresponding to enhanced interaction redundancy) + reduced perception efficiency (special relativity, corresponding to weakened perceived interaction), resultant velocity emerging resultant force (classical mechanics or velocity increase equation), causal inertial state (classical mechanics or velocity increase equation). For detailed principles, see the chapter The Nature of Force [6] in this evolution theory framework.

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