# Unified Cosmic Mechanics Evolution Theory (XXI) : Large-Scale Galaxy Co-Evolution: Momentum Deviation Unloading and Reticulate Gravitational Model

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## Abstract

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

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

Based on the framework of Momentum Unit Evolution Theory, this paper re-examines the co-evolution mechanism of large-scale galaxies and the problem of dark matter existence. By introducing the principles of ”local rigid connection” and ”mutual unloading of momentum deviations”, a new model is proposed that explains the flatness of galaxy rotation curves without the need for dark matter, and dark matter is inconsistent with extensive statistics. This model shares the same underlying logic as the formation mechanisms of ordered structures commonly found in nature (synchronized pendulums, crystal growth, geometric patterns, etc.) — each unit in the system mutually unloads excess momentum deviations through interactions, ultimately achieving a co-evolution state with consistent phases [1] [2]. This mechanism requires no dissipation, no information exchange, and only appropriate constraint conditions (such as gravitational potential wells) to be realized. This paper also distinguishes the essential differences between the feedback-based ordered structures of living systems and the momentum deviation unloading mechanism of physical systems, providing a unified perspective for understanding the self-organization phenomena of the universe from the microcosm to the macrocosm.

**Keywords:** Reticulate Gravity; Dark Matter; Rotation Curve; Newtonian Gravity Correction; Galaxy Co-Evolution; Dark Matter Contradiction; Unified Mechanics

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# 1 Introduction

## 1.1 A Fundamental Premise Ignored by Traditional Theories on Dark Matter

This paper clarifies its core viewpoint at the outset: dark matter does not exist. The fundamental basis for this conclusion is that the solar system is also located in the outer region of the Milky Way, yet all gravity-related calculations, observations, and experiments on Earth can achieve perfect fitting without introducing dark matter. This key logic has long been ignored by traditional galaxy evolution theories, which constitutes a major contradiction.

From an everyday perspective, when we weigh objects on Earth, the gravity calculated according to existing gravitational theories is completely consistent with the measured results, and there is no need to consider the gravitational contribution of dark matter; from astronomical observations, the orbital calculations of all planets in the solar system and the orbital control of satellites can be accurately derived only through known celestial masses and gravitational laws, and there has never been a need to introduce dark matter to supplement due to ”insufficient gravity”, which has also been confirmed by relevant high-precision observation experiments [3,4,5]; from micro-precision experiments, the electron transition period of atomic clocks strictly follows existing gravitational theories and quantum mechanical laws, and their high-precision operation is not disturbed by any unknown gravitational sources (dark matter). If dark matter existed, its cumulative gravitational effect would inevitably lead to observable

deviations in the electron transition period, but no such signals have been captured by all precision experiments to date.

### 1.2 Rationale for Introducing Dark Matter in Traditional Theories

However, since Vera Rubin discovered the anomaly of galaxy rotation curves through spectral observations in the 1970s [6], the dark matter hypothesis has become the mainstream direction in astrophysics to explain this phenomenon. Subsequent observational data on the rotation curves of hydrogen atoms in a large number of galaxies have further confirmed the universality of flat rotation curves [7], which has further increased the support for the dark matter hypothesis. Based on the Newtonian gravity formula $v = \sqrt{GM(r)/r}$, the traditional model infers that the velocity of stars in the outer regions of galaxies should decrease with distance, but observations show that the rotation curve is flat or even rising. This leads to two inferences: (1) there exists a large amount of invisible mass (dark matter); (2) the gravitational law needs to be corrected (such as MOND theory [8]).

### 1.3 The Unsustainability of the Dark Matter Hypothesis

Both inferences imply a common premise: gravity is mainly provided by the galactic center, and stars are mainly subject to central gravitational force. This premise holds in the solar system (the sun accounts for 99.86% of the total mass), but whether it still holds in galaxies with widely distributed mass has never been strictly tested. More importantly, traditional theories ignore a core logic: since all gravitational phenomena on Earth and in the solar system can be explained by known masses and gravitational laws without dark matter, gravitational phenomena on the galactic scale should also be explainable by a more reasonable gravitational interaction mechanism, rather than introducing an "unknown substance" that is completely traceless in short-range gravitational scenarios. The development, basis, and current status of the dark matter hypothesis have been detailed in authoritative reviews [9], but its core misunderstanding has not yet been resolved.

### 1.4 Reconstructing the Galactic Model Based on the Evolution Theory Proposed in This Paper

Starting from the Momentum Unit Evolution Theory, this paper proposes a more fundamental perspective: gravity is local, reticulate, and nested layer by layer, rather than central, long-range, and unipolar. This perspective naturally leads to the mechanism of flat rotation curves, without the need for dark matter or modification of gravity, which is consistent with gravitational observations on Earth and in the solar system, and also unified with the formation principles of ordered structures commonly found in nature [2,12].

## 2 Core Mechanisms: Local Rigid Connection and Mutual Unloading of Momentum Deviations

### 2.1 Basic Elements of Momentum Unit Evolution Theory

According to previous work, the Momentum Unit Evolution Theory establishes three basic elements:

| Element | Symbol | Essence | Physical Significance |
|---|---|---|---|

| Number of Carriers | $N$ | Total number of momentum units | Mass $m = N$ |
|---|---|---|---|
| Basic Potential Energy | $c$ | Evolution amplitude of a single unit | Speed of light, benchmark of interaction capability |
| Directional Proportion | $\lambda$ | Proportion of units with the same direction | Velocity $v = \lambda c$ |

Key Inference: The upper limit of the total interaction capability of each particle is $mc$, and interaction resources are preferentially allocated to neighboring particles (since the interaction intensity is proportional to $1/r^2$) [13].

### 2.2 Formation of Local Rigid Connections

Assume that the total interaction capability $mc$ of a particle needs to be allocated to all interaction objects:

$$mc = \sum_i \frac{k}{r_i^2}$$

This implies:

- A large amount of resources are allocated to short-range interactions → strong coupling
- Very few resources are allocated to long-range interactions → weak coupling

Result: Each particle mainly forms strong coupling with surrounding substances, nested layer by layer, and ultimately forms a local rigid connection network of the entire system. This is not a "unipolar gravity" dominated by the center, but a "multipolar gravity" coordinated by the entire network. This mechanism is completely consistent with the logic of gravitational interaction on Earth and in the solar system — the gravity received by the Earth mainly comes from the sun (short-range strong coupling), rather than dark matter in distant galaxies (long-range weak coupling can be ignored); the gravity received by objects on the Earth's surface mainly comes from the Earth (short-range strong coupling), rather than unknown masses outside the solar system. This is also the core reason why dark matter is not needed in daily gravity calculations. For the basic derivation of the gravitational potential and rotation curve of the galactic disk, refer to the detailed discussions in classic works [14,15,16,17], whose core logic is consistent with the view that local gravity is dominant.

### 2.3 Principle of Mutual Unloading of Momentum Deviations

The initial state of the system often has a random distribution of momentum deviations (such as random phases of pendulums, random orbits of galaxies). When there are common constraints (such as the suspension base of pendulums, the gravitational potential well of galaxies), the units mutually unload excess momentum deviations through interactions, and ultimately reach a consistent state. This principle has been fully verified in the research on coupled oscillators and synchronization phenomena [18,19,20], and its mathematical and physical foundations have also been systematically elaborated by authoritative scholars [2] [20].

Mathematical Expression:

Assume the system has $n$ units with initial momentum deviations $\{\Delta p_1, \Delta p_2, ..., \Delta p_n\}$ and a total sum $\sum \Delta p_i = P$ (conserved). Through interactions, momentum deviations are transferred between units:

$$\Delta p_i(t+1) = \Delta p_i(t) + \sum_{j \neq i} J_{ij}(\Delta p_j - \Delta p_i)$$

When the coupling strength $J_{ij}$ is sufficiently large and the number of interactions is sufficient, the system reaches:

$$\Delta p_1 = \Delta p_2 = ... = \Delta p_n = P/n$$

This is co-evolution — phases, frequencies, and directions tend to be consistent.

# 3 Evolutionary Explanation of Galaxy Rotation Curves

## 3.1 Implicit Assumptions of the Traditional Model

Rotation curve derived from Newtonian gravity:

$$v(r) = \sqrt{\frac{GM_{\text{center}}}{r}}$$

**Implicit assumptions:**

- Mass is concentrated at the center
- Peripheral mass is negligible
- Peripheral stars are only subject to central gravity

The fatal flaw of this assumption is the unreasonable generalization of the special scenario of "central mass dominance" in the solar system to the scenario of galaxies with widely distributed mass, while ignoring the basic logic of "short-range local gravity dominance" that has been fully verified on Earth and in the solar system — just as the Earth is not mainly dominated by the gravitational force of the galactic center (otherwise it would be dragged out of its existing orbit), stars in the outer regions of galaxies are also not mainly dominated by the gravitational force of the galactic center, but by the coordinated gravitational effect of surrounding local substances. The high dependence of current mainstream cosmological models on dark matter [21] is essentially the result of this unreasonable assumption.

## 3.2 Actual Mass Distribution of Galaxies

Typical spiral galaxies:

- Bulge mass accounts for 10-30%
- Disk mass accounts for 70-90%

- Peripheral regions: mass is mainly contributed by the disk

For a star at radius $r$, the gravity it receives comes from:

- Internal mass $M_{\text{in}}(r)$ (including the center and the inner part of the disk)
- External mass $M_{\text{out}}(r)$ (outer part of the disk) — according to Newton's shell theorem, the gravity inside an external uniform spherical shell is zero, but the galactic disk is not spherically symmetric, so the external disk still has a contribution

A more accurate calculation needs to consider the disk mass distribution:

$$v^2(r) = \frac{G}{r} \int_0^r \frac{dM}{dr'} \cdot f(r/r') dr'$$

where $f$ is the disk gravity enhancement factor. This calculation logic is consistent with the derivation in classic galactic dynamics works [14], and also consistent with the mass distribution characteristics reflected by a large number of galaxy observation data [7].

### 3.3 Dominant Role of Local Rigid Connections

In the framework of the Evolution Theory, the stellar velocity is determined by the local mass distribution:

$$v(r) \approx \sqrt{\frac{GM_{\text{local}}(r)}{r}}$$

where $M_{\text{local}}(r)$ is the mass near radius $r$, not the central mass. This logic is completely consistent with the calculation of the gravity of objects on the Earth's surface — the gravity of an object is only determined by the local mass of the Earth (surface and internal mass), not solely dominated by the core mass at the Earth's center, nor does it need to consider the influence of external celestial bodies or dark matter.

For an exponential disk mass distribution:

$$\rho(r) = \rho_0 e^{-r/r_d}$$

The calculation shows:

1. When $r \ll r_d$: $M_{\text{local}}(r) \propto r^3 \to v \propto r$ (rising segment)
2. When $r \sim r_d$: $M_{\text{local}}(r) \propto r^2 \to v \approx$ constant (flat segment)
3. When $r \gg r_d$: $M_{\text{local}}(r) \to$ constant $\to v \propto 1/\sqrt{r}$ (Keplerian descending segment)

This is exactly the observed typical rotation curve [6,7]! No dark matter is needed; only mass distribution and local gravity dominance need to be considered, which is consistent with the law of gravitational interaction on Earth and in the solar system.

### 3.4 Why Don't the Peripheral Regions "Fly Out"?

The traditional model worries about "flying out" because it assumes that all gravity comes from the center. The central gravity decays with $1/r^2$, while the centrifugal force $v^2/r$, if $v$ is constant, decays with $1/r$, which decays more slowly $\rightarrow$ insufficient centripetal force.

Evolutionary model:

- Peripheral stars are subject to local gravity from all directions
- The resultant force of these gravitational forces points to the local mass center
- The local mass center moves together with the stars
- The overall rotation is the result of the coordination of the entire network, not the pull of the center

Analogy: A rotating rigid disk, the edge particles will not be thrown out — because the centripetal force provided by adjacent particles is sufficient. This is consistent with the logic that the Earth will not be thrown out of the solar system: the centripetal force received by the Earth comes from the short-range strong coupling gravity of the sun, not the superposition of gravity from distant celestial bodies, and there is no need for dark matter to supplement gravity. Regarding the stability of the galactic disk, classic studies have explored relevant mechanisms [22], whose core logic echoes the view that local rigid connections maintain the stability of the disk.

## 4 The Principle of Momentum Deviation Unloading in Nature

The co-evolution of galaxies is not an isolated case, but a manifestation of the universally existing principle of mutual unloading of momentum deviations in nature. The following phenomena can all be explained by the same mechanism, without introducing unknown entities, and consistent with the logic of the Earth's gravitational scenario:

### 4.1 Synchronized Pendulums

Phenomenon: Multiple pendulums hanging on the same movable base have random initial phases and swing synchronously after a period of time.

Mechanism:

- The base provides common constraints
- Each pendulum exerts a small disturbance on other pendulums through the base
- These disturbances are transmitted to each other, gradually unloading phase deviations
- Finally, all pendulums are in the same phase

Mathematics: Coupled oscillator equation

$$\ddot{\theta}_i + \omega^2 \theta_i = \sum_j K_{ij}(\dot{\theta}_j - \dot{\theta}_i)$$

After a sufficiently long time, all $\theta_i(t)$ tend to be in phase. The original discovery of this phenomenon can be traced back to classic research [18], and subsequent experimental and theoretical studies have further verified this mechanism [19,23].

### 4.2 Crystal Growth

Phenomenon: Disordered atoms form regular lattices during the cooling process.

Mechanism:

- Random motion of atoms has momentum deviations
- When the temperature decreases, the interaction between atoms dominates
- Atoms mutually unload excess momentum deviations through collisions
- If the unloading is successful, the atoms are locked in the lattice positions with the lowest energy
- If the unloading is not complete, defects are formed or growth continues

Key point: The crystal structure is the equilibrium state after the unloading of momentum deviations, not a product of dissipation. Dissipation (heat release) is a by-product of the unloading process, not the cause of order.

### 4.3 Geometric Patterns (Desert Ripples, Snowflakes)

Phenomenon: Wind-formed sand dunes form regular ripples; water vapor condenses to form hexagonal snowflakes.

Mechanism:

- Initial random disturbances have various wavelengths
- Certain wavelengths are enhanced by positive feedback
- Other wavelengths are suppressed (unloading excess momentum deviations)
- Finally, the dominant pattern with the most stable wavelength is formed

Essence: This is the redistribution of momentum deviations in the spatial frequency domain.

### 4.4 Interference Waves

Phenomenon: Two waves meet to form interference fringes.

Mechanism:

- Waves are flowing momentum currents
- When they meet, the momentum currents interfere with each other
- The interference result is the intermediate state distribution of momentum deviations
- If excess momentum is radiated outward after interference, standing waves are formed (similar to crystals)
- If momentum is converted internally after interference, phase convergence is formed (similar to synchronization)

### 4.5 Macroscopic Rotation (Planets, Galaxies)

Phenomenon: Isolated systems often form overall rotation.

Mechanism:

- Initial fragments have random angular momentum
- Angular momentum is transferred between each other through collisions
- Angular momentum deviations are mutually unloaded
- Finally, an overall consistent angular momentum direction is formed

This is exactly the process of galaxy formation — random orbits gradually unload deviations through gravitational interactions, and ultimately form a coordinately rotating disk, which is completely consistent with the formation logic of planetary orbits in the solar system, without the participation of dark matter. The orbital resonance and angular momentum distribution mechanisms of celestial bodies in the solar system [24,25,26,27] further confirm the role of momentum deviation unloading in celestial evolution.

## 5 Re-examining the Concept of ”Dissipation”

### 5.1 Limitations of Traditional Dissipation Theory

The traditional view holds that: ordered structures require energy dissipation (such as Prigogine's dissipative structure theory [28]).

**But the above examples show that:**

- Synchronized pendulums: Almost no energy dissipation
- Crystal growth: Heat release is a by-product, not the cause
- Galaxy formation: Gravitational interactions have almost no dissipation

Problem: Dissipation theory ignores the ”process of mutual unloading of momentum deviations through multiple collisions” and ”constraint conditions (such as gravity constraints)”. This neglect is similar to the misunderstanding of the traditional dark matter hypothesis — both fail to attach importance to the basic law of ”local interaction dominance” that has been verified in the Earth's scenario.

### 5.2 Momentum Deviation Unloading vs. Dissipation

| Characteristics | Momentum Deviation Unloading | Dissipation |
|---|---|---|
| Energy Change | Total amount remains unchanged, redistributed | Total amount decreases |
| Process | Multiple interactions | Single irreversible |
| Result | Coordinated state | Thermal equilibrium |
| Conditions | Common constraints | Open system |

**Core Differences:**

- Unloading is the formation process of order
- Dissipation is the final static result

Galaxy formation: Unloading momentum deviations through gravitational interactions → forming coordinated rotation → eventually reaching static state through dissipation (but galaxies are not static and still evolving)

### 5.3 No "Information Protocol" Between Non-Molecules

It should be emphasized that this coordination is not due to an "information protocol", but due to common constraint conditions and the physical mechanism of mutual transmission of momentum deviations.

- Pendulum synchronization: Coupling through the base
- Crystal growth: Through lattice potential field
- Galaxy rotation: Through gravitational potential well

Constraint conditions provide channels for interaction, enabling the redistribution of momentum deviations within the system. This mechanism also applies to the Earth's scenario — the gravity coordination of objects on the Earth's surface is realized through the constraint condition of the Earth's gravitational potential well, without the participation of dark matter. Authoritative research in the field of coupled oscillators has also confirmed that system synchronization can be achieved only through coupling without information exchange [20].

## 6 Dark Matter Inference: Why It Is Not Needed

### 6.1 Local Rigid Connection Explains Rotation Curves

According to the derivation in Section 3, after considering mass distribution and local gravity dominance, the rotation curve is naturally flat:

$$v(r) \approx \sqrt{\frac{GM_{\text{local}}(r)}{r}} \approx \text{constant}$$

This has the same fitting effect as the dark matter model, but does not require the introduction of new entities. More importantly, this explanation is consistent with the law of gravity on Earth and in the solar system — local mass dominates gravitational interaction, and no unknown mass is needed for supplementation. A large number of galaxy observation data [7] also support this explanation, and the observation results can be fitted without introducing dark matter.

### 6.2 Explanation for "Faster Periphery"

Some galaxies show an increase in peripheral velocity, which requires careful adjustment of the dark matter density distribution in the traditional model.

**Evolutionary explanation:**

- There may be density waves (spiral arms) in the peripheral regions
- Density waves enhance local gravity
- Or there are unresolved angular momentum deviations in the periphery
- Or the galaxy is in the evolutionary process and has not reached a steady state

### 6.3 Explanation for "Failed Dark Matter Searches"

Decades of experiments have not found dark matter, further confirming its non-necessity:

- Earth experiments: The gravity of uniform dark matter inside the spherical shell is zero, so it cannot be measured; and all daily gravity calculations and precision experiments (atomic clocks [5]) do not require dark matter, indicating that even if it exists, it will not have an impact on short-range gravity, which contradicts the "gravity supplement" logic of the galactic dark matter hypothesis.
- Space experiments: If dark matter exists, it should produce measurable signals (such as gravitational lensing, particle collision signals), but no reliable evidence has been found to date. Authoritative reviews have clearly sorted out various null results regarding the current status of dark matter searches [9].
- Observations: There is no reliable evidence for the existence of dark matter, and its density distribution, particle form, etc. are all theoretical speculations that cannot be verified by actual measurements.

Evolutionary prediction: Dark matter will never be found, because galaxy stability does not require it, and the law of gravity on Earth and in the solar system has proven that dark matter is not a necessary component of the gravitational mechanism.

### 6.4 Dark Matter Dynamics Paradox

If dark matter has the ability to penetrate space-time between substances, then it cannot provide pulling force. If it is said that they cannot form aggregates and can only provide average gravity, on

the contrary, take an example: we grind iron into powder, remove the electromagnetic force that connects them, then use iron powder instead of dark matter, then use a magnet instead of a star after the aggregation of dominant matter, and then use these magnets to absorb these dark matter-representing iron powders without electromagnetic force, then the magnet can completely absorb the iron powder representing dark matter, and there is no need for electromagnetic force to provide aggregation ability. Therefore, according to the dark matter logic, we need to measure the total amount of dark matter when measuring all gravity in the solar system, which is inconsistent with any observation facts.

### 6.5 Reticulate Rigid Connection and mc Interaction Upper Limit

The mc interaction upper limit is the microcosmic basis of local rigid connections:

Each particle has a limited interaction capability of $mc$ and can only form strong coupling with a limited number of objects [10] [11]:

- Strong coupling forms local clusters
- Weak coupling between clusters
- Nested layer by layer to form full-network rigidity

This is the physical root of "local dominance and global coordination", and also the microcosmic explanation for why dark matter is not needed in daily gravity calculations on Earth — the interaction capability of particles is preferentially allocated to neighboring particles, and the coupling between distant dark matter and Earth particles is extremely weak, so its gravitational effect can be ignored. This logic is consistent with the discussion on local gravity and global potential wells in classic galactic dynamics [14].

## 7 Essential Differences Between Living Systems and Physical Systems

### 7.1 Feedback-Based Order in Living Systems

The order of living systems (such as cells, organs, organisms) has:

- Purposefulness: Rules based on genetic information
- Feedback control: Adjust behavior according to state
- Continuous energy input: Far from equilibrium

### 7.2 Essential Differences

| **Characteristics** | **Physical Systems (Galaxies, Crystals)** | **Living Systems** |
|---|---|---|
| Source of Order | Mutual unloading of momentum deviations | Genetic information + feedback |

| Energy | Total amount conserved | Continuous input |
|---|---|---|
| Constraints | External potential field | Internal rules + external environment |
| Evolution Direction | Towards coordinated equilibrium | Towards complex adaptation |
| Information | None (only physical laws) | Yes (DNA, nerves) |

### 7.3 Limitations and Possibilities of a Unified Perspective

Although the formation mechanisms of order in physical systems and living systems are different, they are still unified in momentum unit evolution at the underlying level:

- Living systems are also composed of momentum units
- The feedback mechanism is essentially the regularized unloading of momentum deviations
- Information is the encoded form of constraint conditions

Living systems can be understood as:

A unified group set generated based on rule functions, whose momentum deviation unloading follows specific protocols (genetic, neural), rather than pure physical interactions.

## 8 Conclusions and Outlook

### 8.1 Core Conclusions

1. Dark matter does not exist — it is a mathematical illusion of the "central dominance model". All gravity-related calculations, observations, and experiments on Earth and in the solar system (atomic clocks [5], planetary orbits [4], object weighing, etc.) can be perfectly explained without introducing dark matter. This fundamental logic ignored by traditional theories confirms that dark matter is not a necessary component of the gravitational mechanism.
2. The reason for the flatness of galaxy rotation curves is not dark matter or gravity correction [8], but the dominance of local rigid connections — stars are mainly subject to the gravity of surrounding stars, not central gravity, which is consistent with the law of "local mass dominating gravity" in the Earth's scenario and consistent with a large number of galaxy rotation curve observation data [7].
3. The microcosmic basis of local rigid connections is the mc interaction upper limit — each particle has limited interaction capability and can only form strong coupling with neighboring particles, nested layer by layer to form full-network rigidity, which is consistent with classic galactic dynamics theory [14].
4. Mutual unloading of momentum deviations is a universal mechanism for the formation of order in nature — synchronized pendulums [18,19], crystal growth, geometric patterns, and galaxy rotation all originate from this, and its theoretical basis has been verified by authoritative research [20].

5. Dissipation is not a necessary condition for order — order can be achieved through the redistribution of momentum deviations through multiple interactions, and dissipation is only the final static result, which is in contrast to the limitations of dissipative structure theory [28].

6. The reason why the outer orbital planets in the solar system need a slow orbital speed is that in the solar system, they rely on the sun to provide absolute traction. The solar system does not have the ability of a reticulate model, nor does it have the extensive influence ability of mutual unloading of momentum deviations. In large-scale galaxies, however, it is a reticulate structure, and all stars with considerable mass can form a reticulate gravitational traction radiating outward with themselves as the center. This is not a contribution of dark matter, but a difference in matter distribution. We cannot generalize the phenomena in the solar system to the stable evolution of large-scale galaxies as a whole. Its logic is hidden in the Newtonian gravity formula; the gravity formula is instead convenient for including multi-body relationships and radiation relationships, while the rotation curve formula is essentially a degenerate formula of force lens and also a deflection formula, which is not easy to include multi-body radiation integral relationships. The orbital resonance and angular momentum distribution mechanisms in the solar system [24,25,26,27] further illustrate that there are differences in the evolution logic of celestial systems of different scales. To summarize the logic: mass concentration → central gravity dominance → Keplerian decline; mass dispersion → reticulate gravity dominance → flat curve.

7. In two-body motion, we can directly remove dark matter, because it is extremely difficult to introduce the dark matter factor in two-body motion, and introducing it is already included in the dominant matter and all calculation formulas. In two-body motion,

   (a) How can celestial bodies with equivalent mass stably capture each other's inertial motion into a two-body circular motion system?

   (b) How can small-mass celestial bodies not fall into the primary star or be thrown out?

   This should be the main research entry point to solve the dark matter problem.

### 8.2 Theoretical Significance

- Unifies the microcosm (mc interaction upper limit) and the macrocosm (galaxy rotation)
- Unifies physical systems (galaxies) and complex systems (synchronization, crystals)
- Clarifies the essential difference between "order formation" and "dissipation"
- Provides a new paradigm for understanding the self-organization phenomena of the universe, and solves the contradiction between the dark matter hypothesis and Earth's gravitational observations

### 8.3 Future Directions

1. **Numerical simulation:** Construct a galaxy evolution model based on local rigid connections to reproduce the rotation curve
2. **Observational verification:** Find the direct correlation between local density and rotation velocity in the outer regions of galaxies, which can be studied by combining existing galaxy observation data [7]

3. **Experimental verification:** Design macro analog experiments to verify the principle of momentum deviation unloading, which can refer to the experimental methods related to synchronized pendulums [19]

4. **Extension to living systems:** Explore the relationship between biological order and momentum deviation unloading

# 9 Appendix: Derivation of Key Formulas

## 9.1 Velocity Formula of Local Rigid Connections

Considering a star at radius $r$, its velocity is determined by the local mass distribution:

$$v^2(r) = G \int_0^{\infty} \int_0^{2\pi} \frac{\rho(r', \phi) r' dr' d\phi}{|\vec{r} - \vec{r}'|} \cdot \cos\theta$$

For an axisymmetric disk, it can be simplified to:

$$v^2(r) = \frac{4G}{r} \int_0^{r} \frac{dM}{dr'} \cdot K(r/r') dr'$$

where $K$ is the elliptic integral function. This derivation refers to the relevant methods in classic galactic dynamics works [14].

## 9.2 Momentum Deviation Unloading Equation

Assume the system has $n$ units with momentum deviations $\Delta p_i$ and coupling strength $J_{ij}$:

$$\frac{d\Delta p_i}{dt} = \sum_{j \neq i} J_{ij} (\Delta p_j - \Delta p_i)$$

The total momentum deviation of the system $P = \sum \Delta p_i$ is conserved. In the steady state, all $\Delta p_i = P/n$.

Convergence time scale:

$$\tau \sim \frac{1}{\min(\text{coupling strength})}$$

For galaxies, the coupling strength comes from gravity, and the time scale is equivalent to the orbital period. The theoretical basis of this equation originates from the research on coupled oscillators [20].

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