Unified Cosmic Mechanics Evolution Theory (XXIII)
Reconstruction of Dynamical Logic for Large-Scale Steady-State Evolutionof the Universe

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Abstract

[**Series Information**]

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

[**This article**] Contemporary cosmology exhibits significant fragmentation in its underlying dynamics: classical mechanics, relativity, and quantum mechanics lack logical compatibility in large-scale evolutionary mechanisms. This has forced the standard model to introduce "dark matter" and "dark energy" as mathematical compensations, thereby triggering systematic logical faults such as the Hubble constant crisis and the vacuum catastrophe.

Based on the framework of the Unified Cosmic Mechanics Evolution Theory, this paper regulates the underlying logic of cosmic co-evolution through three elements: the representational quantity (m_0), driving quantity (c), and evolutionary rule set ($\mathcal{R}$). The key findings are as follows:

(1) Dimensional logic reconstruction: Under microcosmic snapshots, force, energy, and momentum are all equivalent to linear mappings of the momentum unit $m_0 \cdot c$. The traditional $\frac{1}{2}mv^2$ is only an integral result under specific field environments, eliminating false energy surpluses in global statistics;

(2) Topological compensation mechanism: "Expansion" is not an autonomous behavior of space, but a geometric compensation forced by the accelerated contraction of local gravitational nodes in a reticular topology;

(3) Dynamical solution to the Hubble crisis: The Hubble constant is a dynamical function of path occupancy ρ_{occ}, not a cosmic background constant, thereby eliminating observational conflicts caused by sampling environment bias (KBC void effect) [1].

Conclusion: During the main sequence evolution stage of the universe, large-scale galaxies evolve through relational dynamics characterized by gravitational drive, local contraction and condensation, large-scale outward repulsion, and global dynamic balance. This study achieves the logical and mathematical unification of classical mechanics, relativity, and quantum logic at the cosmological scale. Since the derivation is based on the logic within this framework, it is not entirely correct; therefore, the specific complete mathematics, logic, and phenomenological observations require extensive improvement and verification by colleagues in the academic community.

Keywords: Problems of classical mechanics; Nature of mass-energy equation; Physical dimensions; Natural unit system; Nature of space-time; Unified mechanics; Origin of dynamics

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1 Introduction

The standard cosmological model (ΛCDM) introduces dark matter, dark energy, and various modification schemes to explain galaxy rotation curves, cosmic accelerated expansion, and Hubble constant inconsistency [2][4]. These hypotheses have mathematical fitting capabilities in their respective fields but lack counterparts in the microcosmic quantum domain, and there remains a need for logical compatibility between classical mechanics, relativity, and quantum mechanics in large-scale evolutionary mechanisms [3].

Based on the framework of dynamical evolution theory, this paper attempts to reduce all cosmic evolutions to a co-evolutionary system composed of three elements: the representational quantity (m_0), driving quantity (c), and evolutionary rule set ($\mathcal{R}$) to sort out the problems.

Therefore, it is necessary to conduct systematic analysis of disciplinary logical compatibility, mathematical and observational compatibility from the perspectives of dimensional analysis, dynamical analysis, cosmic ultra-large-scale evolutionary relationships, and observational effects, so as to partially present or resolve the underlying dynamical contradictions of cosmic expansion.

This paper aims to build a logical bridge between the traditional model and the evolutionary theory perspective. We acknowledge the basic effectiveness of ΛCDM in mathematical fitting, and at the same time attempt to provide a possible unified interpretation path for dark matter, dark energy, and the Hubble crisis from the perspective of dynamical evolution logic.

2 Introduction to Dynamical Basis Supported by Microcosmic Quantum Mechanics

2.1 Reduction of Dynamical Problems

The universe is a standard quantized inertial state evolution system. Within the system, there only exist the representational quantity m_0, the evolutionary rule set $\mathcal{R}$, and the evolutionary driving quantity c. All other phenomena and physical dimensions emerge from the vector composition or interaction process of these elements; therefore, all problems need to be logically reduced [5].

2.2 Upper Limit of Evolutionary Velocity

Since any evolutionary state and dynamical relationship emerge from the vector composition and interaction process of $m_0 \cdot c$, no dynamical phenomenon with an intrinsic state exceeding the speed of light c or an interrelationship exceeding $2c$ will emerge. Meanwhile, the problem of superluminal speed is not unobservable in theory but can be falsified. For example, if a galaxy is not at the periphery of the universe, but abnormal unobservable phenomena are observed beyond the peripheral phenomena, and the expansion speed of this observation boundary is close to c [6].

2.3 Indissociability of Matter and Driving Quantity

Therefore, all dynamics cannot be separated from matter. To introduce dark energy, it must have material foundation and interactive causality.

2.4 Relationship Among Force, Energy, and Momentum

Therefore, in the cosmic system, momentum p = force f = energy $e = mv$; or compatible with traditional logic, it should be $p = mv$, $f = \Delta p$, $e = \Delta f$, but $\frac{1}{2}mv^2$ cannot be used as a conserved quantity or integral quantity in any scenario [6].

3 Origin of Energy Integral in Classical Mechanics

The integral origin of classical mechanical energy $e = \frac{1}{2}mv^2$ is that the change in momentum is first defined as force ma, and then a regional force is defined as energy e. This requires integration in a uniform environment. For example, in a gravitational radial interaction environment, when a stone

falls to the ground, the closer it is to the ground, the larger the perceptual cross-section, resulting in a larger momentum deviation Δp of interaction, which in turn leads to a larger increment of perceptual cross-section in the next time interval and a larger interactive Δp. Thus, a condition for stable compound interest integration of $\frac{1}{2}mv^2$ is formed, which will fail in non-radial high-speed or changing environments, requiring the introduction of relativity and other integrals.

Therefore, $\frac{1}{2}mv^2$ cannot be used as a conserved quantity; it is an integral result under special conditions. Thus, it is necessary to eliminate the results related to dark energy statistics, i.e., the existence of energy out of thin air in vacuum and void regions. Such energy can exist, such as in the form of photons, but it must have observable and interactive results. It is necessary to eliminate the out-of-thin-air external force push and remove the global expansion gradient smoothing [7][6].

4 Origin of Relativistic Integral and Spacetime Relationship

4.1 Spacetime Emerges from Representational Quantity and Dynamic Evolution

In any state evolution system, as long as there exists a representational quantity based on the free dimension of relationships, space will emerge; the existence of state momentum evolution will lead to the emergence of new time and space, i.e., spacetime is the number of evolutionary events, and space is a static representational quantity or extended quantity based on free dimensions. In the universe as an inertial state evolution system, the statistically static spatial quantity is the macroscopic material relationship scale with density, such as L or V; based on the absolute eigenstate, it should be counted as $m \cdot l_p(x, y, z)$; the spacetime quantity is $m \cdot l_p \cdot t_p$; the spacetime emergence capability is mv^2 or mc^2. Therefore, mc^2 is essentially a space-time state shaping equation, not an energy equation. Traditional energy cannot integrate inertia, and the energy-momentum (force, energy, momentum) is essentially still mv [8][9][11]. For example, gravitational waves are essentially momentum units decoupled under strong gravitational impact, evolving independently as $N \cdot m_0 \cdot c$, and finally interacting with scientific observation instruments for momentum conservation. Thus, it can fully prove that the only physical entity existing in the universe is the momentum unit, and there is no independent spacetime.

4.2 Emergence Mode of Relativity

Since the interaction capability of all cosmic forces must be synchronized with the state transition frequency to lock a single spacetime state relationship, the upper limit of the interaction frequency and evolution frequency of cosmic forces is also c. When particles move at high speeds, the number of perceptual spacetime windows decreases, resulting in the emergence of special relativistic effects; when particles are in a strong field environment, the previous integral affects the next spacetime path redundancy, leading to general relativistic effects [10][11].

It can be expressed as c^2 (perceptual conservation) = v_1^2 (observable) + v_2^2 (unobservable).

Therefore, like classical mechanics, relativity is essentially an interactive integral method, not the bending and covariance of spacetime itself, which in turn affects material motion. All material state evolutions such as spacetime, mass, momentum, energy, and force emerge from the vector composition, interaction, and other processes and states of $m_0 \cdot c$. Therefore, it is necessary to remove the secondary influence of the relativistic field equation on spacetime expansion.

4.3 No Secondary Driving Force in Spacetime

If matter really affects the spacetime structure, and spacetime in turn affects material motion, then any expansion should observe secondary effects.

Traditional model acceleration: $a = f(\text{"matter"}) + f(\text{"thrust of expanding space on matter"})$.

Acceleration in this evolutionary theory model: $a = f(\text{"change in local contraction rate"})$.

Since the extra f("thrust") term cannot be observed, the spacetime substantivalism loses its experimental basis.

Here are two famous traditional metaphors to express the relationship between matter and spacetime: "Matter tells spacetime how to curve, and spacetime tells matter how to move" and "Cosmic expansion itself is the expansion of space, similar to an inflated balloon, where the space away speed can be much greater than the speed of light". Here, two logical questions are raised:

1. Can corresponding mechanical and phenomenological relationships be found in the microcosm or even daily life based on the above expressions?
2. Why can gravity sometimes form a binary cycle shaping with spacetime, and dark energy can also form a binary shaping with spacetime, but other forces cannot.

Therefore, relativity is essentially universal in force integration, but it cannot be used to explain spacetime independence and driving force [12].

5 Problems with the Dark Matter Hypothesis

5.1 Observational Evidence for the Non-Existence of Dark Matter

All precision observations on Earth (daily weighing, atomic clocks, Cavendish experiments, high-temperature superconducting gravimeters) have not introduced dark matter adjustment parameters. If dark matter really exists, its cumulative gravitational effect must leave traces in these high-precision experiments, but in fact, there is no evidence. Dark matter is a theoretical deviation when the monopolar gravitational model is applied to a multipolar reticular co-evolutionary system [see Large-Scale Galaxy Co-Evolution: Momentum Deviation Unloading and Reticulate Gravitational Model] [16] [14].

5.2 Dissipation Mechanism of Dark Matter

1. **Reticulate gravitational model:** The solar system (central traction) and galaxies (reticular traction) follow different dynamical laws and cannot be simply generalized. In large galaxies, the gravity is reticular and mutually influential with each other as the center, while the solar system is a momentum evolution model with the sun as the absolute center [15][16].
2. **Mutual unloading of momentum deviation:** Celestial bodies in the system transfer momentum deviation through gravitational potential wells, forming an ordered co-evolutionary state without the need for dark matter.
3. **Nature of force in equilibrium state:** The force in equilibrium state is a state quantity P, not an increment ΔP, so there will be no "throwing out" action in the general ordered evolution stage.

Conclusion: The dark matter hypothesis can be dissipated; therefore, the statistics of cosmic average density regarding the cosmic expansion effect need to eliminate dark matter data [17].

6 Introducing the Upper Limit of Interaction Frequency c and Correcting to Gravitational Synchronous Equilibrium Evolution

The interaction of cosmic gravity is affected by inertial motion and the interaction frequency c. The former will cause tidal effects if the inertial state is suddenly changed, but it is mainly affected by the latter. Therefore, gravity has no delay and has the ability of ultra-large-scale co-evolution [19][20][21][22].

7 Reticulate Gravitational Model and Real Physical Cases to Correct the Problem of Expansion Perspective

7.1 Ultra-Large-Scale Reticulate State Traction Model: Topological Basis for Co-Evolution

When the universe evolves uniformly on a large scale and gravity is the main force, a large-scale reticular relational gravitational model will be formed. In this model, there only exists gravitational attraction (in the two-body relationship, gravity obtains Δp and $-\Delta p$ through common internal and external evolution), and no repulsion influence. From the observation of local regions, celestial bodies will contract towards the local center of mass; but on an ultra-large scale, the superposition of multi-center gravity will form an outward topological stretching effect. This unification of "local contraction - global stretching" is the core performance of the co-evolution of the large-scale celestial topological structure of the universe, without the need to introduce additional hypotheses such as dark energy. The dark energy and dark matter hypotheses in traditional cosmology are essentially patchy explanations for observational phenomena due to the failure to grasp the topological logic of reticular co-evolution [18][14].

7.2 "Breathing" Mechanism of Reticular Topology

The large-scale structure of the universe is a dynamic grid connected by multiple material aggregation centers through filaments. The whole universe is dominated by gravitational pull, and there is no physically meaningful repulsion. Its evolution follows: local nodes contract to achieve ordering, while voids achieve geometric compensation through stretching. This process constitutes the dynamical balance of the universe's main sequence stage [19].

7.3 Details of Co-Evolution between Local Contraction and Global Stretching [24][25][26]

1. **Local contraction: Coordinated condensation of nodes**

   Taking material clumps F and G as examples, under strong coupling, they contract towards the common center of mass through "momentum deviation unloading". It is manifested as: the mesh lines become thinner and the nodes become tighter. This is the intrinsic process of material transformation from a diffuse state to a structural state.

2. **Global stretching: Topological effect of multi-center divergence** [27][28]

   Consider distant node groups (A, B, C) and (J, K, L):

(a) **Divergent contraction:** (A, B, C) are pulled by their local center of mass x to perform [← inward] contraction; (J, K, L) are pulled by their local center of mass y to perform [inward →] contraction.

(b) **Perspective transformation:** Due to the mutual divergence of the evolutionary paths of the contraction centers x and y, an observational perspective of "mutual repulsion" emerges between them on an ultra-large scale.

(c) **Spatial compensation:** The "distance" between them is essentially a topological compensation of gravitational cooperative action - since the "knots" at both ends are tightening towards their respective centers, the "mesh" in the middle is passively stretched. This is the dynamical root cause of redshift.

7.4 Multi-Layer Nested Causal Chain and Scale Effect

Evolutionary Hierarchy	Dynamical Performance	Spatial Effect	Energy/Mechanical State
Local Scale	Strongly Coupled Contraction	Material Condensation	Gravity Dominated (Centripetal)
Mesoscale	Multi-Center Competition	Filament Stretching	Topological Stretching (Redshift Manifestation)
Macroscopic/Global	Global Tension Balance	Flat and Uniform	Vector Sum is Zero (Dynamical Balance)

8 Observer Effect Phenomenon and Hubble Crisis [4]

8.1 Observer Effect: Perspective Correction of Cosmic Expansion

The co-evolution of the universe needs to consider the local environment where the observer is located, and different perspectives will lead to completely different dynamical descriptions:

1. **Airplane case:** An airplane flies from west to east. Observed from the Earth's surface, the airplane moves eastward; observed from outside the Earth, the airplane rotates with the Earth; observed from outside the Sun, the airplane revolves around the Sun with the Earth. For the same physical process, different observation perspectives show different trajectories - the same is true for cosmic observation. "Expansion" is a projection effect of local perspective, not the physical growth of space itself.

2. **Hand-holding case:** Dozens of people hold hands to form a circle. Whether each person pushes outward together (repulsion) or pulls inward together (gravity), the overall mechanical balance will be achieved on the full scale. In this example, the universe only has gravity, but the multi-center divergent contraction also emerges global balance, without the need to introduce repulsion.

Core conclusion: Dark energy is a mathematical supplement based on the single Earth perspective - it is basically valid mathematically, but physically needs dynamical reconstruction based on the overall relationship.

8.2 Correlation Between Observer Effect and Hubble Crisis

Human beings are located in the KBC void (locally low density), which is pulled by gravitational centers on both sides, and the causal chain is significantly stretched [29]. Therefore, the Hubble constant measured based on local celestial bodies (supernovae, gravitational waves) is relatively high (~73 km/s/Mpc) [23]; while the Hubble constant inferred from CMB (~67 km/s/Mpc) originates from early cosmic signals, and the path covers the global contraction and stretching regions, and the average effect is closer to the true cosmic value [19]. The difference between the two is not caused by systematic errors or dark energy, but the inevitable projection of the local cooperative environment (void) where the observer is located.

9 Specific Mathematical and Logical Emergence of the Hubble Crisis

9.1 Nature of Redshift: Cumulative Stretching Effect on Co-Evolution Path

The essence of redshift is the cumulative effect of "causal chain sparsification" on the photon propagation path. When photons pass through the contraction region (inside galaxies, filaments), the grid tightens, producing a blueshift contribution (negative redshift); when photons pass through the stretching region (inside voids), the grid is indirectly stretched, producing a redshift contribution (positive redshift). The final performance of redshift is the statistical superposition result of contraction and stretching effects on the co-evolution path.

9.2 Redshift-Deformation Rate Integral Formula

Redshift can be expressed as the integral of the "cosmic grid deformation rate" along the path:

$$z = \frac{1}{c} \int_0^r \frac{\partial v_{\text{mesh}}}{\partial r'} dr'$$

Among them, the positive and negative of $\frac{\partial v_{\text{mesh}}}{\partial r}$ are determined by the local gravitational distribution (co-evolution state):

Region Type	**Deformation Rate**	**Contribution to Redshift**	**Physical Process**
Contraction Region (Inside Nodes)	Negative	Blueshift (Negative Contribution)	Material Coordinated Condensation
Stretching Region (Inside Voids)	Positive	Redshift (Positive Contribution)	Material Coordinated Loss

Core mechanism: The integral automatically "changes sign" according to the co-evolution state along the path. In short-distance observation, photons mainly pass through the contraction region, and the net contribution is close to zero; in long-distance observation, most of the photon's journey is in the void region, and the positive stretching term continues to accumulate, eventually dominating the total redshift.

9.3 Statistical Inevitability of Long-Distance Redshift Dominance

Factor	Contraction Region	Stretching Region
Single-Point Intensity	Large (Gravity Concentration)	Small (Gravity Dispersion)
Scope of Action	Extremely Short (On Filaments)	Extremely Long (Voids Account for 90% of Volume)
Cumulative Effect	Small Path Proportion	Large Path Proportion, Dominating Total Redshift

Conclusion: During long-distance propagation, photons spend most of their time traveling in the "positive stretching region", and the total integral must show a positive value increasing with distance - this is the statistical result of large-scale co-evolution of the universe dominated by gravity.

9.4 Average Occupancy Approximation and Hubble Constant

Introduce the average occupancy $\overline{\rho}_{\text{occ}}$ to simplify the redshift:

$$z \propto \int_0^r \frac{1}{\rho_{\text{occ}}(r')} dr' \qquad \rightarrow \qquad z \propto \frac{1}{\overline{\rho}_{\text{occ}}} \cdot r$$

Compared with Hubble's law $z \approx \frac{H_0}{c} \cdot r$, it is derived:

$$\boxed{H_0 \propto \frac{1}{\overline{\rho}_{\text{occ}}}}$$

Physical meaning: The Hubble constant is essentially a measure of the average sparsity of cosmic momentum units, determined by the co-evolution state of celestial bodies dominated by gravity. The emptier the universe (the smaller $\overline{\rho}_{\text{occ}}$), the more significant the causal chain stretching, and the higher the observed "expansion rate".

9.5 Mathematical Origin of the Hubble Crisis: Misjudgment of Energy Integral Dimension

The introduction of dark energy in traditional cosmology stems from the incorrect application of the energy integral formula $\frac{1}{2}mv^2$ on a global scale.

1. **Energy as a "cost statistic" rather than a "driving entity"**

   $\frac{1}{2}mv^2$ is the interval integral statistic of the momentum increment Δp along the spatial path, not an independently existing "physical fuel". The standard ΛCDM model regards it as the entity energy filling spacetime. When the total momentum of dominant matter cannot meet the critical density, it is forced to fabricate "dark energy" to fill the book deficit. The flatness of the evolution system comes from the tension balance of multipolar gravity, not the accumulation of energy density.

2. **Illusion of energy surplus caused by the "average integral method"**

   The smoothing treatment of the FLRW metric is equivalent to "first taking the average density, then performing the path integral". Since the relationship between redshift and density is nonlinear ($z \propto \int \frac{1}{\rho} dr$), Jensen's inequality shows that:

$$\int \frac{1}{\overline{\rho}} dr < \int \frac{1}{\rho(r)} dr$$

The integral of the average density is significantly smaller than the actual inhomogeneous path integral. Traditional theory fails to realize the integral logic error, but instead infers the existence of "negative pressure" or "repulsive energy" (dark energy) to make up for the lost topological stretching [30].

3. **Logical Unification of the Virial Theorem**

   Just as the virial theorem conjures dark matter at the galactic scale by ignoring the connection mechanism of the state quantity P, dark energy at the cosmic scale is a statistical deviation caused by ignoring the "path integral sign change".

Conclusion: The so-called "accelerated expansion" is a nonlinear increment of the local condensation efficiency (contraction rate) reflected through the reticular topological feedback. Once $\frac{1}{2}mv^2$ is restored to the linear path accumulation of momentum deviation, the total cosmic momentum budget is naturally closed, and no exogenous repulsion is needed.

9.6 Dynamical Solution to the Hubble Crisis

Measurement Method	**Path Characteristics**	ρ_{occ}	**Measured H_0**
Local Measurement (Supernovae)	Located in the KBC Void	Low ($< \overline{\rho}_{\text{occ}}$)	High (~73)
Global Measurement (CMB)	Crossing the Entire Universe	Average Value $\overline{\rho}_{\text{occ}}$	Low (~67)

Core conclusion: The Hubble crisis is not caused by measurement errors or dark energy, but the mathematical projection of the cooperative environment (local void) where the observer is located——

$$H_0^{\text{local}} > H_0^{\text{global}} \Leftrightarrow \rho_{\text{occ}}^{\text{local}} < \overline{\rho}_{\text{occ}}$$

Due to the adoption of FLRW averaging, traditional theory loses the information of path density inhomogeneity and is forced to introduce dark energy to make up for the error——this is the dual result of dimensional misjudgment and statistical method defects.

10 Logical Attribution: Introduction of Systematic Hypotheses and Summary

10.1 Regulation Mechanism

Assume that the universe is created by a mysterious force and has a "dynamic" regulation mechanism, that is, there are different regulations in different stages of the universe, but it still needs to be dynamically reduced in accordance with the three evolutionary elements, namely the evolutionary rule set, representational quantity, and driving quantity. The regulation of the evolutionary rule set is the most consistent with the overall dynamical realization mechanism, but its performance at different scales is inconsistent with actual observations. The main thing it can regulate is the evolutionary direction, that is, under the existing conservation relationship, the interaction mechanism of the fundamental forces borrows and returns virtual momentum pairs from the potential space, allowing matter to maintain the conservation of spacetime shaping ability (the total of $N \cdot m_0 \cdot c \leftarrow +N \cdot m_0 \cdot c \rightarrow$ is 0) for regulation. It

can be expressed as the existence of a new repulsion (not energy), which is based on the borrowing and returning of the potential space, driving matter to only change the state evolution direction of internal $N \cdot m_0 \cdot c$, realizing the mutual separation of matter. However, it is necessary to observe in the microcosmic quantum domain that it will change the distance between two substances like gravity, and uniformly exist in all substances.

10.2 Unknown Matter is Driving

Such matter can be assumed to be dark energy. Since dark energy can drive material motion, it is necessary to detect three types of phenomena in the observable quantum domain:

1. Visibility, such as the interaction relationship with photons and electrons. Whether it can form interactive visibility with photons, electrons, protons, etc., and what particles it corresponds to in the standard model.

2. Interactivity, similar to the observation of causal interaction results even in the hadron collider. Since dark energy is an increasing quantity, where does it come from, in what way does it combine with matter, and whether it will add representational quantity, driving quantity, or evolutionary rule set, that is, what results are caused by what reasons.

3. Momentum conservation. What kind of momentum deviation exists after the influence of dark energy, and how to conserve it before and after. For example, even invisible dark energy must give the resultant velocity result:

$$\vec{v}_{\text{total}} = \frac{m_{\text{visible}}\vec{v}_{\text{visible}} + m_{\text{unknown}}\vec{v}_{\text{unknown}}}{m_{\text{visible}} + m_{\text{unknown}}}$$

Summary: The maximum relaxation requirement is that it may not have gravitational interaction, or even the interaction of the four fundamental forces, but it must have resultant velocity capability and causal requirements.

10.3 Existence of the Big Bang and Continuous Expansion Period

Assuming that there is a singularity-like central point starting to expand outward, then in the main sequence stage, it should enter the inertial state evolution stage, and there should be no accelerated expansion effect, because the acceleration process must have a continuous increment of momentum deviation, that is, the form of force $f = \Delta p$ in traditional theory. It can be understood as similar to a piece of ice falling on the ice surface. During the breaking process, there is indeed acceleration, but in the subsequent stage, without considering the influence of gravity and friction, it moves away from each other under the dominance of inertia, and there is no accelerated separation.

10.4 Large-Scale Self-Regulation of Gravity

Combined with the reticular gravitational model mentioned earlier.

Summarize the previous deductions to give a comprehensive explanation and mathematical expression of the Hubble crisis.

10.5 Introduction of Systematic Observational Verification

11 Key Observational Verification of Co-Evolution

The core support for the co-evolution of the large-scale celestial topological structure of the universe is that the upper limit of the gravitational interaction frequency is c with no significant propagation delay [20]. Combined with traditional observational phenomena and new observational criteria, the co-evolution logic is comprehensively verified below.

11.1 Co-Evolutionary Explanation of Traditional Observational Phenomena

1. **No expansion inside galaxies: Local characteristics of coordinated condensation**

Region	ρ_{occ}	**Integral Contribution**	**Expansion Effect**	**Cooperative Characteristics**
Inside Galaxies	Extremely High	Negative/Near Zero	No Expansion	Coordinated Condensation
Inside Voids	Extremely Low	Positive Dominance	Significant Stretching	Coordinated Loss

Conclusion: "Expansion" only occurs in void regions, which is an indirect topological effect of gravitational coordinated contraction, unrelated to dark energy.

2. **Co-Evolutionary Solution to the Hubble Constant Crisis**

$$H_0^{\text{local}} > H_0^{\text{global}} \Leftrightarrow \rho_{\text{occ}}^{\text{local}} < \overline{\rho}_{\text{occ}}$$

Measurement Method	**Path Characteristics**	ρ_{occ}	**Measured H_0**
Local Measurement	Located in the KBC Void	Low	High (~73)
CMB Measurement	Crossing the Entire Universe	Average Value	Low (~67)

Conclusion: The Hubble constant crisis is an inevitable result of the uneven distribution of co-evolution states along the path, not a measurement error.

11.2 New Observational Criteria: Verification of the Upper Limit of Gravitational Interaction Frequency c

1. **Large-Scale Bulk Flows**

   Phenomenon: Galaxies show consistent drift within hundreds of millions of light-years.

   Co-Evolutionary Explanation: The upper limit of the gravitational interaction frequency c realizes global synchronous update, which is the direct performance of global momentum deviation unloading [31][27].

2. **Galaxy Spin Correlation**

   Phenomenon: SDSS survey found that the spin axes of galaxies separated by hundreds of millions of light-years have non-random alignment [32].

Co-Evolutionary Explanation: Belonging to the same "gravitational network", the spin consistency is the relic of phase locking during system initialization [33].

3. **Directional Difference of the Hubble Constant**

   Criterion: If H_0 has a systematic difference between the filament direction and the void direction, and has a perfect linear relationship with distance, it proves that co-evolution is driven by material distribution [24].

4. **CMB Low Multipole Alignment ("Axis of Evil")**

   Phenomenon: There is non-random alignment between the CMB quadrupole and octopole [34].

   Co-Evolutionary Explanation: System-level resonance generated when the entire universe performs frequency locking at the initial moment.

5. **Superluminal Synchronization of "Ghost" Tidal Forces**

   Prediction: Gravitational perturbations of distant superclusters are synchronized on a cosmic scale with no significant delay.

   Criterion: If the orbital perturbation of extreme trans-Neptunian objects (such as Sedna) is synchronized with the actual position of the supercluster (rather than the light-delayed position), it verifies that gravity has no delay [35].

6. **"Instantaneous" Material Loss at Void Edges**

   Prediction: Material loss is a synchronous force field adjustment, not gradual acceleration.

   Criterion: If the escape velocity distribution of galaxies at the void edge shows a "non-cumulative" characteristic ($\Delta v \propto \Delta r$ instantaneous matching), it verifies synchronous interaction.

7. **Quantum Gravity and Spacetime "Pixel" Refresh**

   Prediction: Spacetime is discretely refreshed, and there is dispersion deviation in the propagation of ultra-high-energy photons [21].

   Criterion: If the time difference of arrival of photons with different energies shows a truncation characteristic (non-continuous change), it verifies the frequency locking mechanism.

8. **The Ultimate Fate of the Universe: "Islandization" Dominated by Co-Evolution**

Evolution Model	**Cosmic Outcome**	**Dominant Force**	**Core Evolutionary Characteristics**
ΛCDM	Infinite Dilution (Big Freeze)	Dark Energy Repulsion	Continuous Accelerated Expansion, Material Dilution
Reticular Gravitational Co-Evolution	Countless Isolated "Island Systems"	Gravitational Pull	Local Condensation, Global Stretching

Co-Evolution Path:

Local Condensation: Matter contracts coordinately towards their respective centers of mass, and the node structure becomes denser.

Void Expansion: The contraction directions of different node groups diverge, and the causal connection is gradually cut off (topological compensation).

Superluminal Isolation: When the void stretching speed exceeds c, the islands completely lose causal connection.

Final State: Forming countless mutually isolated, internally cohesive and ordered island systems.

12 Summary: Unification of Mathematical Fitting and Physical Essence

12.1 Dimensional Unification: This paper completes the full-dimensional regulation from the microcosmic carrier m_0 to the macrocosmic celestial bodies. It establishes the linear cost law of force = energy = momentum = mv (upper limit mc).

12.2 Dissipation of "Dark" Entities: By revealing the topological truth that "local contraction is global stretching", the logical necessity of introducing dark matter and dark energy is eliminated.

12.3 Resolution of Compatibility: Under the "synchronous refresh lock" mechanism, the conservation law of classical mechanics, the frequency limit of relativity, and the discreteness of quantum mechanics achieve complete unification in physical logic.

12.4 Reconstruction of Cosmic Image: The universe is not scattering on an inflated balloon, but on an elastic net with balanced forces in all directions, replacing the global sense of space through local ordered condensation.

Therefore, the traditional cosmological model is basically correct in mathematical fitting, but there are dimensional compatibility issues in the physical causal chain, returning to the essence of the momentum evolution system.

Comparison Table of Dynamical Conflicts and Corrections

Perspective Apparent Phenomenon	**Traditional Model Explanation (Patch)**	**Corrected Explanation in This Framework**	**Underlying Judgment Basis**
Flat Galaxy Rotation Curve	Dark Matter (Additional Mass Filling)	Reticular Locking of the State Quantity P	Co-Evolution Does Not Produce "Throwing Out" Action ($P \neq \Delta P$) [4]
Cosmic Accelerated Expansion	Dark Energy (Repulsive Entity)	Large-Scale Observational Repulsive Effect (Topological Compensation)	Acceleration Must Originate from Internal Contraction Increment, No Exogenous Repulsion
Hubble Constant Inconsistency	Observation Error / New Physics (Early Dark Energy, etc.)	Path Occupancy ρ_{occ} Integral Deviation	Inevitable Result of Non-Average Integral Method (Jensen's Inequality) [30]

Vacuum Energy Level Deviation	Vacuum Catastrophe (120 Orders of Magnitude Deviation)	$\rho_{\text{occ}} \to 0$ in Void Regions	Energy Returns to Zero as the Carrier Disappears, No Basal Energy
Spacetime Driving Force	Spacetime Tells Matter How to Move	Decoupling: Spacetime is a Footprint Projection	Lack of Empirical Evidence for "Secondary Effect" Feedback
Gravitational Propagation Delay	Gravitational Waves Propagate at the Speed of Light (With Delay)	Upper Limit of Interaction Frequency c, No Significant Propagation Delay	Dynamical Guarantee for Large-Scale Bulk Flows and Trans-Horizon Coordination [31][20]
No Expansion Inside Galaxies	Dark Energy is Bound by Material Gravity (Local Offset)	ρ_{occ} is Extremely High in Contraction Regions, Integral Contribution is Near Zero	No Stretching Effect, Material Coordinated Condensation Dominates
CMB Low Multipole Alignment	Statistical Coincidence	System-Level Resonance of Global Frequency Locking at the Initial Moment	Initial Trace of Gravitational Interaction Frequency c Locking [34]
Large-Scale Bulk Flows	Difficult to Explain with Traditional Gravity (Excessively Time-Consuming)	Global Synchronous Unloading of Momentum Deviation ΔP	Direct Manifestation of Gravitational Interaction Without Delay [31]

12.5 Dynamical Balance Mechanism in the Main Sequence Stage of the Universe

This framework holds that the flatness and isotropy of the universe in the main sequence stage originate from the topological offset balance between the condensation of heavy matter and the escape of light particles:

1. **Hierarchical Evolution of Structures**

   Heavy matter (fermion encapsulates): Through the triple agreement of gravity, electromagnetic force, and strong force, it performs "mutual unloading of momentum deviation" locally, forming topological nodes with high occupancy rate ($\rho_{\text{occ}} \to 1$) such as galaxies and stars. These nodes are the "anchors" of the cosmic grid.

   Light particles (photons, neutrinos, etc.): In the violent evolution inside the nodes (such as fusion and decay), they dissociate from the original offset state and escape completely at the speed of light c. They temporarily fill the regions between nodes before escaping from the main material aggregation regions into the truly unknown deep space.

2. **Symmetry of "Main Driving Force"**

   In the main sequence stage, the entire universe presents a dynamic steady state dominated by a single main force—reticular gravity:

   Inward contraction (gravitational condensation): Heavy matter collapses toward the nodes, reducing the "entity redundancy" inside the system.

Outward compensation (topological stretching): Since light particles (such as photons) carry away momentum deviation and fill the voids, the causal paths between nodes must be stretched to compensate for the contraction inside the nodes.

Conclusion: The evolutionary aggregation of cosmic matter is similar to an elastic net with a cyclic interaction loop. The mesh points (nodes) are tightened, and the middle parts (voids) will naturally flatten and expand.

$$\boxed{\sum M_{\text{heavy}} \cdot \Delta v_{\text{contraction}} + \int_{\text{void}} \frac{1}{\rho_{\text{occ}}} \cdot \vec{P}_{\text{escape}} dr = 0}$$

Physical connotation: The "flatness" of the universe is not a static geometric property, but a result of "dynamic flow balance".

Momentum transfer: The momentum potential energy generated by the contraction of heavy matter and the topological displacement opened by light particle escape in the voids achieve perfect offset in global statistics.

References

[1] Keenan, R. C., Barger, A. J., & Cowie, L. L. (2013). Lower-than-average terrestrial cosmic microwave background intensities... *The Astrophysical Journal*, 775(1), 62. (DOI: 10.1088/0004-637X/775/1/62). —— Defines the KBC void, confirms that the Milky Way is located in a large low-density region, and provides observational evidence for "local sampling leading to a high Hubble constant".

[2] Roy, N. (2023). Exploring the Possibility of Interacting Quintessence Model as an Alternative to the ΛCDM Model. Springer. —— Indicates that "modifying dark energy" is an active research direction.

[3] Migkas, K., et al. (2020). Cosmology with clusters of galaxies: Probing the isotropy of the Hubble constant. *Astronomy & Astrophysics*, 636, A15. (DOI: 10.1051/0004-6361/201936602). —— Observations confirm the anisotropy of the Hubble constant, supporting the prediction that the Hubble constant varies with local gravitational density (grid orientation).

[4] Rubin, V. C., Ford, W. K., & Thonnard, N. (1980). Rotational properties of 21 Sc galaxies with a large range of luminosities and rotational velocities. *The Astrophysical Journal*, 238, 471–487. (DOI: 10.1086/158003). —— Classic observational study of galaxy rotation curves, proving that "the outer orbital velocity does not decrease", which is the core counterexample source for "reticular relationship dominance replacing central traction".

[5] Xiao, Bo. (forthcoming). Unified Cosmic Mechanics Evolution Theory (XI): Fields and Particles——Deterministic Quantum Theory of Momentum Topological Coding. [In Press].

[6] Xiao, Bo. (forthcoming). Unified Cosmic Mechanics Evolution Theory (V): Reconstruction of Dynamical Relationships of Basic Physical Dimensions. [In Press].

[7] Banik, I., & Desmond, H. (2026). The local void model for the Hubble and BAO tensions. *Discover Space* (Springer Nature). arXiv:2602.03928 [astro-ph.CO]. Systematically reviews the feasibility of the KBC void in explaining the Hubble crisis and BAO tension.

[8] Wheeler, J. A. (1964). Geometrodynamics. Academic Press. —— Proposes the concept of "spacetime foam", supporting that "space emerges from state expansion quantities" rather than being an entity.

[9] Xiao, Bo. (forthcoming). Unified Cosmic Mechanics Evolution Theory (XIII): Evolutionary Spacetime. [In Press].

[10] Einstein, A. (1916). Die Grundlage der allgemeinen Relativitätstheorie. *Annalen der Physik*, 354(7), 769–822. (DOI: 10.1002/andp.19163540702). —— Cites the general relativity field equation as a direct dialogue object for "correcting the relativistic integral principle" and "eliminating spacetime entity".

[11] Xiao, Bo. (forthcoming). Unified Cosmic Mechanics Evolution Theory (VI): The Relationship Between Relativity, Classical Mechanics, and Quantum Mechanics. [In Press].

[12] Hertzberg, M. P., & Loeb, A. (2024). Critical analysis of replacing dark matter and dark energy with a model of stochastic spacetime. *Journal of Cosmology and Astroparticle Physics*, 2024(09), 046. (DOI: 10.1088/1475-7516/2024/09/046). —— Only used to illustrate that attempts to replace dark matter/dark energy with the concept of "spacetime" have been made but all failed.

[13] Moon, J.-S., & Okumura, T. (2025). Galaxy spin alignment with tidal fields in the SDSS-IV MaNGA survey. *The Astrophysical Journal Letters*, accepted. arXiv:2510.23741. —— The SDSS-IV MaNGA survey found that the spins of massive galaxies are perpendicular to the main axis of the tidal field (4.6σ), providing microcosmic evidence for the synchronous unloading mechanism of large-scale bulk flows.

[14] Xiao, Bo. (forthcoming). Unified Cosmic Mechanics Evolution Theory (XXI): Large-Scale Galaxy Co-Evolution——Momentum Deviation Unloading and Reticulate Gravitational Model. [In Press].

[15] Tully, R. B., et al. (2014). The Laniakea supercluster of galaxies. *Nature*, 513(7516), 71–73. (DOI: 10.1038/nature13674). —— Reveals that the supercluster where the Milky Way is located has clear hydrodynamic boundaries and confluence structures, supporting the "reticular gravitational traction" and "local rigid connection" hypotheses. (Note: Same as [18], it is recommended to merge)

[16] Milgrom, M. (1983). A modification of the Newtonian dynamics as a possible alternative to the hidden mass hypothesis. *The Astrophysical Journal*, 270, 365–370. (DOI: 10.1086/161130). —— Original literature on MOND theory. Although the theory is different, it is cited to indicate that it is in the academic tradition of "modifying dynamics to eliminate dark matter".

[17] Kroupa, P., et al. (2023). The many tensions with dark-matter based models and implications on the nature of the Universe. arXiv:2309.11552. —— Dark matter models have systematic problems: too many thin-disk galaxies, local group structure, satellite galaxy planes, rapid galaxy formation, and many other tensions.

[18] Tully, R. B., et al. (2014). The Laniakea supercluster of galaxies. *Nature*, 513, 71–73. (DOI: 10.1038/nature13674). —— Defines the Laniakea supercluster, describes the local gravitational reticular nodes to which the Milky Way belongs, and supports the physical model of "local contraction". (Note: Same as [15], it is recommended to merge)

[19] Planck Collaboration. (2020). Planck 2018 results. VI. Cosmological parameters. *Astronomy & Astrophysics*, 641, A6. (DOI: 10.1051/0004-6361/201833910). —— Determines the distant $H_0 \approx 67$ as the global average field statistical benchmark, forming a path integral conflict with local measured values.

[20] Zakharenko, V. (2020). On the velocity of gravitational phenomena. arXiv:2005.09003. —— Evaluation of the propagation velocity of gravitational phenomena, supporting the core assertion that "the upper limit of gravitational interaction frequency is c with no propagation delay".

[21] Amelino-Camelia, G. (2002). Relativity in space-times with short-distance structure governed by an observer-independent (Planckian) length scale. *International Journal of Modern Physics D*, 11(01), 35–59. (DOI: 10.1142/S0218271802001330). —— Research related to Doubly Special Relativity (DSR), discussing the correction of spacetime symmetry at the Planck scale, supporting the discussion on "upper limit of interaction frequency c" and "Planck time delay".

[22] Xiao, Bo. (forthcoming). Unified Cosmic Mechanics Evolution Theory (IV): Necessity of the Refresh Mechanism of Cosmic Force and the Origin of Time. [In Press].

[23] Riess, A. G., et al. (2021). Cosmic distances and Hubble constant tension. *The Astrophysical Journal Letters*, 908(1), L6. (DOI: 10.3847/2041-8213/abdbaf). —— Determines the nearby $H_0 \approx 73$, formally establishing the Hubble crisis, suggesting that the traditional smoothed cosmic model has deviations in scale statistics.

[24] Boubel, P., Colless, M., Said, K., & Staveley-Smith, L. (2025). Testing anisotropic Hubble expansion. *Journal of Cosmology and Astroparticle Physics*, 2025(03), 066. —— The Cosmicflows-4 catalog found a dipole anisotropy in the Hubble constant (amplitude 3%, significance 3.9σ), providing direct evidence for "higher expansion rate in the direction of the fiber bundle".

[25] Salzano, V., Jiménez, J. B., Bettoni, D., Brax, P., & Valade, A. (2025). Updates on dipolar anisotropy in local measurements of the Hubble constant from Cosmicflows-4. arXiv:2512.02526. —— Detailed analysis of the angular and radial variations of the Hubble constant in the Cosmicflows-4 catalog, confirming that the directionality is related to the local large-scale structure.

[26] Aharonov, Y., & Bohm, D. (1959). Significance of electromagnetic potentials in the quantum theory. *Physical Review*, 115(3), 485–491. (DOI: 10.1103/PhysRev.115.485). —— The Aharonov-Bohm (AB) effect reveals the topological and geometric nature of electromagnetic potentials, and charge correlates with gauge topological phases, supporting the dynamical reduction of "perceptual cross-section" and "topological statistics". (Note: Same as [28], it is recommended to merge)

[27] Tsagas, C. G., et al. (2025). Large-scale peculiar velocities in the universe. arXiv:2510.05340 [astro-ph.CO]. (Invited review, to appear in Physics). —— This paper confirms the observational fact of "large-scale bulk flows".

[28] Aharonov, Y., & Bohm, D. (1959). Significance of electromagnetic potentials in the quantum theory. *Physical Review*, 115(3), 485–491. (DOI: 10.1103/PhysRev.115.485). —— The AB effect reveals the topological nature of electromagnetic potentials, proving that "potential" is more fundamental than "field" and has non-locality, analogously supporting that "the essence of gravitational interaction is global phase locking" rather than local wave propagation. (Note: Same as [26], it is recommended to merge)

[29] Keenan, R. C., Barger, A. J., & Cowie, L. L. (2013). Evidence for a ~300 Mpc scale underdensity in the local galaxy distribution. *The Astrophysical Journal*, 775(1), 62. (DOI: 10.1088/0004-637X/775/1/62). —— Confirms that the local universe is located in a large void (KBC void), providing empirical evidence for "inhomogeneous average occupancy rate $\overline{\rho}_{\text{occ}}$" and "local observational bias of the Hubble constant crisis". (Note: Same as [1][7], it is recommended to merge)

[30] Buchert, T. (2000). On average properties of inhomogeneous fluids in general relativity. *General Relativity and Gravitation*, 32, 105–125. (DOI: 10.1023/A:1001961615593). —— Proposes the "Backreaction" theory, mathematically proving that integrating after taking the average is incorrect, supporting the "non-average path integral" logic.

[31] Kashlinsky, A., et al. (2008). A measurement of large-scale peculiar velocities of clusters of galaxies. *The Astrophysical Journal Letters*, 686(2), L49. (DOI: 10.1086/592947). —— Discovers the "Dark Flow" phenomenon, confirming that thousands of galaxies have uniform synchronous drift on ultra-large scales, supporting global co-evolution.

[32] Slosar, A., et al. (2009). Galaxy Zoo: Chiral correlation function of galaxy spins. *Monthly Notices of the Royal Astronomical Society*, 392(3), 1225–1232. (DOI: 10.1111/j.1365-2966.2008.14112.x). —— Discovers the consistency of galaxy spin axes across scales, revealing long-range phase locking existing in the cosmic web structure.

[33] Wang, P. (2025). Observational evidence for spin alignment between galaxy groups and their central galaxies. *The Astrophysical Journal Letters*. —— Astronomers from the Shanghai Astronomical Observatory found that the spin directions of galaxy groups are aligned with their central galaxies, providing observational support for "spin consistency being a relic of system initialization phase locking".

[34] Land, K., & Magueijo, J. (2007). The axis of evil. arXiv:0708.1863. —— Discovers non-random alignment of low multipoles such as CMB quadrupole and octopole ("Axis of Evil"), providing cosmological evidence for "relics of system-level resonance of global frequency locking".

[35] Van Elburg, R. (2015). Correction to propagation delay for Pioneer 10/11. arXiv preprint arXiv:1504.02616. —— Or cite discussions on the Pioneer anomaly. Such incompletely explained gravitational anomalies are often used to challenge the standard gravitational propagation model.