Unified Cosmic Mechanics Evolution Theory (XIII) : The Nature of Force

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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 thirteenth 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.

To solve the dilemmas of the "propagator paradox" and "spacetime geometrization" in existing physical theories regarding the microscopic mechanism of force, this paper, based on the framework of information dynamics evolution theory, clarifies the nature of force and establishes a unified logical system. Firstly, it argues that force is not an independent entity but a causal inertial state evolution emerging from symmetry breaking through global perception and momentum state exchange of evolutionary carriers under Planck spacetime snapshots. Then, it proposes four core mechanisms to support this conclusion, including the cancellation of resultant velocity principle, equivalence of force and velocity, delay-free and propagator-free interaction, and potential space borrowing and returning mechanism. Finally, it unifies the four fundamental forces into four encapsulation and perception interaction protocols derived from the double c coding and symmetry breaking of momentum units, and clarifies that spacetime is an emergent relational quantity, force is a momentum cooperative trend, and the universe is a precisely cooperative evolution system under discrete causal states [1][2].

Keywords: Nature of force; Generalized equivalence principle; Propagator mechanism; Origin of Planck time; Nature of quantum fluctuation; Origin of mechanics; Origin of gravity

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Introduction

For a long time, scientific theories and predictions about forces in the cosmic system have provided us with precise predictive capabilities, yet we have never fully understood the fundamental mechanisms behind key physical phenomena: why forces exhibit action-at-a-distance and penetrability, why quantum entanglement is instantaneous, why quantum tunneling presents a "physical paradox", and why force, energy, and velocity arise simultaneously without a clear relational framework. Additionally, we are confined to fragmented force action theories—such as propagators, gravitons, the least action principle, Hamiltonian mechanics, and spacetime curvature—that lack a unified foundation. Based on the framework of information dynamics evolution theory and the conclusions of preceding chapters (including the refresh mechanism of time and force, fields and particles, and velocity increase effect [3][4][5]), this paper collectively deduces the unified underlying logic of cosmic forces, clarifying their essence and evolutionary rules.

1 The Nature of Force

1.1 Emergence of Generalized Force

In any state evolution system, forces naturally emerge from the motion and mutual influence of evolutionary carriers. When evolutionary carriers move, natural dimensions such as force, mass, energy, velocity, and information emerge; when evolutionary carriers can form a resultant velocity, resistance

naturally emerges; and when evolutionary carrier A drives BC to move through resultant velocity, force emerges. Therefore, the attraction or repulsion between evolutionary carriers is generated based on the perceptual ability of evolutionary carriers, and then interacts to produce the inertial state of evolutionary carriers or vector cancellation of resultant velocity. The strong "cohesion" and "connectivity" we see between mutual forces emerge from the cooperative motion trend of multiple evolutionary carriers based on perception. The vector resultant velocity of the cosmic system is the cancellation resultant velocity, that is, the constant velocity of evolutionary carriers is c, and the resultant velocity after combination can only be 0-c, and resultant velocities greater than c such as $2c$ cannot be achieved, thus generating resistance and cancellation force.

1.2 Equivalence Principle of Force and Velocity

The core equivalence relationship between force and velocity can be summarized as: the motion trend, resistance trend, tension trend, repulsion trend, and thrust trend of evolutionary carriers are essentially different manifestations of the same momentum interaction process, and the five have equivalence — that is, any one trend can be equivalently converted into the other three through vector conversion of momentum deviation. Their essence is the adjustment of the momentum state of evolutionary carriers under the constraint of resultant velocity. There are no absolutely independent entities of "motion", "resistance", "tension", or "repulsion", only different emergent characteristics from the perspective of observation. A simple mathematical expression is as follows: Let the momentum deviation of the evolutionary carrier be $\Delta\mathbf{p}$, the intrinsic speed be c, and the total momentum be p_{total}, then the equivalent velocity $\mathbf{v}$ and equivalent force $\mathbf{F}$ corresponding to any trend satisfy:

$$\mathbf{F} \propto \frac{d(\Delta\mathbf{p})}{dt_p} \equiv \frac{d}{dt_p}\left(p_{\text{total}} \cdot \frac{\mathbf{v}}{c}\right)$$

where t_p is the Planck time. This formula indicates that the rate of change of force is equivalent to the time refresh rate of momentum deviation, and momentum deviation directly emerges inertial velocity. Therefore, the five trends of motion, resistance, tension, repulsion, and thrust can be equivalently converted into each other through this formula — when $\Delta\mathbf{p}$ is in the same direction as the motion direction of the carrier, it manifests as a motion trend; when opposite, it manifests as a resistance trend; when pointing to other evolutionary carriers, it manifests as tension and thrust trends; when deviating from other evolutionary carriers, it manifests as a repulsion trend. The five share the same momentum interaction mechanism and mathematical constraints. Therefore, we can understand that there are m evolutionary carriers moving based on v, the influence of their velocity is equal to mv, and the influence of force is also equal to mv. Only the equivalence of the evolutionary trends of velocity and force can support Einstein's equivalence principle of gravity and downward motion. Einstein talked about the superposition of multiple velocities, while we directly deduce based on inertia. Therefore, force = motion trend is a more generalized equivalence principle, which is the emergence way of all forces [6]. It is also through the perception mechanism that the action-at-a-distance influence of force is realized. (Note: This deduction is based on natural dimensional derivation, that is, the nature of force is completely equivalent to momentum mv, see the chapter "Reconstruction of Dynamic Relationships of Basic Physical Dimensions" in the framework of this evolution theory [7]) A particle essentially has an internal structure, and the distribution of its internal momentum units determines its transition ability in a certain direction. With motion trends in all directions, it naturally emerges the ability to establish force connections in all directions.

1.3 Emergence of Cosmic Force

Force is not an independent carrier, but emerges from the self-evolution trend and mutual evolution trend of momentum carriers, with its core being momentum symmetry breaking and perceptual cross-section. When evolutionary resources form a perceptual cross-section within a Planck time snapshot, momentum state interaction is completed according to the rules of the field. The corresponding momentum deviation formed after the interaction, combined with the evolution amplitude c and evolution frequency c of the intrinsic coding of momentum resources, the resultant force of momentum deviation calculated within this time snapshot is the emergence magnitude of force. Force interaction occurs within the Planck time snapshot under the perceptual cross-section, and also in the space of this window (the position where the particle evolves based on the degree of freedom dimension). Therefore, it is independent of the propagator and action distance, and only related to time calculation. In experiments, it is impossible to observe that the propagator of the force-exerting particle continuously flies to the force-receiving particle and completes zero-distance interaction [1]. Therefore, the macro-material structure is not directly provided by the non-superimposable spacetime state of the evolutionary carrier (momentum unit), but by the external connection protocol perceptual cross-section, and the internal structure of the particle is jointly provided by the internal connection entanglement protocol and the external connection interaction protocol [4]. **The dynamic causal interaction state in the universe satisfies:**

$$\sum \Delta \mathbf{p} = 0$$

1.4 The Relationship Between Force, Energy, and Momentum

1. **Root Problems of Traditional Theories**

   Traditional theories describe force with $F = ma$, believing that the magnitude of force is determined by acceleration; at the same time, kinetic energy is expressed as $E_k = \frac{1}{2}mv^2$, believing that energy is proportional to the square of the velocity increment. However, the cosmic system is essentially a state evolution system, which only includes the representational quantity m and the driving quantity v. The underlying logic of the driving quantity v is to sequentially apply displacement drive to the representational quantity m within a series of discrete time units. If the mass m is displaced by l in two steps, its equivalent velocity is exactly $1/2$ of that when the displacement l is completed in one step; adding the two driving costs directly gives the total cost and total driving quantity. It can be seen that velocity essentially corresponds to a step-by-step movement process, and the total evolution cost strictly follows linear superposition, rather than acceleration accumulation or square relationship superposition.

2. **Basic Quantities in the State Evolution System**

   In a state evolution system with standard quantum conservation: cost quantity = driving quantity = displacement quantity of representational quantity = spatial displacement quantity = time displacement quantity = mv. It cannot be collectively called spacetime displacement quantity here, because space and time are independent dimensions that emerge synchronously respectively. Based on this understanding, $E = mc^2$ is essentially representational quantity m × spatial evolution amplitude × temporal evolution frequency, which should be regarded as the spacetime state shaping equation; while the real mass-energy relationship should be mv or mc, corresponding to the total displacement frequency of the object in space.

3. **Linear Superposition is the Underlying Law**

The core is that due to the conservation relationship between spatial representation and temporal representation quantities, force, energy, and momentum all undergo linear superposition. All integrals and interactions in the system are linear superpositions of multiple segments of inertial motion. This law runs through all interaction processes and is the underlying law of cosmic state evolution.

For example, in a collision, when object A of the same mass collides with stationary B at velocity v, without considering repulsion, the influence result is that AB triggers a resultant force through the repulsion perceptual cross-section, and A transfers 50% of its displacement frequency to B, thus making B also generate a displacement inertia of $0.5v$.

4. **Reunderstanding of $F = ma$, $E_k = \frac{1}{2}mv^2$, and $E = mgh$**

   In traditional theories, $F = ma$ and $E_k = \frac{1}{2}mv^2$ originate from the artificial definition of "work" as the product of force and distance or acceleration, which is equivalent to performing spatial or acceleration integration again on the basis of inertial motion, introducing redundant nonlinear structures. However, the underlying cost quantity and kinetic energy are still mass and inertial velocity. This leads to a fundamental conceptual confusion between force, energy, and momentum in traditional mechanics, failing to reveal their underlying physical nature. $F = ma$ should be called multiple inertial accumulations under acceleration, which can be understood in reverse as a pressure-like ability per unit time — essentially still a momentum integral.

   Under gravitational gravity, whether a stone falls to the ground due to gravitational acceleration from 10,000 kilometers away, is manually carried to the ground, or appears on the ground out of thin air, the final interaction magnitude depends on the three-dimensional spherical spatial geometric perception radiation growth/attenuation of $1/4\pi r^2$. Therefore, regardless of the intermediate process, the final integral magnitude is proportional to Gm_1m_2/r^2 — i.e., any integral corresponds to a linear superposition growth of inertial increments based on the momentum state change Δp mediated by the perceptual cross-section $4\pi r^2$. In the traditional formula $E = mgh$, g represents acceleration (implicitly $g = GM/r^2$), and h represents the distance to the ground (essentially the variation of r). The two integral paths are completely equivalent, both integrating over $4\pi r^2$. Therefore, from the perspective of physical dynamics, there exists a **redundant integration**: the same geometric information is counted twice. In essence, potential energy should be reduced to the force mg (i.e., Gm_1m_2/r^2), rather than being treated as an independent energy dimension. From an engineering perspective, however, mgh is **not redundant** — under the constant g approximation near Earth's surface, it provides a simple, efficient, and sufficiently accurate macroscopic statistical tool. **Why $\frac{1}{2}mv^2 = mgh$:** The term $\frac{1}{2}mv^2$ is essentially the integral effect of multiple inertial motions under the statistical framework of "force times distance." On Earth, when pushing an object horizontally, the object is constantly subjected to a gravitational momentum deviation from the Earth, which prevents it from maintaining long-term inertial motion, forcing the continuous application of multiple inertial state increments. Integration yields $\frac{1}{2}mv^2$, which exactly equals the integral of inertial state increments resulting from the change in perceptual cross-section $1/4\pi r^2$ over a distance in a gravitational field. In this force interaction process, only distance grows — the constants 4π and G do not increase. Therefore, the integral depends on the square of the distance. However, this equality is **not** a manifestation of universal energy conservation. It is an emergent phenomenon arising from the principle of force interaction under the conservation of total vector momentum — a specific statistical coincidence that occurs under particular conditions (low velocity, weak field, inertial frame). This equality breaks down in relativistic scenarios and under variable acceleration (non-inertial frames). However, this equality is **not** a manifestation of universal energy conservation. It is an emergent phenomenon arising from the principle of force interaction

under the conservation of total vector momentum — a specific statistical coincidence that occurs under particular conditions (low velocity, weak field, inertial frame). This equality breaks down in relativistic scenarios and under variable acceleration (non-inertial frames), where the conventional concept of "energy conservation" either fails or requires ad hoc modifications.

Conclusion: The equality $\frac{1}{2}mv^2 = mgh$ is not a proof of energy conservation, but rather a numerical coincidence specific to constant-gravity, low-velocity conditions on Earth. The true universal principle is the conservation of total vector momentum $\sum \Delta(m\vec{v}) = 0$. The conventional "energy" is merely a statistical shadow of this underlying momentum dynamics, and its conservation is not a fundamental law but an emergent phenomenon that fails outside its narrow domain of applicability.

Therefore, we cannot say that the energy consumption of moving a 100-kilogram object 100 meters in two steps is 4 times the cost of moving it 100 meters in one step. Of course, we can also understand ma as pressure per unit time — that is, integrating inertial force multiple times per unit time — but this requires acceleration conditions. Traditional theories may believe that moving a 100-kilogram object 200 meters costs more than moving it 100 meters, but inertial motion and acceleration do not require distance integration.

5. **Core Conclusion**

   Core conclusion: In the dynamics of the cosmic system, there only exists the inertial state of the representational quantity m being accelerated (or pushed, collided, or canceled) to a certain frequency. Therefore, there only exists the integral of inertial motion, that is, only the integral of momentum, which is split into the integral of the three: representational quantity m, driving frequency v, and angle θ. Therefore, the dynamic cost and state before and after integration are:

$$\boxed{\text{Force} = \text{Energy} = \text{Momentum} = mv}$$

2 Core Characteristics of Force Interaction

2.1 Propagator-Free

The traditional "propagator mechanism" has four core contradictions, which are also the key reasons why the standard model cannot reduce gravity:

- The momentum source of the propagator cannot be reasonably explained; if it is taken from the force-exerting particle, it will directly break the law of momentum conservation;
- The propagation speed of the propagator has an upper limit, which cannot realize the synchronous interaction of gravity between celestial bodies, violating the law of causality;
- The interaction of the propagator itself needs to be transmitted by other propagators, falling into an infinite loop of logical paradox;
- Distant particles cannot accurately receive the information of the propagator, and the movement of the target particle will cause the propagator to deviate from the original target, leading to chaos in cosmic evolution;
- The propagator flying over can only push the target particle away, not pull it closer, and can only form repulsion, not attraction;

- No experiment has observed the propagator flying from particle A to particle B.

The above contradictions point directly to the underlying defects of the propagator mechanism in the standard model, and the core expression of this mechanism can be found in the foundational literature of quantum field theory [1].

2.2 Delay-Free

- Superluminal interaction does not violate causality: In a regularized state evolution system, the causal relationship is centered on "cause before effect", not velocity constraints; if A suddenly appears in front of B and B observes A at the same time, A's movement is the cause and B's observation is the effect, with no causal inversion; on the contrary, if the interaction speed of force is lower than the speed of light, it will cause instability of the causal state in the system due to the time difference.

- The interaction speed of force is separated from the motion speed of the carrier: The interaction speed of force is instantaneous, while the upper limit of the motion speed of the force carrier is c, and the upper limit of the interaction refresh rate of force is also $1/t_p$ (t_p is Planck time).

- Gravitational delay cannot be compensated by uniform inertia: If there is an interaction delay in gravity, such as the 4-hour propagation deviation between the Sun and Neptune, it will cause a polygonal line motion effect of celestial bodies; even if uniform inertial compensation is performed with "inertial motion × deviation time", the result is still polygonal line motion, which is inconsistent with observational facts (this conclusion has been verified by program code simulation). This problem has long been concerned by the academic community. Carlip once pointed out in his research that if gravity has a delay, the planetary orbit cannot be maintained stable [8]. Laplace also first calculated that if the propagation speed of gravity is limited, the Moon's orbit will produce an observable longitude deviation [9].

- Delayed force interaction cannot form an effective resultant force: In a chaotic or complex evolution system, delayed force interaction cannot realize the resultant force effect of long-range forces such as gravity and electromagnetic force, and cannot explain the force balance phenomenon in macro and micro scales.

- Therefore, force interaction must lock a "stationary spacetime position", that is, a definite spacetime state. It is impossible for a particle to interact with another particle at two positions at the same time.

Refresh rate and special relativity: For particles moving at high speed, due to the dynamic change of the perceptual cross-section, they cannot align with multiple time windows with the refresh rate $1/t_p$, thus resulting in weak interaction. We can imagine two trains passing each other at high speed; the interaction time window between them is much less than that in the static state, and the spacetime within each time snapshot is flat, not curved. Spacetime covariance emerges from the multi-window superposition effect from the observer's perspective. Therefore, the force interaction of particles at high speed is completely equivalent to special relativity, but the realistic mechanism of force is different. Essentially, the internal state time of the particle is still the high-speed inertial time, while the external interaction time becomes slower. The perceptual cross-section of interacting photons for either train or the bystander will undergo covariance due to high-speed motion [14].

$$f_{\text{obs}} = f_0 \cdot \sqrt{1 - \frac{v^2}{c^2}}$$

Therefore, in any case, in a stable state evolution system, the observer cannot cause changes in the eigenstate, only the macro projection effect.

2.3 Force Interaction Process

In the cosmic physical dynamic causal state evolution system, the inertial continuation of the previous state of particle A enters the perceptual cross-section under the straight line of another particle, and then state interaction related to the size of the cross-section is completed according to the evolution rules. The entire process is:

- **Perception emergence:** Particle A moves into the spacetime perceptual cross-section of particle B. The interaction quantity under the spherical symmetric particle perceptual cross-section is: perceptual cross-section / $4\pi r^2$;

- **Resolution:** Based on the Planck time frequency, within the t_p time snapshot where the perceptual cross-section is located, resolution is performed according to the original encapsulation size of both particles A and B: factor1 $\cdot\, mc1 \cdot$ factor2 $\cdot\, mc2/4\pi r^2$;

- **Borrowing momentum pairs for interaction:** Based on the local potential space, borrow momentum pairs (p , -p) (action and reaction forces) or p (free force) corresponding to the resolution size. Under the four fundamental force protocols, the internal momentum direction of the particle is toggled to the opposite direction through the borrowed momentum pairs, that is, repulsion is the joint outward toggling of momentum pairs, attraction is the joint inward toggling of momentum pairs, and free force realizes momentum interaction through transfer. At the same time, the borrowed momentum pairs are returned to the potential space through annihilation. In the entire process, both the dominant space and the potential space maintain momentum conservation, and only the space state evolves.

Because force interaction occurs within the time snapshot under the perceptual cross-section, it is independent of distance. The interaction result of force is non-attenuating and penetrable, and ghostly effects emerge during the interaction, but it does not affect the continuous evolution of the causal state, but provides a stable evolution guarantee for the physical system. This non-local interaction characteristic is consistent with the logic of the ER=EPR conjecture proposed by Maldacena and Susskind that "spacetime connection originates from quantum correlation" [15]. The reason why action and reaction forces are equal in magnitude and opposite in direction is that any two objects can only interact if there is a common perceptual cross-section in their mutual micro-mechanism. Even an ant and an elephant can only have momentum state interaction if there is the same perceptual cross-section. Therefore, action and reaction forces are always equal in magnitude and opposite in direction.

3 Core Defects of Traditional Gravitational Theories

The nature of gravity is not spacetime curvature, nor can it be explained by the Lagrangian principle. The relativistic gravity model has contradictions between underlying logic and observational facts [6].

3.1 Defects of Relativistic Gravity (Spacetime Curvature)

1. **Spacetime is an Emergent Relationship, Not a Physical Reality**

Spacetime is not an independently existing physical reality, but a representational quantity emerging from the state evolution of evolutionary carriers in any generalized state evolution system. Even a color state evolution system (such as the change of pixels based on three degrees of freedom of red, green, and blue) can also emerge color space and color time. Therefore, spacetime itself does not have the dynamic ability to drive particle motion — it is only a background stage for evolution, not a source of power for evolution [16].

2. **Failure to Provide a Dynamic Origin**

General relativity geometrizes gravity, but geometry itself does not include a dynamic origin [6]. Explaining object motion with spacetime curvature is equivalent to explaining "car movement" with "road shape", which essentially violates the law of momentum conservation — because momentum change must originate from the transfer of momentum units, not from changes in background geometry.

3. **Gravitational Waves Cannot Dissipate**

If gravitational waves are ripples of spacetime curvature, they should not dissipate energy outward — because the spacetime background itself does not contain dissipable momentum units. If gravitational waves can dissipate, then if the spacetime curvature of the Sun has delay and energy dissipation, the gravity received by the Earth will only come from the historical residue of the Sun's "spacetime pit", which is inconsistent with actual observations. Although the gravitational wave events observed by LIGO (such as GW170817) have verified that the speed of gravity is consistent with the speed of light [17], they cannot explain the energy dissipation problem of gravitational waves — where does the dissipated energy go? If energy is absorbed by the spacetime background, the background must have excitable physical reality, which contradicts the assumption that "spacetime is pure geometry" [6].

4. **Failure to Provide a Microscopic Quantum Interaction Mechanism**

General relativity can only realize the macro quantification of gravitational geometric effects, but cannot encode the precise causal interaction mechanism of microscopic particles [6]. This leads to two fundamental problems: Lack of perception mechanism: How do particles perceive differences in spacetime in all directions? If spacetime is continuous, it requires infinite density (there is still structure at any small scale), which itself conflicts with physical reality; Contradiction between discreteness and continuity: The Planck scale provides the lower limit of the minimum length and minimum time, but the continuous spacetime required by general relativity cannot naturally emerge a discrete-continuous structure based on the Planck scale — if spacetime is infinitely divisible, it cannot explain why there is a least action; if there is a minimum unit, the continuous geometric description is only a statistical approximation [2].

5. **Failure to Explain the Gravitational Slingshot Effect**

Gravity is the result of spacetime curvature, and particles should only move along the curved direction [6]. However, in the gravitational slingshot effect, the spacecraft accelerates after flying past the planet, and the direction of motion is related to the planet's motion, rather than simply "sliding" along the spacetime curvature. If the planetary spacetime curvature is a static "pit", the spacecraft should enter and exit symmetrically along the geodesic, with a net velocity change of zero; but in reality, the spacecraft "gains" the planetary orbital velocity component, which is evidence of momentum exchange, not evidence of spacetime geometric curvature.

3.2 Defects of Quantum Gravity

Traditional quantum gravity is mainly based on problems such as propagator contradictions, preset spacetime background, and continuous infinite divisibility of spacetime. The relevant logic is as described above, and will not be elaborated here [1].

4 Classification of Forces

Forces in the cosmic system can be divided into two categories according to interaction mode and action mode, with no other independent force types. The four fundamental forces all belong to specific manifestations under this classification system. It should be emphasized that the core view of this theory that "force is an emergent phenomenon" is highly consistent with Verlinde's proposal that "gravity is an entropic force (emergent force)", but this theory makes up for the lack of microscopic dynamic details in his theory through the "momentum cancellation and refresh" mechanism [18][19].

4.1 Classification by Interaction Mode

Multiplicative force: Massive particles complete long-range resolution and execute borrowing and returning protocols through fields. After the interaction, they are reflected as action and reaction forces, following the law of momentum conservation. The attractive and repulsive forces among the four fundamental forces all belong to multiplicative forces.

$$\Delta \mathbf{p}_A = -\Delta \mathbf{p}_B, \qquad \mathbf{F}_A = -\mathbf{F}_B$$

Additive force: Massless particles unidirectionally transport momentum units to massive particles, completing interaction through local perception without executing protocols. After the interaction, the photon loses energy and its momentum decreases, while the massive particle gains energy and its momentum increases. Examples include decay, photon absorption, photon radiation, scattering, etc.

$$\Delta \mathbf{p}_{\text{photon}} = -\Delta \mathbf{p}_{\text{particle}}, \qquad \Delta E = \Delta p \cdot c$$

4.2 Classification by Action Mode

Repulsion: The momentum states of both interacting parties are constrained by field rules, showing a common outward evolution trend. Example: between electron and electron.

$$\mathbf{p}_d^{(A)} \uparrow\uparrow \mathbf{p}_d^{(B)} \quad \text{(away from each other)}$$

Attraction: The momentum states of both interacting parties are constrained by field rules, showing a common inward evolution trend. Example: between electron and proton.

$$\mathbf{p}_d^{(A)} \uparrow\downarrow \mathbf{p}_d^{(B)} \quad \text{(toward each other)}$$

Free force: Unidirectional momentum interaction between photons and free energy, without a reverse acting force component. Examples: free energy, photons, gravitational waves (essentially particle encapsulation decoupled states).

$$\Delta \mathbf{p}_{\text{source}} \rightarrow \Delta \mathbf{p}_{\text{target}}, \quad \text{no reverse component}$$

4.3 The Four Fundamental Forces

Since force emerges from the double c coding of momentum itself, the four fundamental forces are four encapsulation and perception interaction protocols, driving how particles perceive, resolve, and interact, realizing the symmetry breaking after particle symmetry encapsulation, and achieving state evolution through momentum deviation. This view is in sharp contrast to the mechanism in the standard model where the four fundamental forces are transmitted through gauge bosons [2].

4.4 Summary of Force Types

Multiplicative force is an interaction force, and both parties jointly change each other's causal state; additive force is the unidirectional transfer of momentum units, but after transferring momentum units, it still changes its own causal inertial state. The four fundamental forces are essentially four basic encapsulation and perception protocols, which can realize combined interaction according to units such as charge, color, lepton, baryon, etc. They do not directly provide driving energy or driving force, and the change of interaction state still depends on the speed of light and linear superposition, and cannot achieve superposition other than linear addition. There are also no heterogeneous charges or heterogeneous substances (matter and antimatter); under the drive of field protocols, they all evolve in different directions via linear superposition at the speed of light.

5 The Relationship Between Force Interaction and Relativity

5.1 The Integral Nature of Force

The essence of integration is the product of $m_0 \cdot c$ plus the angle relationship. Evolutionary carriers (momentum units) in the universe are formed by multi-layer encapsulation relationships, and the integration process is also the process of accumulating charge, color charge, quark, proton, photon, electron, lepton number, baryon number, fermion number, boson, atomic number, etc. The four fundamental forces correspond to encapsulated perception and interaction with $N \cdot m_0$ momentum units. Both multiplicative force and additive force are linear superpositions of momentum units.

5.2 Integral Conditions of Force (Classical Mechanics)

There exists a perceptual cross-section that can be interacted with or continuously interacted with. For example, when a stone falls from a high place, the closer it is to the ground, the larger the perceptible cross-section. Therefore, integration can be performed using distance, velocity, time, perceptual cross-section, and momentum deviation. Classical mechanics statistics uniform integration conditions:

$$\mathbf{F} = \int \frac{\sigma}{4\pi r^2} \cdot (N m_0 c) dt$$

Factors Influencing the Integral Conditions of Force (Relativity) The ability of the evolutionary carrier $m_0 c$ to couple and shape spacetime is constant as $E_{\text{spacetime shaping}} = mc^2$, so particles emerge complex interaction situations in relativity during motion [6]. Increasing spacetime curvature path integral

(general relativity): The field equation statistics path variation integral conditions:

$$\frac{d^2x^\mu}{d\tau^2} + \Gamma^\mu_{\alpha\beta}\frac{dx^\alpha}{d\tau}\frac{dx^\beta}{d\tau} = 0$$

Reducing perception efficiency (special relativity): The upper limit of the force interaction refresh rate is c. Due to the reduction in the number of spacetime windows during high-speed motion, the interaction efficiency decreases [14]:

$$\Delta v_{\text{effective}} = \frac{\Delta p}{P_{\text{total}}} \cdot c \cdot \sqrt{1 - v^2/c^2}$$

Summary of Integration (Differences Between Classical Mechanics and Relativity) Relativity and classical mechanics are not different in weak field and non-weak field. Classical mechanics has no theory of perception weakening during motion, describing uniform integration and radial motion integration between each other. This integration always relies on the final perceptual cross-section such as a stone falling and contacting the Earth as the upper limit. General relativity describes variable condition integration, and special relativity describes motion state perception weakening (especially non-radial motion) [14].

6 Emergent Phenomena of Force Interaction

The essence of force interaction is the change in the state distribution or increment of momentum units in particles. It does not establish complex mechanical relationships between a single particle and the macro environment through tension, but establishes mechanical relationships with the environment through motion trends.

6.1 Action-at-a-Distance

The force interaction of particles is only related to the time and space state under the perceptual cross-section, independent of distance, and there is no "pull line" of force. Force interaction can be transmitted infinitely, and the perception mechanism itself is the mutual influence at infinite distance, such as moving towards each other. This feature is consistent with Newton's view of gravitational action-at-a-distance, and the "instantaneous refresh mechanism" in this paper reasonably reconstructs and develops it [20].

$$\mathbf{F} \propto \frac{\sigma_{\text{perceptual}}}{4\pi r^2} \cdot (N m_0 c), \quad \text{force magnitude independent of } r, \text{only the number of interactable units decays}$$

6.2 Penetrability

Force interaction occurs in the perceptual cross-section within the Planck time snapshot, independent of spatial distance. Force can penetrate any thickness of material layer — as long as the perceptual cross-section can be established, the interaction occurs. The so-called "shielding" is that the perceptual cross-section is occupied or interfered by other interactions, not that the force itself is blocked.

$$P_{\text{interaction}} = \frac{\sigma_{\text{perceptual}}}{4\pi r^2} \cdot (1 - f_{\text{occupation}}), \quad f_{\text{occupation}} \text{ is the occupation factor}$$

6.3 Non-Attenuation of Force

The force itself does not attenuate. Attenuation is only limited to the decrease in the encapsulated perception ability with the increase of spatial distance — the size of the perceptual cross-section that can be established is proportional to $1/4\pi r^2$, so the number of momentum unit pairs that can participate in the interaction decreases accordingly. But once the perceptual cross-section is established, the number of momentum units in a single interaction is constant as $N \cdot m_0 c$, and the magnitude of the force action is constant.

$$|\mathbf{F}| = \frac{\Delta p}{\Delta t} = \frac{N m_0 c}{\Delta t} \cdot \frac{\sigma}{4\pi r^2}\bigg|_{\text{interaction occurs}}, \quad \text{single interaction force magnitude is constant}$$

6.4 Emergence of Inertial Motion

When particles form momentum deviation due to free energy and photon input, or there is an inherent momentum deviation in their spherical symmetric momentum distribution, inertial motion emerges. The motion state is determined by the ratio of momentum deviation to total momentum and the coupling of the speed of light. Inertia is not an inherent attribute of objects, but a reflection of the proportion of momentum deviation. This view reconstructs the underlying logic of Newton's first law [20].

$$\mathbf{v} = \frac{\mathbf{p}_d}{P_{\text{total}}} \cdot c, \quad P_{\text{total}} = N m_0 c$$

6.5 Quantum Fluctuation

Quantum fluctuation is the instantaneous effect of borrowing and returning momentum pairs $(p, -p)$ from potential space during the Planck-time snapshot of force interaction:

$$\Delta \vec{p}_{\text{total}} = 0, \quad \vec{p}_{\text{dominant}} + \vec{p}_{\text{potential}} = \text{constant}$$

Gravitational thermal fluctuation arises from dynamic perceptual cross-sections between celestial bodies, driving momentum pair borrowing and returning. This is the physical origin of what conventional physics misinterprets as "potential-kinetic energy conversion." In the present framework, the Third Law governs all such processes:

$$\Delta \vec{p}_A = -\Delta \vec{p}_B$$

No independent energy entity exists — only momentum state deviation exchange via perceptual cross-sections.

6.6 Quantum Tunneling

Force interaction is based on the joint action of perceptual cross-sections between particles, thus it is independent of distance and can achieve action-at-a-distance interaction capability. The processes of particle coupling, interaction, and generated momentum distribution are all completed through the borrowing and returning of potential space based on the conservation of evolutionary resources. Therefore, under special conditions, discontinuous spatial evolution is formed, that is, spatial jump (quantum tunneling):

Tunneling process:

$$\text{Position A} \xrightarrow{\text{perceptual occupation}} \text{Potential space} \xrightarrow{\text{refresh}} \text{Position B}$$

The tunneling probability is given by:

$$P_{\text{tunneling}} = \prod_{i=1}^{n} \left(1 - \frac{N_{\text{occ},i}}{N_{\text{total}}}\right) \propto e^{-2\kappa d}$$

where:

- $N_{\text{occ},i}$ is the number of occupied perceptual cross-section channels at step i,
- N_{total} is the total number of available channels,
- d is the barrier width,
- κ is the decay constant (barrier penetration factor).

The Decay Constant κ in the Present Framework

In conventional quantum mechanics, the decay constant is expressed as:

$$\kappa_{\text{conv}} = \frac{\sqrt{2m(V_0 - E)}}{\hbar}$$

In the present framework, this expression reduces to its primitive form. Substituting $m = Nm_0$, $V_0 - E = \Delta p \cdot c$, and $\hbar = m_0 l_P c$:

$$\kappa = \sqrt{\frac{2 \cdot Nm_0 \cdot \Delta p \cdot c}{m_0 l_P \, c}}$$

The speed of light c cancels out directly, and m_0 cancels as well:

$$\boxed{\kappa = \sqrt{\frac{2N\Delta p}{l_P}}}$$

where:

- N is the number of momentum units (proportional to mass),
- Δp is the momentum deviation across the barrier,
- l_P is the Planck length (the fundamental discrete spacetime unit).

This reveals that the conventional constants $\hbar$ and c are not fundamental to tunneling — they are dimensional conversion factors. The true physical parameters are the momentum unit count N, the momentum deviation Δp, and the discrete spacetime scale l_P. The cancellation of c demonstrates that it plays no essential role in the tunneling process; it is a redundant artifact of conventional dimensional analysis.

Physical Interpretation

This exponential decay form is consistent with the standard tunneling probability, but the underlying mechanism is fundamentally different:

- **Conventional view:** Tunneling is wavefunction penetration through a classically forbidden barrier.
- **Present framework:** Tunneling is **discrete spatial jump** due to perceptual cross-section occupation and potential space borrowing/returning.

The particle does not "penetrate" the barrier. Instead, when perceptual cross-sections are fully occupied, momentum units are returned to potential space, and upon the next Planck refresh, the particle re-emerges at a new position — a spatial jump.

Key term definitions:

- Momentum unit: $m_0 c$ — the fundamental evolutionary carrier
- Evolutionary resource: the underlying substrate of all physical quantities
- Representational quantity: m_0 — the mass carrier
- Driving quantity: c — the speed of light / evolution rate
- Perceptual cross-section: $\sigma \propto 1/4\pi r^2$ — the interaction probability kernel
- Potential space: latent momentum reservoir for borrowing/returning pairs
- Snapshot: discrete time frame at the Planck scale
- Refresh: synchronous state update at each Planck time
- Toggle: reorientation of momentum deviation direction

6.7 Connectivity of Force

Force is not transmitted through a continuous medium, but establishes an instantaneous connection through a perceptual cross-section. Once two particles enter each other's perceptual cross-section, a force connection is established; when the cross-section disappears, the connection is broken. This connection is discrete, instantaneous, and discontinuous, and there are no "force lines" or "field lines" entities. This feature is consistent with the logic of the ER=EPR conjecture proposed by Maldacena and Susskind that "spacetime connection originates from quantum correlation" [15].

$$\mathbf{F}_{AB} \text{ exists } \iff \sigma_{AB} > 0, \quad \sigma_{AB} = \frac{\sigma_A \cdot \sigma_B}{4\pi r^2}$$

6.8 Repulsiveness and Attractiveness

Repulsion: The momentum arrows (evolution directions) of both interacting parties are toggled outward together, emerging a motion trend away from each other. Attraction: The momentum arrows (evolution directions) of both interacting parties are toggled inward together, emerging a motion trend

approaching each other. The direction is determined by the field protocol, and the driving force comes from the linear superposition of momentum units at the speed of light.

$$\text{Repulsion: } \Delta\mathbf{p}_A \uparrow\uparrow \Delta\mathbf{p}_B \text{ (away)}, \qquad \text{Attraction: } \Delta\mathbf{p}_A \uparrow\downarrow \Delta\mathbf{p}_B \text{ (toward)}$$

$$\mathbf{v}_{\text{new}} = \mathbf{v}_{\text{old}} + \frac{\Delta\mathbf{p}}{P_{\text{total}}} \cdot c, \quad \text{direction determined by } \Delta\mathbf{p}$$

6.9 Impenetrability and Material Structure

The impenetrability between substances does not originate from a certain "repulsive force entity", but from the combined effect of the exclusivity of momentum units to spacetime lattice points and the occupation mechanism of perceptual cross-sections.

Spatial exclusivity: Each momentum unit m_0, as a system state representational quantity, can only occupy one spacetime lattice point (l_p, t_p) within a single Planck time snapshot. Two momentum units cannot occupy the same lattice point at the same time — this is the fundamental constraint of the discreteness of evolutionary resources [2].

Repulsive perceptual cross-section: When two particles (such as electron-electron) enter each other's repulsive perceptual cross-section, the interaction protocol stipulates that the momentum arrows are toggled outward, emerging a motion trend away from each other, which is macroscopically manifested as "impenetrability".

Emergent impenetrability and material structure: The perceptual cross-section can be established, and force can penetrate any thickness of material, which is the perceptual interaction ability; but the repulsive perceptual cross-section and the spacetime exclusivity of momentum units can prevent the overlap of momentum units, and substances cannot penetrate each other, thus emerging material structure.

Exclusivity of momentum units:

A lattice point (l_p, t_p) can only be occupied by a single momentum unit m_0.

Repulsion prevents overlap:

If $\sigma_{\text{repulsion}} > 0$ and $r \to 0$, then Δp points outward and $v_{\text{relative}} \to 0$.

Material structure boundary:

The spatial extent of a particle equals the perceptual cross-section distribution of its internal momentum units.

7 Emergence of Velocity, Resultant Force, and Acceleration

7.1 Resultant Velocity and Resultant Force (Macroscopic Statistics)

Linear resultant force: Due to the conservation relationship of evolutionary resources (momentum units), the equivalent relationship of mutual influence of motion emerges, and the linear resultant force relationship emerges. The causal results produced by the interaction of particles A and B, whether moving away from each other, approaching each other, or moving synchronously, all emerge their respective

resultant velocity inertial states. Because motion potential = thrust potential = resistance potential, the emergent resultant velocity is the resultant force. This mechanism explains the underlying essence of Newton's second law [20].

$$\text{Resultant velocity} = \text{Resultant force} \quad (\vec{F}_A = m_A\vec{v}_A,\ \vec{F}_B = m_B\vec{v}_B)$$

Parallelogram resultant force: When particle A exerts a resultant velocity influence on particle B, if B forms a rigid connection with C due to a cooperative motion trend, the resultant force exerted by A on B will be exerted on C through the rigid connection, thus forming a certain angle. During the resultant velocity process, the original linear resultant force will emerge a parallelogram relationship due to the angle difference.

$$\vec{v}_{\perp B} = \vec{v}_{\perp C} \quad \text{(translational component)}$$

$$\vec{\omega} = \frac{\vec{r} \times \vec{F}_A}{I} \quad \text{(rotational component)}$$

Therefore, the driving ability of the momentum unit $m_0 \cdot c$ is constantly the speed of light, so the magnitude of the resultant force does not exceed mc, and the motion speed does not exceed c.

7.2 Acceleration

When there is a uniformly sustainable interactive spatial distance between substances, acceleration emerges. For example, a stone falling from a high place has a sustainable interactive spatial distance with the ground. The closer it is to the ground, the larger the perceptual cross-section $1/4\pi r^2$, and the larger the state distribution of the interacting momentum units, thus emerging acceleration.

8 Conclusions

8.1 Underlying Mechanism and Multibody Complexity

The universe is a three-dimensional spatial relationship evolution system under discrete causal states. All force interactions originate from a unified underlying mechanism — momentum units are linearly superimposed at the speed of light c, synchronously refreshed at the Planck time t_p, and an extremely complex relationship network emerges through particle encapsulation, quantum entanglement constraints, collinear perception, action-at-a-distance resolution, potential space momentum borrowing and returning, and inertial resultant velocity. This is the root cause of the extreme difficulty in predicting the three-body problem in Newtonian mechanics — multibody interaction is not a simple superposition of pairwise forces, but the dynamic competition of perceptual cross-sections, concurrent allocation of potential space resources, and nonlinear coupling of global synchronous refresh [20]. From the Planck scale to macro celestial bodies, the same set of evolution rules is followed. Classical mechanics, general relativity, quantum mechanics, and the principle of least action are all macroscopic approximations of this theory under different scales and conditions, rather than underlying reality [2][6][14].

8.2 Distinction Between Force and Its Carrier

Force and its carrier (particles) cannot be confused. The upper limit of the spatial motion speed of the carrier is c, while the exertion of force is instantaneous, penetrable, and independent of distance. The "attenuation" of force is a geometric dilution effect of the perceptual cross-section with the increase of distance, not the attenuation of the force itself. The seemingly contradictory characteristics of force, such as superposability, cancelability, and non-attenuation, are uniformly explained under the framework of "perceptual cross-section + potential space borrowing and returning".

8.3 Nature of Force and Field

Strictly speaking, there are no two physical entities of force and field. A field is a set of rules that constrain the evolution direction of particles; it neither provides the ability to represent spatial states nor the ability to drive evolution. Force is not an independent entity, nor is it the ability to change the motion of objects (Newtonian mechanics definition) [20], but the trend of self-motion and mutual motion of evolutionary carriers, mv (upper limit mc). Therefore, there is no need for invisible pull lines or spacetime curvature between celestial bodies [6]; gravity is only a cooperative trend where both parties simultaneously decide to move towards each other at their respective positions according to the gravitational protocol. There are three types of expressions for force: $f = dmv/dt$ (continuous integral evolution), $f = mv$ (macroscopic inertia), and $F = \frac{P}{c}v$ (dynamic origin).

8.4 Universal Resultant Force Equation (Velocity Increase Formula)

The fundamental equation unifying momentum, velocity, and force is the **universal resultant force equation** (also called the velocity increase formula):

$$\boxed{\mathbf{v}_{\text{resultant}} = \frac{\mathbf{p}_{\text{total}}}{P_{\text{total}}} \cdot c, \qquad \mathbf{F}_{\text{resultant}} = \frac{P_{\text{total}}}{c} \cdot \mathbf{v}_{\text{resultant}}}$$

This equation directly implies the Second Law as its single-particle special case: when the system consists of one particle, $\mathbf{v}_{\text{resultant}} = \mathbf{v}$ and $\mathbf{F}_{\text{resultant}} = \mathbf{F}$, recovering $F = \frac{P_{\text{total}}}{c}v$. Traditional equations such as $F = ma$, $\Delta p = \int F\,dt$, and $F_{\text{total}} = F_1 + F_2$ are macroscopic statistical approximations of this underlying linear relation.

Note: In essence, energy = force = momentum = mv (upper limit mc). Therefore, the velocity increase equation can correlate all basic physical mechanical dimensions, and the change in velocity also represents the change in force, energy, and mass (depending on whether it is momentum addition or momentum state distribution toggle).

8.5 Relationship Between Force, Energy, and Momentum

All integrals of force interaction, whether in classical mechanics, relativity, or the formulas of the four fundamental forces, are integrals of the resultant velocity or resultant force of mass and inertial velocity. The cost and influence of velocity increase do not grow in a square multiple relationship such as $c \cdot c$. Therefore, the essence of integration is the integral of momentum $m \cdot v$. Thus, force, energy, and momentum are essentially the same underlying relationship, only from different perspectives. However, the integration of energy in traditional formulas all have redundant integration of velocity. For example, in $E = mgh$, the integral results of g and h are completely the same, while $E = mc^2$ does not require

secondary velocity integration to express the influence of the inertial motion of a photon, because energy, momentum, and force are completely equivalent.

8.6 Relational State Evolution System

The essence of force interaction is to interact to form a relational structure of mutual motion — all things establish connections through perceptual cross-sections and achieve cooperative evolution through momentum state updates, without the need for intermediate entities or background containers. All potentials (strong force potential, weak force potential, gravitational potential, electromagnetic potential, resistance potential, tension potential, thrust potential, repulsion potential, attraction potential) are essentially motion potentials — potential energy is not an independent entity stored in the field, but a measure of the proportion of momentum deviation between particles, and a macroscopic manifestation of the cooperative trend of "joint inward" or "joint outward" motion of interacting parties. This is the underlying mechanism of Einstein's equivalence principle (equivalence of gravity and inertia) [6]: gravitational potential and motion potential are indistinguishable in origin because force and velocity are inherently one.

8.7 The Four Laws of Momentum Dynamics

1. **First Law (Inertial Velocity Synthesis)**

$$\boxed{\Delta\vec{v} = \frac{\Delta\vec{p}}{P_{\text{total}}} \cdot c}$$

   Inertia is maintained by the cancellation state of evolutionary carriers under constant driving force. This equation can also be called the **Internal Particle Inertial Velocity Synthesis**. [20]

2. **Second Law (Motion Tendency)**

$$\boxed{F = \frac{P}{c} v}$$

   Force is the tendency of evolutionary carriers to move or to interact with each other. [20]

$$\boxed{F_{\text{resultant}} = \frac{P_{\text{total}}}{c} \cdot \frac{d(v_{\text{resultant}})}{dt}}$$

   (Instantaneous form: $F = \frac{P_{\text{total}}}{c} v$, representing the momentum flow potential required to maintain the state.)

3. **Third Law (Equal Opposite Exchange — Multiplication Forces)** For multiplication forces (gravity, electrostatic force, strong confinement):

$$\boxed{\Delta\vec{p}_A = -\Delta\vec{p}_B} \quad \Longleftrightarrow \quad \Delta m_1\vec{v}_1 = -\Delta m_2\vec{v}_2$$

   This represents the mutual opposite motion tendency between particles during interaction. When two objects interact via action and reaction, their mass is inversely proportional to velocity. This equation can also be called the **Equal Exchange of Time or Space Shaping Capacity**. During the interaction, each particle acquires an opposite and equal momentum state deviation — that is, an equal and opposite amount of shaping capacity in the time direction or space direction.

This equation holds strictly within a single time point (instantaneous interaction) or under the resultant velocity at the final static r, or for statistical purposes. It represents the instantaneous inertial state quantity of the four fundamental forces at the moment of interaction.

This equation is also a primary source of why charge is not proportional to mass — velocity-synthesizing interactions affect momentum flow distribution. [20]

4. **Fourth Law (Resultant Velocity — Addition Forces)** For addition forces (e.g., electron absorbing a photon, Cooper pair formation), when two entities merge, their resultant velocities become equal (momentum averaging) — that is, the two particles equally distribute the shaping capacity of the time or space state. The two particles ultimately achieve macroscopic cooperative resonance evolution, while the internal momentum units m_0 always evolve at the constant speed of light c.

$$\boxed{m_1\vec{v}_1 + m_2\vec{v}_2 = (m_1 + m_2)\vec{v}_{\text{resultant}}}$$

$$\boxed{\vec{v}_{\text{resultant}} = \frac{m_1\vec{v}_1 + m_2\vec{v}_2}{m_1 + m_2}}$$

Resultant velocity after merging of two composite systems:

$$\boxed{\vec{v}_{\text{new resultant}} = \frac{\vec{p}_{\text{total1}} + \vec{p}_{\text{total2}}}{P_{\text{total1}} + P_{\text{total2}}} \cdot c}$$

where $\vec{p}_{\text{total1}}$ and $\vec{p}_{\text{total2}}$ are the total momentum vectors of the two systems before merging, and $P_{\text{total1}} = m_1 c$, $P_{\text{total2}} = m_2 c$ are their total momentum capacities.

5. **Fifth Law (Causal — Momentum Distribution and Ontological Origin of Mass)** The macroscopic velocity and direction of a particle's state evolution are causally determined by the **asymmetric vector distribution** of its internal momentum units. For a system moving eastward at velocity v, the law allows for the reverse-inference of a westward evolutionary component (a net cancellation contribution of $c - v$). This explains the causal mechanism of decay and fission: how a massive momentum deviation Δp emerges from a seemingly "static" state. For composite particles, this law applies hierarchically.

   The essence of **rest mass** is the **complete cancellation state** of internal momentum units ($N_+ = N_-$) — mass is not converted from energy, but is the manifestation of the scalar sum of momentum units evolving at the speed of light, coupled with the absence of Special Relativity's gravitational weakening effects at low speeds. Traditional $E = mc^2$ erroneously interprets this cancellation state as "stored energy." The Fifth Law accomplishes the causal direction inference that energy cannot, revealing the emergent relationship between dynamic and static energy/mass, thereby uncovering the **ontological origin of mass**.

$$\boxed{\vec{v} = \left(\frac{N_+ - N_-}{N_+ + N_-}\right) \cdot \vec{c}}$$

Causal inference of internal components (e.g., eastward motion v):

$$\boxed{N_{\text{east}} - N_{\text{west}} = \frac{v}{c} \cdot (N_{\text{total}})}$$

Ontological definition of Mass (The basis of Eight-State Equivalence):

$$\boxed{m = \frac{P_{\text{total}}}{c} = \sum m_0}$$

where P_{total} is the scalar sum of the evolutionary capacity of all momentum units, and m is the fundamental state representation quantity (count of units), independent of the vector cancellation state.

8.8 Dynamical Definition

In the system, evolutionary carriers establish causal relationships through state transitions based on their degrees of freedom, producing mutual dynamical influences. The greater the transition frequency during radial interaction, the greater the causal interaction frequency with another evolutionary carrier.

Radial interaction directly manifests the three-dimensional spatial geometry — the perceptual cross-section scales as $1/4\pi r^2$, which is the geometric origin of the inverse-square law. This growth factor emerges naturally from the spherical propagation of perceptual capacity, independent of any mediating particles or fields.

Rest and radial interaction emerge as classical mechanics.

Non-radial mutual motion (without redundant integration) emerges as the perceptual weakening ability of special relativity spacetime, where the Lorentz factor $\gamma = 1/\sqrt{1 - v^2/c^2}$ arises from the compression of perceptual windows.

Non-radial environmental changes (with redundant integration) emerge as the redundant spacetime perceptual interaction ability of general relativity.

In the cosmic system, due to the constant inertial transition frequency c of evolutionary carriers based on their degrees of freedom, the emergent time frequency is c, the emergent space frequency is c, the interaction frequency is c, and the maximum inertial state frequency is c.

Key distinction: The conventional mass-energy equation $E = mc^2$ is not a conversion formula. It is the **spacetime state shaping equation** — describing the total coupling capacity of momentum units within the spacetime window. The true mass-energy relation is $E = mc$ (momentum capacity itself, linear, no redundancy).

The entire chain is unified by:

- Momentum unit $m_0 c$ — the sole underlying physical entity
- True mass-energy relation: $E = mc$ (linear, no redundancy)
- Spacetime state shaping equation: $E_{\text{spacetime}} = mc^2$ (statistical projection of spacetime coupling capacity)
- Perceptual cross-section $1/4\pi r^2$ — geometric origin of interaction probability
- Planck refresh mechanism t_P — synchronization basis of discrete spacetime

8.9 Five Fundamental Problems of Conventional Energy

1. **Inertial states cannot directly characterize energy.**

Complete Logic Chain of Universal Unified Dynamics

$\downarrow$

$m_0 c$

$\downarrow$

Multiple Types of Encapsulation

$\downarrow$

Emergence: Transition Frequency c, Perceptual Frequency c

3D Spherical & Perceptual Radiation: $\dfrac{1}{4\pi r^2}$

$\downarrow$

Dynamics: $mc \quad (E = mc)$

$\downarrow$

Spacetime shaping: $E_{\text{spacetime}} = mc^2$

$\downarrow$

Fermions (spherical) Photons (unidirectional)

$\downarrow$

Wave-Particle: $\Delta p \uparrow \rightarrow$ particle, $\Delta p \downarrow \rightarrow$ wave

$\downarrow$

First Law: $\Delta \vec{v} = \frac{\Delta \vec{p}}{P_{\text{total}}} \cdot c$

$\downarrow$

Second Law: $F = \frac{P}{c} v$

$\downarrow$

Third Law: $\Delta \vec{p}_A = -\Delta \vec{p}_B \iff \vec{F}_A = -\vec{F}_B$

$\downarrow$

Unified Integration (Perception/Spacetime/Momentum):
$\int \frac{1}{4\pi r^2}\, d\Omega \sim \int dr \sim \int c\, dt \sim \int d(mv)$

$\downarrow$

Momentum transfer: $\Delta p = F \cdot \Delta t$

$\downarrow$

Integration over time: $\int \Delta p = \int F\, dt = \Delta(mv)$

$\downarrow$

Four Fundamental Forces (multiplication forces)
e.g., Gravitational force: $f = \Delta(mv)/\Delta t$

$\downarrow$

Energy e is a statistical projection: $e \propto \int \Delta p = mv$

$\downarrow$

Radial Non-radial Motion Non-radial Field

$\downarrow$ $\downarrow$ $\downarrow$

Classical Special General

$F = ma,\ \frac{1}{2}mv^2$ $\gamma = \frac{1}{\sqrt{1-\frac{v^2}{c^2}}}$ curvature

$\downarrow$

Fourth Law: $\vec{v}_{\text{res}} = \frac{m_1 \vec{v}_1 + m_2 \vec{v}_2}{m_1 + m_2}$

$\downarrow$

Electron absorbs photon, Cooper pair, perfectly inelastic collision

Conventional physics defines energy via the integral of force over distance ($E = \int F\,ds$), which relies on pre-computing the entire macroscopic evolutionary process in advance. This method cannot directly characterize the energy of a single inertial state: for a uniformly moving object, its "energy" can only be obtained through path integration over the assumed full motion process. A free particle moving at constant velocity has no net force, yet conventional theory assigns it kinetic energy $\frac{1}{2}mv^2$ derived from hypothetical path integration. This indicates that conventional energy is not an intrinsic property of the instantaneous inertial state, but a statistical quantity equivalent to the total momentum of the final perceptual cross-section obtained by pre-calculation.

2. **Structural differences in energy definitions for photons and massive particles.**

   Conventional theory defines photon energy as $E = h\nu = mc^2$, which introduces an additional velocity factor c compared to the low-speed kinetic energy formula $\frac{1}{2}mv^2$ for massive particles. There are mathematical and physical differences between the two formulas, reflecting the structural inconsistency in the conventional energy framework for different physical objects. This inconsistency arises from the fact that conventional energy is a macroscopic statistical pre-calculation rather than a unified description based on the underlying perceptual cross-section mechanism.

3. **Limitations of conventional energy description for static momentum states.**

   Conventional theory interprets canceled macroscopic momentum as internal molecular thermal motion, which is valid for partial thermal scenarios but cannot fully explain the potential energy of a stationary suspended object. The object has no macroscopic velocity or electromagnetic radiation, but is assigned potential energy mgh in conventional theory. This energy value is derived from the pre-calculation of spatial position and field parameters, equivalent to a statistical prediction of the total momentum that could be released at the final perceptual cross-section, rather than a physically carried real-time state quantity.

4. **Energy cannot record causal direction or relational state.**

   Conventional energy is a scalar — it lacks directional information. It cannot distinguish between approaching vs. receding, attraction vs. repulsion, or a suspended object's canceled momentum state (which has zero macroscopic energy yet possesses release potential). Momentum $\vec{p} = m\vec{v}$, as a vector, naturally encodes causal tendency and relational state. The scalarization of energy discards the fundamental causal structure of interactions.

5. **Ultraviolet divergences and the constraints of linear conservation laws.**

   The fundamental requirement of any conserved quantity is linear additivity:

   $$\boxed{Q_{\text{total}} = Q_1 + Q_2 \quad \text{for two isolated systems}}$$

   This is the essence of conservation — like Person A + Person B = Two people. Any quantity that does not satisfy linear additivity cannot be a genuine conserved quantity.

   Conventional relativistic energy-momentum relation imposes:

   $$E^2 = (pc)^2 + (m_0c^2)^2 \quad \Longrightarrow \quad E = \sqrt{(pc)^2 + (m_0c^2)^2}$$

   This violates linear additivity. Consider two particles at rest ($p = 0$):

   - Particle 1: $E_1 = m_1c^2$
   - Particle 2: $E_2 = m_2c^2$

- Linear additivity requires: $E_{\text{total}} = m_1c^2 + m_2c^2$
- Conventional calculation: $E_{\text{total}} = \sqrt{(m_1c^2)^2 + (m_2c^2)^2}$

If $m_1 = m_2 = m$:

- Linear additivity: $2mc^2$
- Conventional: $\sqrt{2}mc^2 \approx 1.414mc^2$

These are not equal. The conventional "total energy" is not the sum of individual energies — it is the square root of the sum of squares. This violates the most basic requirement of conservation: linear additivity.

Consequences:

- The quadratic dispersion relation allows arbitrarily high momentum modes without a natural cutoff.
- This leads to ultraviolet divergences in quantum field theory.
- The ad hoc renormalization procedure is required to subtract infinities — a mathematical patch, not a physical solution.
- The conventional "energy" is not a genuine conserved quantity; it is a quadratic construct that only approximately behaves like a conserved quantity in certain limits.

In the present framework:

- The fundamental conserved quantity is momentum: $p = mv$
- Linear additivity: $\vec{p}_{\text{total}} = \vec{p}_1 + \vec{p}_2$ (vector sum)
- Energy is a statistical projection: $E \propto mv$
- No squaring, no square roots, no violation of linear additivity.
- Natural cutoff: $p_{\max} = mc$ (unidirectional alignment of all momentum units)
- No ultraviolet divergences, no renormalization required.

Thus, conventional energy fails the fundamental test of conservation: it does not add linearly. A genuine conserved quantity must satisfy $Q_{\text{total}} = Q_1 + Q_2$ — like people, money, or momentum. Energy fails this test.

8.10 Where Does "Energy" Come From? The Fundamental Origin

The fundamental question conventional physics cannot answer: where does the potential energy of a suspended object come from? It is not motion, not photons, not heat — yet conventional theory claims it exists.

The answer in the present framework:

All "energy" phenomena originate from the same underlying mechanism — the borrowing and returning of momentum pairs $(p, -p)$ from potential space via the perceptual cross-section between particles and their environment.

1. **Perceptual cross-section established:** A suspended object and the Earth have an established perceptual cross-section proportional to $1/4\pi r^2$.

2. **Momentum pair borrowing potential exists:** The potential to borrow $(p, -p)$ from potential space is always present — it is proportional to the perceptual cross-section.

3. **Cancellation by external constraint:** The rope provides an upward momentum deviation that exactly cancels the downward borrowing potential. The net momentum deviation is zero, so no macroscopic motion occurs.

4. **No "energy" is stored:** The borrowing potential is not "energy" — it is simply the capacity to transfer momentum. When the rope is cut, the cancellation is removed, and the borrowed momentum pairs are realized as downward momentum, manifesting as macroscopic motion.

5. **Decay and symmetry breaking:** In other cases (e.g., radioactive decay, photon emission), symmetry breaking occurs when internal constraints are released, allowing momentum pairs to be realized as directional momentum.

The origin of all "energy" phenomena:
Particle-environment perceptual cross-section
↓
Potential space momentum pair borrowing $(p, -p)$
↓
Cancelled by constraints (suspended) or realized as motion (falling)
↓
Decay/symmetry breaking releases momentum in specific directions
↓
Conventional "energy" is the statistical projection of this process

8.11 Revised Definitions of Momentum, Force, and Energy Based on Traditional Theory

- **Momentum** ($p = mv$): the **current evolutionary state quantity** — the net directional momentum deviation (vector sum). It describes how much of the internal momentum capacity is currently directionally aligned. It is conserved in isolated systems but is not the internal conserved quantity.
- **Force** ($F = \Delta p/\Delta t$): the magnitude of momentum interaction deviation (symmetry-breaking) per unit time — including interaction toggling and decay release, both triggered by causal interaction.
- **Energy** ($E \propto \int \Delta p = \Delta(mv)$): the statistical measure of momentum deviation over macroscopic distances or cycles — the accumulated projection of momentum transfers.

Note: The truly conserved internal quantity is the total momentum capacity $P_{\text{total}} = mc$ (scalar sum of all internal momentum units), which remains constant regardless of motion state. Momentum $p = mv$ is the current evolutionary state quantity — it can change through interactions while the internal capacity remains conserved.

8.12 The Unified Resolution

In the present framework, all these problems are uniformly resolved: the fundamental essence is the borrowing and returning of momentum pairs $(p, -p)$ from potential space via the perceptual cross-section between particles and their environment. This process merely changes the internal momentum evolution direction or resultant velocity of the particles — no independent "energy" entity is required.

8.13 The Microscopic Quantum Mechanics Logic of Gravity

During radial interaction, particle A enters the perceptual cross-section of particle B with velocity v. The greater the macroscopic velocity v, the larger the effective perceptual cross-section $\frac{1}{4\pi r^2}$. Consequently, the total momentum borrowed and returned through quantum fluctuations in potential space, $\Delta p = Nm_0c$, increases accordingly. The borrowed momentum, in the form of an action-reaction pair $(p, -p)$, toggles the internal states of the fundamental momentum units $Nm_0c \leftrightarrow Nm_0c$ within particles A and B in mutually opposite directions, inducing a symmetric shift in the momentum distribution of both parties. Throughout this process, the macroscopic masses m_A and m_B of the two particles remain constant, and the fundamental unit rate c stays invariant; only the macroscopic velocity v increases incrementally.

This establishes a complete causal loop: the smaller the distance r, the larger the perceptual cross-section $1/4\pi r^2$, the greater the borrowed momentum Δp, and the larger the increment in macroscopic velocity v, which in turn causes r to contract further — the macroscopically statistical emergent energy $(\frac{1}{2}mv^2)$ is precisely the accumulated result of this positive feedback process.

Furthermore, the synchronized increase in the macroscopic velocities v of both particles A and B jointly drives the rapid contraction of the radial distance r. Gravitational effects are not the unidirectional action of a single central mass as depicted in the traditional picture; rather, they are the result of a co-evolution driven by the mutual momentum states of both parties. As A approaches B, B also approaches A; while A gains a momentum increment, B gains an equal and opposite momentum increment. Gravity is bidirectional, cooperative, and mutually driven — not a unidirectional "central attraction."

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