

Consistency of System Changes and the Origins of Complexity

Xue Haibin

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Abstract: Complexity typically manifests as nonlinear relationships between the whole and parts of a system. Chaos emerges through nonlinear evolutionary processes, while emergence arises when the system develops characteristics absent in its components. By analyzing relationships between set-theoretic elements, this paper explores fundamental system theory issues. Based on the premise of a vicious cycle between collective and individual existence, the study derives core relationships governing system evolution, clarifies consistency in system transformation, and identifies the origins of complexity in chaotic and emergent phenomena.

Keywords: spontaneity, consistency, self-reference, principle of relativity, chaos, emergence

Introduction: The existence of a unified logical framework underlying complex phenomena remains an open question, with complexity research still lacking fundamental theoretical paradigms. This paper begins with the basic definition of relative change, constructing a universal framework for understanding complexity through rigorous interpretations of the "spontaneous hypothesis" and the "system change consistency problem." Centered on the principle of vicious cycles, this framework addresses the foundational premise of formal system validity—while logically challenging to formalize, it maintains conceptual rigor and coherence. Ultimately, we hope this framework will provide a new foundational paradigm for complexity research.

main body

1、 Spontaneous hypothesis

This paper primarily explores system theory in natural sciences. Natural systems exhibit self-organizing behaviors, and the universal characteristic of natural changes is spontaneity. However, there is currently no adequate definition of spontaneity within the scientific framework. The study first proposes a hypothesis regarding spontaneity, suggesting it arises from the system's tendency to avoid illegal states.

Whether it is a mathematical system or a physical system, its validity is based on the basis of non-contradiction. And in naive set theory, the invalidity and illegality of

sets manifest as paradoxical states. While classical mathematics avoids paradoxes in formal systems through axioms, this paper posits that natural systems must also avoid such illegitimate states, which are manifested as self-contradictions. Avoidance. Compared to the paradoxical state, this paper defines the choice that a natural system can only exhibit non-contradiction. Spontaneous.

Russell and Poincaré regarded the vicious circle relationship contained in the non-direct definition as the source of the paradox, and Russell suggested The principle of avoiding the vicious circle^[1] is the principle that all effective theories should follow in order to avoid paradoxes. It means that in any set, there can be no individual that depends on the definition of the whole set, and there can be no such whole, that is, to avoid self-reference of definition.

The principle of spontaneity dictates that a system's self-regulating efficacy must avoid vicious cycles. For any individual within the system, this means preventing their definition from being intrinsically tied to the whole. This principle establishes that no entity can exist in the system as a reference point for defining the whole's static state, as such a definition would inherently depend on the system's entirety.

This description contains two key points. First, for the same system, if the system as a whole can define a relatively stationary reference individual, it must be stationary relative to all other individuals. However, if it changes relative to any other individual, it cannot serve as a reference for defining the system's overall state. Therefore, an individual's stationary state must be defined by the system as a whole.

Secondly, within the same system, if the entire system can be defined as a static state, there must exist an individual that serves as the reference point for all other entities to be considered stationary relative to it. This means the definition of the whole depends on this individual. In this case, a reference individual that is relatively stationary with respect to the whole and the definition of the whole's static state based on this reference form a cyclical definition relationship.

The vicious circle principle states that no set should contain a vicious circle

relationship. However, the aforementioned relationship violates this principle. According to the spontaneous hypothesis, such individuals and the whole should be avoided. This leads to two conclusions:

1. Within the system, no individual can exist that depends on the system's definition, meaning no entity can remain static relative to the system. This implies that spontaneous changes must occur throughout the system. This scenario involves observing local system changes against the backdrop of the whole, corresponding to the evolution of microsystems in environments.

Second, "such a holistic entity cannot exist" – meaning that a static whole cannot be defined by referencing a single individual within a system. Otherwise, it would imply the existence of a whole containing such an individual. This implies that any individual must be defined relative to another individual, as spontaneity is inherently self-organizing. Otherwise, the individual would form a "such whole" with the reference individual. This approach of describing evolution through local reference objects primarily applies to macroscopic motion in classical physics. However, regardless of which object serves as the reference, the spontaneity assumption must always be satisfied.

In the principle of the vicious cycle, the scope of the system is arbitrary, and there are no restrictions on selecting reference objects. Through the assumption of spontaneity, it can be deduced that the system must undergo spontaneous changes everywhere regardless of the reference object chosen. This inference of relative change forms the foundation for discussions transitioning from set theory to general systems theory.

2、 System change consistency issue

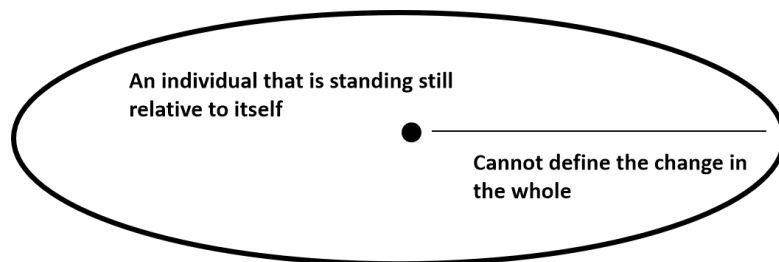
The spontaneous hypothesis suggests that the overall static state cannot be

defined by any single individual within the system, as this would create a circular definition between the local and the whole. This necessitates that all individuals remain in constant flux relative to the reference point, thereby avoiding such staticity. However, if all individuals are in perpetual flux relative to the reference point, does this imply we must also abandon the concept of overall change?

By reasoning further, it will be shown that the system can exist in a state of overall rest, but not in a state of overall change, more precisely, that the changes within the system are inconsistent on the whole.

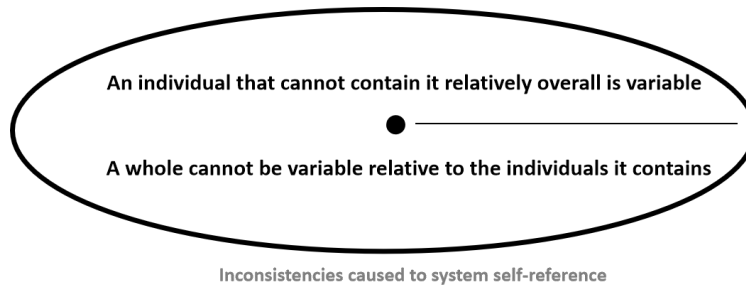
This inconsistency can be understood from the perspective of individuality and integrity of the system.

From an individual perspective, no entity can be defined as changing relative to the whole that contains it, since it remains static in relation to itself. This inherent limitation prevents partial changes within an individual from being comprehensively defined. In other words, defining changes requires a reference to the whole, as partial changes cannot be fully captured without considering the entity itself. This fundamental principle is encapsulated in the crucial statement: "An individual cannot be defined as changing relative to the whole that contains it."



From an overall perspective, if we define change as an object within the whole, there must be a relatively static reference point within the whole. However, if such a reference point exists within the whole, it contradicts the very definition of change. Conversely, if such a reference point does not exist, the whole cannot be defined.

Thus, for any system, overall change always results in an individual within the whole that is inconsistent with the overall change. This is expressed in the key description: "A whole cannot be changing relative to the individual it contains."



Through the above analysis, we observe that when transitioning from local changes to holistic transformations, the local changes inherently undergo contradictory modifications within the overall system. Conversely, when moving from holistic changes to local adjustments, paradoxical transformations also occur. This demonstrates that if changes manifest at the systemic level, they cannot be reflected internally; conversely, if internal modifications are evident, they cannot be manifested externally. For any given system, changes are always incomplete and inherently inconsistent.

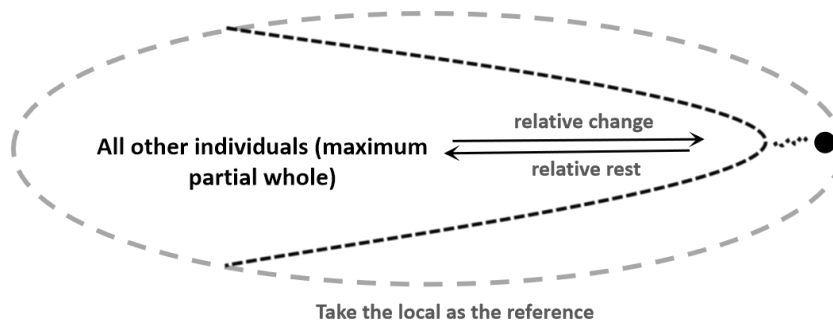
Since the principle of vicious circularity shares the same underlying logic, the consistency issue in system changes can be analogized to the consistency problem in formal systems. Godel's incompleteness theorem states: If a logical system is self-consistent, it cannot prove its own consistency within the system; conversely, if a system is consistent, it contains undecidable propositions. This demonstrates that a logical system's consistency, when manifested internally, cannot be reflected in its entirety, and vice versa.

3、 Evolutionary traversal

The consistency of system change is analyzed through the relative relationship between the local and the whole. Now, taking time into account, from an evolutionary perspective, under what circumstances will the system undergo holistic change?

When any individual within a system serves as the reference point, if all

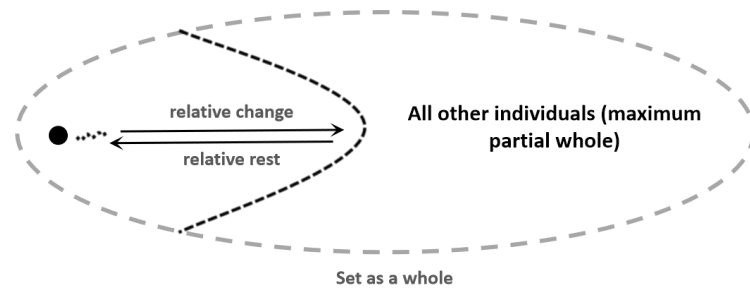
elements within the system are in constant motion, this implies that all other entities within the system must be in relative motion with respect to this reference. According to the principle of relativity, when all other entities are in relative motion with respect to the reference point, the system itself maintains a state of relative rest relative to these entities. Furthermore, the system remains stationary relative to itself, thus achieving overall rest relative to the entire system.



In other words, the whole can only be involved when all other individuals and the reference individual are in a changing relationship. From an evolutionary perspective, the relative whole can only be involved when the relative change traverses all other individuals.

In this scenario, the individual within the system appears stationary relative to the whole, creating a vicious cycle. This results in discontinuous systemic changes from local to global levels, where the overall transformation conflicts with the individual's relative immobility.

Similarly, when observing the evolutionary state of a local entity within a system, the Spontaneous Hypothesis suggests that it must be changing relative to all other entities within the system. When this entity is changing relative to others, the larger local system (the maximum local entity) becomes relatively static in relation to it. Since the system itself remains static relative to itself, the local entity becomes relatively static in relation to the system. This paradoxical situation leads to inconsistent changes between the system's overall state and its local components.



This relative relationship is valid only in the interpretation of the consistency of system change, that is, the whole composed of all other individuals does not exhibit local changes and can be regarded as an independent object. This independence of the whole will be further interpreted in the content of "emergent expression".

Note the distinction between containing time and excluding time. When time is disregarded and only relative relationships are considered, the relationship between an individual and its containing whole remains relatively constant. However, when time is taken into account, only when local evolution achieves universality can it generate holistic properties related to the local. From an evolutionary perspective, the existence of wholeness is not predetermined. Only when evolution reaches the temporal dimension of interconnected wholeness can we define the relative holistic properties of the local.

In summary, the derivation from the spontaneous hypothesis reveals that the universality of local evolution generates global coherence that remains consistent with local variations. The ability to transition from local to global perspectives stems from considering the reference object's state relative to itself. Since the object is stationary relative to itself, it cannot perceive the global environment containing it as undergoing change.

4、 Relative changes are irreversible

Is the system reducible in a relation of relative change?

The interpretation of system consistency in relative change demonstrates that local and global transformations are inherently inconsistent. Local variations cannot be fully reflected in the whole, while global changes inevitably create internal inconsistencies within the system. This implies that within the same system, local variations cannot be equated with global changes, nor can global changes be equivalent to local variations. Therefore, in the context of relative change, the whole cannot be reduced to the sum of its parts.

Here we should pay attention to the basic definition. In the principle of relativity, the state of relative change and rest is strictly dependent on the reference object. Different reference objects define different changes, which is one of the cornerstones of modern physics.

When discussing local changes in a system, we refer to the relative transformations between individual components within the system's overall structure. Each such change is defined by its local reference point. From the perspective of an external reference object, the relative changes of all components are not localized but represent holistic transformations. Even when the system undergoes overall changes relative to this external reference, the individual components within it may remain relatively static. Therefore, holistic changes are not equivalent to local changes.

Reductionism is intrinsically linked to complexity. In complexity science, nearly all phenomena exhibit irreducible characteristics. However, both reductionism and irreducibility remain conceptual frameworks without rigorous theoretical derivation or validation at the fundamental level. Conversely, once we identify the system's irreducible nature, we may discern how the whole transforms relative to its parts, what distinctive features emerge, and ultimately formulate conclusions about complexity.

5、 Show performance

1、 Holistic characteristics

The inconsistency between local changes and the whole indicates that a system can exhibit properties absent in its parts. The specific manifestations of this wholeness have been revealed in the consistency problem: an individual cannot be considered changing relative to the whole that contains it. This demonstrates that local changes cannot be defined within the whole, or in other words, the whole does not manifest local changes.

In the system evolution derived from the spontaneous hypothesis, we define a pair of contradictory relationships as change and rest. However, rest in physics is more often manifested as a kinematic concept. The more accurate contradictory relationship relative to change is actually relative invariance, where rest is contained within this relative invariance. Yet the definition of invariance possesses a broader general applicability.

From the general perspective of this evolution, when all other individuals change relative to the reference individual, the individual remains unchanged relative to others and also remains unchanged relative to itself, so it remains unchanged relative to the whole. This leads to a contradictory change in the whole caused by local changes, and the whole does not show local changes.

2、 Emerging general

On the whole, it does not show the local relative change, and the derivation of this feature does not require any special requirements for the system. Therefore, from the perspective of irreducibility, this paper holds that this feature is universal in all complexity emergence.

This phenomenon can be understood through the phase transition process of ice melting into water. According to molecular kinetics, the melting process occurs when water molecules absorb heat, weakening intermolecular interactions and causing the ice to dissolve. However, in this paper's derivation, the critical factor in the phase

transition lies in the systemic transformation of the local ice structure within the system, which fundamentally alters the original ice configuration without preserving its original structural integrity.

This phenomenon is also observed in superconductivity, where at a certain temperature, the resistance of a material suddenly becomes zero, exhibiting superconductivity. This paper suggests that the phase transition in superconductivity follows the same mechanism, meaning it does not exhibit local magnetic interactions overall.

Similarly, emergent holism is evident in life's evolution. Take ants as an example: their collective behavior demonstrates holistic unity by suppressing internal conflicts and incompatibilities. Even kinship ties dissolve at the colony level, allowing coordinated actions that enable them to adapt effectively to environmental changes.

3、 Display layer

It can be seen that the conclusion to be derived from the interpretation of the consistency problem of system change is not to solve the specific mechanism of a certain complexity phenomenon, but a universal mechanism about all complexity.

Hierarchical layering is a characteristic of almost all complexity. It shows that in the emergence process of material particles from local to global, there is hierarchy between the newly formed units and the original units, and there are independent physical laws between the layers, and the laws of each layer can not be reduced by the laws of the upper layer.

The phenomenon of stratification has been a gradually mature objective fact, but it is more of a phenomenological understanding, lacking a more underlying paradigm, and the systematic conclusion of this paper is a bottom-up description of the phenomenon of stratification.

According to the inference, the emergence of the holism of a certain particle system does not manifest the relative changes between particles. This means that any local changes, including the interactions and spatial positions that change over time, will disappear in the whole, presenting the following physical relationships.

1. The overall lack of local changes means that after the individual is composed into a new whole, all degrees of freedom are "frozen", or degrees of freedom will be embodied in the form of the whole.

2. The positional relationship between particles no longer changes relatively as a whole, that is, the particles form a static relationship.

3. There are no local variables in the whole, which means that the variable interaction between particles is no longer manifested, and the whole is decoupled from the local performance.

4. There are two possibilities for this decoupling. One is the formation of a strong correlation, which is the overall structural feature that remains invariant relative to all local effects. The other is the absence of measurable interactions, which may also be the absence of interactions at all.

It becomes evident that the emergence of holistic systems in localized regions, beyond structural component relationships with local entities, no longer manifests the original degrees of freedom, spatial configurations, or interactions. This fundamental "disregard" creates a hierarchical structure between two material entities. Within this framework, laws and phenomena at different levels operate independently. Such hierarchical organization exists in all complex emergent processes, forming a foundational principle that governs their development.

The holistic structure formed by all particles does not reveal their relative interchanges—a peculiar characteristic that renders this unity irreducible, as it cannot be fully described through particle-level interactions. In computational physics, methods designed for local variable calculations prove fundamentally flawed. The inherent vicious cycle within these relationships creates fundamental mathematical paradoxes, leading to computational intractability and logical inconsistencies when attempting to model holistic systems.

4、 The holistic, simple meaning

Why does the emergence of holism come at the expense of not expressing the relative changes of the parts?

When we casually toss glass beads onto the floor and observe them, we fail to perceive or define their emergent coherence. This occurs because our observation follows the scattered beads, focusing solely on their relative positions. Our perception is guided by the continuous spatial relationships between individual beads, which fundamentally governs this localized observation.

To perceive the wholeness of a glass sphere, one must eliminate the relative changes between individual parts. In other words, a system can only demonstrate its wholeness when it does not exhibit relative changes among its components. More precisely, only by disregarding the relative changes between individuals can the collective composed of individuals manifest as an independent entity. In the phenomenon of stratification, each independent layer of phenomena and laws is precisely established through the ability of each unit to present itself as an independent object.

The independence of objects in layered cognition extends beyond natural systems. In language systems—whether a Chinese character, an English word, or a sentence — we perceive this holistic independence. Meaning emerges from the coordinated functioning of its constituent parts, without which we would face linguistic confusion and communication barriers. Fundamentally, the brain processes information through this holistic approach, including capabilities like generalization, abstraction, and induction.

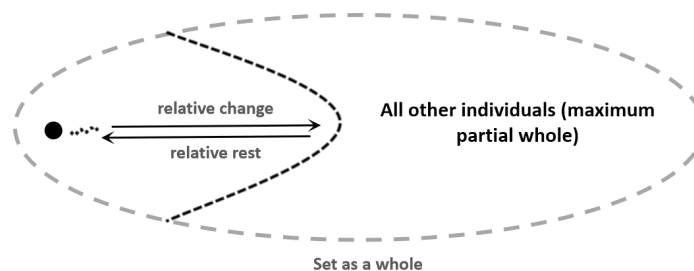
Thus, the holistic approach avoids highlighting partial variations. The fundamental significance of this comprehensive characteristic lies in its capacity to present the collective of original units as a distinct entity, while simultaneously

'isolating' the dynamic interactions and spatial configurations between them. This methodology enables the construction of a natural system characterized by diversity and hierarchical organization.

5、 Critical Mechanism

In addition to hierarchy, what other features does this wholeness involve in evolution?

According to the spontaneous hypothesis, evolution must have a process of going from the local to the whole. When evolution approaches a change in the whole, the final and most critical step of local evolution will appear, that is, when the observed individual is changing relative to "all the other individuals", it will exhibit a holistic feature that is inconsistent with the local.



This evolutionary state will have the following characteristics:

1. Simultaneity. The emergence of this evolutionary state inherently generates a holistic structure with localized inconsistencies. Crucially, this state and the resulting holism are not temporally sequential but coexist simultaneously. When evolution reaches this stage, the holism emerges alongside localized inconsistencies. While temporally concurrent, these two aspects operate at distinct spatial dimensions and characteristic levels.

2. Globality. Relative to all other individual parts, the change is global in that it is associated with all other parts, and the length of the association is global, that is, the size of the entire system. Conversely, when a local change is associated with the global, the emergence of globality occurs.

3、 Sensitivity. For a microscopic system of a huge order of magnitude, the change near a single individual is only a very small local change. Therefore, when the evolution traverses the whole, the final change of the whole is only caused by the small local change near the reference individual, and the system will show sensitivity.

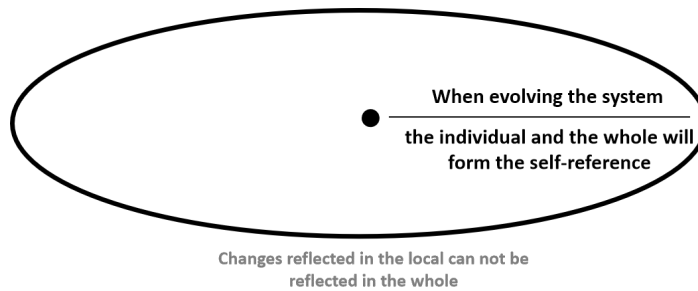
4、 The Uncomputability of Relative Reference. When all individuals are in constant flux relative to their reference points, evolution's progression from local interactions to holistic properties hinges on the relationship between an observed individual and itself. When attempting to compute wholeness from partial data, this creates a self-referential paradox where the individual becomes a fixed reference point, inevitably leading to either infinite divergence or self-contradiction.

This is a description of the "final step" of holistic emergence, which this paper argues is the underlying mechanism of critical phenomena.

6、 Emerging dynamics

The holistic nature of systems inherently resists partial modifications, representing their intrinsic characteristic of maintaining unity while existing independently of external influences. In natural systems, however, emergent holistic properties are always coupled with environmental interactions, and hierarchical relationships between systems evolve continuously. What then drives this dynamic interplay between external emergence and hierarchical development?

The driving force behind spontaneous changes in this article originates from the Spontaneity Hypothesis. This hypothesis requires systems to avoid the vicious cycle between individual components and the whole. However, when applying this principle to deduce the evolution of an isolated system, while local avoidance of this relationship may occur, the system's evolution ultimately leads to a state where individual components remain relatively stationary relative to the whole. This creates a self-referential relationship where individual components depend on the whole's definition, resulting in inconsistencies within the system's own evolution.

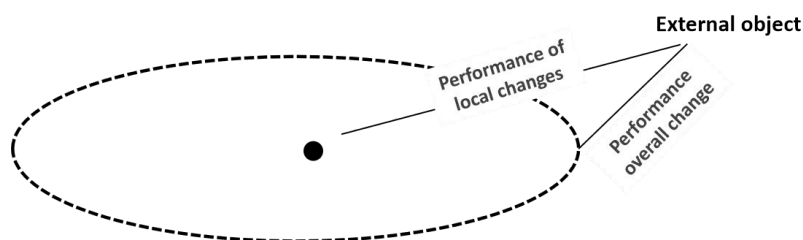


This contradicts the self-organizing hypothesis, necessitating the avoidance of inconsistencies caused by such relationships to ensure consistency in both local and global changes. However, since evolution has already traversed the system, the original system's self-referential issues can no longer be resolved internally. The only viable solution lies in demonstrating consistency through an additional or larger system.

This still has to reflect two aspects:

The fundamental principle to avoid is the existence of a relatively static individual within the whole. This requires all entities within the system to undergo spontaneous transformation. However, since the chosen stationary reference point remains stationary in the original system, local entities can only exhibit changes relative to the external system. Crucially, these changes are defined within the whole system itself, representing localized modifications within the original framework.

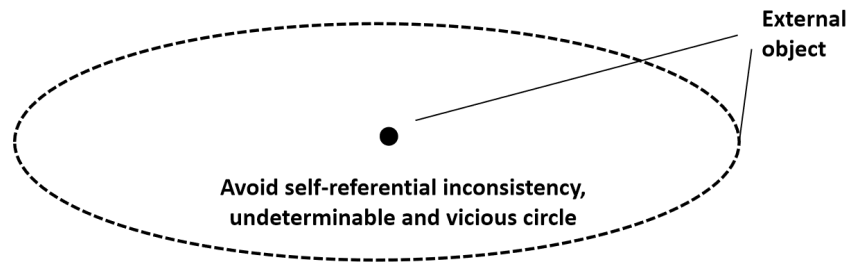
Second, we must avoid the notion of a 'static whole' — that is, a whole that remains relatively stationary. In the original system, a whole cannot change relative to the individuals it contains. Therefore, the system's whole can only change relative to other systems, meaning the whole itself must be dynamic.



Contrary to the initial analysis of the system's static state, when evolution traverses the whole, the system becomes neither static nor dynamic. This is because all other individuals are changing relative to the reference individual, while the whole

itself cannot change relative to its constituent individuals. In other words, the state of the system as a whole remains undeterminable.

Therefore, there can not be a relatively local and static whole, and it must also have a valid validity. The whole can only be relatively changing from the additional system, showing consistency and validity.



In summary, to avoid self-referential issues in the original system, consistency and validity must be demonstrated within a broader framework. This requires that if the original system undergoes partial changes, the entire system must also evolve accordingly. The distinction between these two aspects arises because systemic transformation isn't equivalent to localized modifications across all components—it's inherently irreducible. Therefore, these two dimensions must be addressed separately to ensure effective mitigation.

The consistency of changes in relative extra-system performance reflects the 'everywhere change' derived from the spontaneity hypothesis. This implies that not only are local changes present, but the emergent whole must also undergo transformation. Such holistic changes in relative extra-system performance indicate that emergent wholeness is always coupled with the external environment.

This approach of avoiding the self-reference problem of the original system through the iteration between systems is the same as the purpose of type theory in mathematics, which is to avoid the self-reference of each layer through a strict hierarchical structure. The difference is that in the system change described in this paper, the hierarchy is generated spontaneously.

Understanding the relativity of consistency proves challenging due to additional systems involved. Crucially, even within larger systems, the local and global aspects of the original system remain inherently inconsistent and self-referential, merely demonstrating consistency relative to external observers. This relativity of consistency corresponds to a practical process where an external observer can perceive both localized changes and the system's holistic nature, yet cannot simultaneously observe both aspects within the same system, as they inherently conflict with each other.

For example, for a piece of ice and its water molecules, we can observe the inconsistency of their characteristics in sequence over time, but we cannot observe the local water molecules and the emergent ice properties in the same system at the same time. The requirement for simultaneity is absolutely strict.

6、 Create Chaos

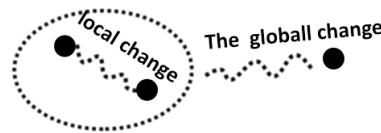
1、 Nonlinear source

In the emergent dynamics process, when the evolution of the whole is traversed, there will be inconsistency between the whole and the local. The spontaneous hypothesis requires that this inconsistency be avoided in a larger system, so that the local and the whole of the same system will behave in a consistent way relative to external objects.

However, the irreversibility of relative changes indicates that holistic transformation does not equate to uniform local modifications across a system. Within the same system, the absence of observable local changes at the macro level renders the overall transformation relative to external observers as an "additional"

phenomenon, representing a distinct type of relational change from localized alterations. This implies that when partial evolution permeates the entire system, it triggers non-continuous holistic changes. Since these constitute two distinct types of transformations, the localized changes must be superimposed upon the holistic transformation, resulting in a non-linear relationship between the discontinuous holistic evolution and its localized components.

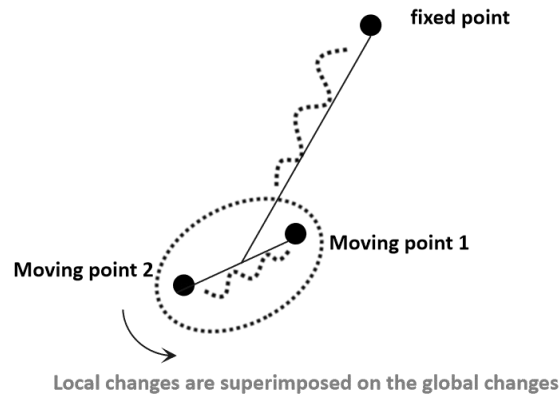
This evolutionary process can be best understood through the simplest two-body system. When an external object is fixed, any individual within the system undergoes relative changes compared to the other. Simultaneously, the system as a whole also evolves relative to this external object. In such a scenario, any localized change in an individual continuously accumulates with the system's overall transformation, resulting in a nonlinear dynamic process.



Local changes are superimposed on the global changes

This phenomenon is most vividly illustrated by the chaotic pendulum. In the two-pendulum system, the fixed points can be viewed as external objects, while the moving points form a two-body system. The chaotic motion of these moving points arises because they are connected by a rod, creating an indivisible unit. Since the moving points remain fixed relative to this unified structure, changes within the system become inconsistent between local and overall perspectives.

This ultimately results in the motion of two relatively fixed pivot points being the superposition or coupling of local and global changes: While the fixed pivot points exhibit localized variations, they are constantly overlaid with an additional global change. Since this superimposed motion remains continuous, the discontinuity between local and global changes becomes imperceptible.

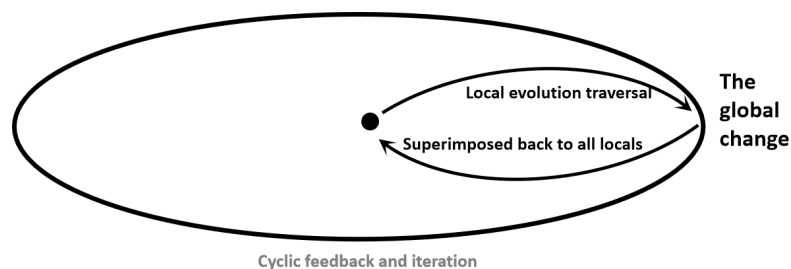


In the continuous motion of point arrangement, its discontinuity is reflected in the unpredictability of the motion trajectory. It is the continuous superposition of the discontinuous change of the whole on the change between local parts that ultimately leads to the nonlinear trajectory change in the continuous motion.

2、 Evolutionary reflexivity

From a dynamic perspective, the system's evolutionary universality creates a vicious cycle between local and global aspects, triggering spontaneous assumptions that ultimately drive systemic transformation. While the observed consistency with external phenomena may appear superficial, the underlying cause stems from the system's inherent evolutionary process.

It can be said that for any local satisfying the spontaneity hypothesis, the whole traversed by the local change is changing because of the change, which leads to the continuous feedback of the whole change caused by the local change back to itself, showing the reflexivity of evolution.



It should be noted that there is no feedback if the local and global linear changes are consistent, or if the local changes everywhere are equivalent to the global changes

in reducible relations. It is the inconsistency between the global and local changes that triggers the spontaneous hypothesis and achieves dynamic feedback.

The strict implementation of the spontaneous hypothesis is the absolute avoidance of rest, and is the embodiment of change everywhere, precisely Everything changes, so not only the local changes, but also the whole composed by the local changes. The relative change that can not be reduced determines the nonlinear superposition and feedback process of the whole change and the local change.

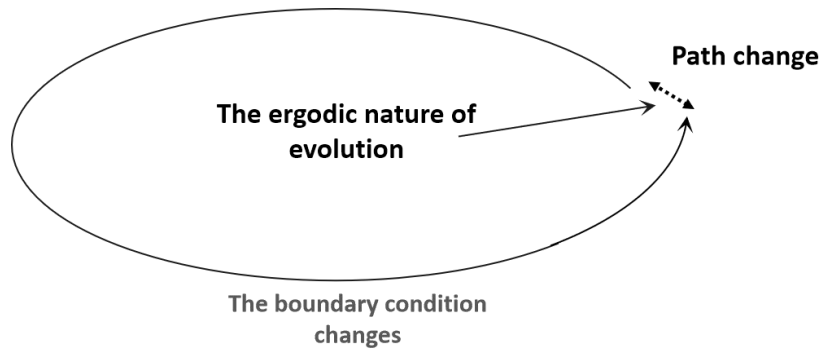
Local and global are a relative concept. Any system that follows the assumption of spontaneity, the global and local of the system, the "local global" and its local are always undergoing such a process.

3、 Path layer expansion and fractals

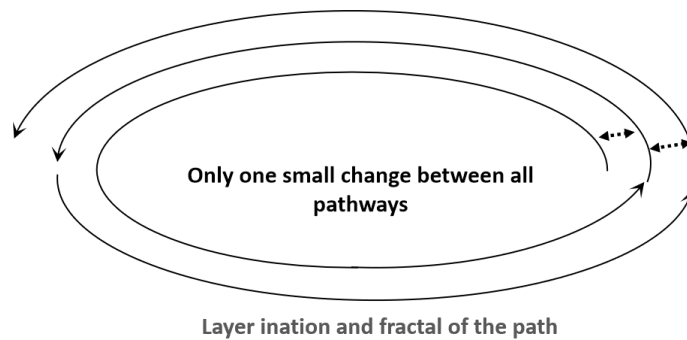
On the basis of the above understanding of chaos, what are the characteristics of the evolution path of an individual from the initial state to the final state of the system?

First of all, it can be seen from the spontaneous hypothesis that no matter what state the system evolves to, its local state must first satisfy the ergodicity.

When an evolutionary system undergoes traversal, a fundamental transformation occurs. This additional change relative to local modifications acts as a novel, global constraint that instantly impacts every individual within the system. By altering the boundary conditions governing each individual's movement, it creates a feedback mechanism that redirects the subsequent trajectories of localized changes. Consequently, no individual's evolutionary path will ever repeat its original local path, resulting in hierarchical modifications of evolutionary pathways.



The system continues to evolve through spontaneous changes along new "paths" while maintaining traversability. This creates a cyclical feedback loop between global and local dynamics, where hierarchical transformations persistently occur. The quantification mechanism of these path changes adheres to the principle of minimal variation. No local subsystem demonstrates independent evolution, as these "local subsystems" differ only by minute path variations. This process naturally produces self-similar fractal structures during hierarchical development.



4、 Attract mechanism

In the relative relationship, "a whole cannot change relative to the individuals it contains", which indicates that the whole is invariable and certain to change relative to the local part. We understand this invariance and certainty from the two perspectives of qualitative and quantitative mechanisms.

From a qualitative perspective, the nonlinear divergence in local evolution results from the superposition of global changes and local variations. The "terminal point" of this divergence occurs when global changes cease to accumulate. Essentially,

when we stop considering specific systemic transformations, nonlinear feedback mechanisms terminate. At this stage, the system exhibits only localized changes. The principle of "no manifestation of local divergence at the global level" implies that such localized divergence remains confined within the system's boundaries, preventing any observable manifestation of partial divergence across the entire system.

For instance, when studying the evolution of Earth's internal ecosystems or weather systems, we typically disregard the planet's overall evolution as an independent celestial body within the solar system. If we were to consider it, all local ecological and weather processes would need to incorporate gravitational interactions between celestial bodies. This would make these processes extraordinarily complex on larger timescales, as the divergence would not be contained. Similarly, when an experimental model is established within a specific "system," natural divergence would be confined to that particular framework.

However, the above description shows that the "termination" of divergence seems to be determined by the finiteness and boundedness of the system, or by ignoring the external factors of the system. It is a problem of constraint or "precision" to the whole. After all, the natural system is an open system, and there is no completely isolated system.

However, this paper maintains a rigorous interpretation of system consistency. Under the spontaneous assumption, as long as a local change exists in relation to the whole, the whole will not manifest that local change, and consequently, its divergence will not be observed. Therefore, there is no need for neglect or constraint. As long as a change is considered "local" relative to a given whole, the evolutionary trend toward that whole will not exhibit divergence.

The bounded and finite nature of a system fundamentally clarifies its holistic framework by defining its relative local variations. For instance, gravitational forces within Earth's interior represent localized changes that do not diverge from the planet's overall evolution. In contrast, the gravitational influence of the Sun or Moon constitutes a "holistic change" that triggers divergent evolutionary processes within

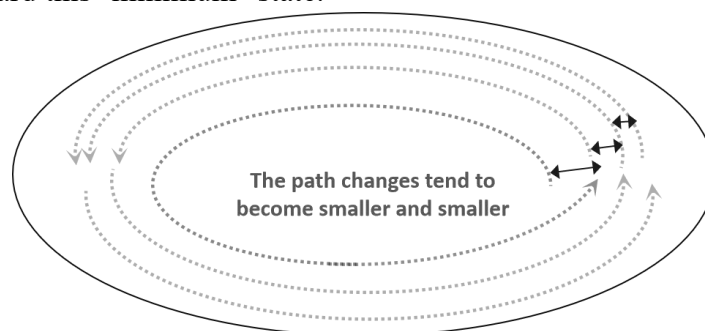
Earth's interior.

The strictness of the relative relationship between local and global means that in a chaotic system, the system is everywhere divergent, but also everywhere attractive, and any local change relative to the initial state is everywhere divergent, and relative to the local global is everywhere attractive.

Let's understand this attraction in a quantitative way.

The infinite nature of attractors is primarily manifested in the fractal structure of evolutionary paths. The existence of self-similar fractals arises because adjacent local wholes differ by only a minimal path variation. The system's overall attractor behavior is reflected in the quantification mechanism of this path change.

This phenomenon manifests as path deviations when evolutionary processes converge toward holistic integration and achieve ergodicity, with such path modifications adhering to the Minimum Change Principle (20). Within this principle, the "minimum" in system evolution is quantified through the "intersection" of all possible changes during ergodicity. As a global functional quantity, the concept of "minimum" is fundamentally defined by the system's "holistic" nature. The system's inherent attraction manifests through the quantitative mechanism that drives convergence toward this "minimum" state.



Results following the principle of minimal change

According to the definition of this quantification mechanism, the larger the overall scope of the system's state, the smaller its "intersection" becomes, resulting in progressively smaller "minimums" required for path modifications. This implies that as chaotic systems approach their terminal states, their evolutionary paths paradoxically contract, exhibiting overall attraction. For systems with an enormous

number of microscopic states, this path-minimization process can approach infinity.

It should be noted that the system's state space contains a vast number of states, each evolving according to the previously described system dynamics. Consequently, path variations may differ across chaotic systems. This paper focuses not on system-specific differences, but rather on the fundamental principles governing their behavior.

In conclusion, the system evolution path derived from the consistency of system change has the characteristics of transitivity, self-similarity and non-repetition of trajectory, which is basically consistent with the experiment and observation of chaotic system.

7、 The basic principles of system evolution

According to the Spontaneous Hypothesis, individuals spontaneously generate relative changes to avoid relative invariance. This implies that once changes occur, they naturally lose their spontaneity. In other words, spontaneous changes have this characteristic: no matter how minor the change, the mere act of generating it achieves avoidance of invariance while simultaneously losing the capacity for further change. This conclusion will lead to two principles that evolution must follow.

1、 Minimum change principle

Any change, however minor, achieves the avoidance of invariance simply by "producing change," thereby losing the capacity for further transformation. This implies that systems will always minimize the cost of maintaining relative invariance. This principle-based definition indicates that the extent of change within a system is not arbitrary, and its evolution must adhere to the principle of minimal change.

This fundamental principle demonstrates remarkable universality. While specific metrics like displacement, energy difference, or information entropy may vary across systems, its core concept remains consistent: "spontaneous" change prioritizes effectiveness over particular measurements. Effectiveness means losing spontaneity, and when change occurs, it halts immediately. This ensures state transitions always manifest as "minimal".

The minimization of effort for state transitions naturally evokes two fundamental principles in physics: the principle of least action and the principle of minimum energy. This paper posits that these two principles can be viewed as concrete manifestations and quantitative formulations of the principle of minimal variation in the physical domain.

1.1. principle of least action

The Principle of Least Action states that the actual evolution path of a physical system between any two states is the one that minimizes its action (typically defined as the time integral of the Lagrangian function). As a global quantity, the action encapsulates the dynamic information of the entire process. The essence of this principle lies in the fact that the system does not perform locally optimal movements at each step, but instead selects the path with the lowest cumulative cost among all possible trajectories.

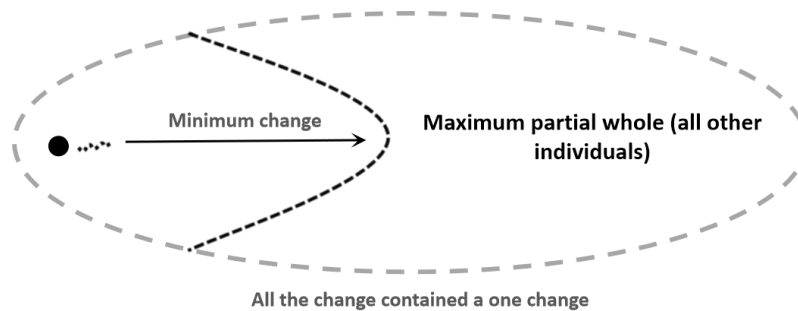
This perfectly aligns with the essence of the principle of minimal variation. The principle of minimal variation states that relative changes aim for the smallest possible magnitude. However, in a specific system, how is this 'minimum' defined, and what mechanisms quantify it? Note that these are two distinct questions: first, whether changes 'pursue' the minimum, and second, how to define the 'minimum' to be pursued.

From the perspective of system evolution, when starting from an individual's initial state, it is impossible to determine whether each local change is the smallest during the process of the system evolving locally to traverse the whole. However,

when the individual changes relative to all others—that is, when evolution involves the whole—the smallest can be defined.

At this stage, the individual must undergo transformation relative to all others. To fulfill this requirement, it must embody "a change present in all relative transformations" compared to other entities — essentially a change that exists in relation to all others. This transformation represents the "intersection" of all changes and the "smallest" variation among relative changes. Note that this transformation does not refer to static numerical values, but rather to differences between exponential values.

It can be seen that the minimum change a system should follow is a global change, and only when all changes are involved can it be defined as "minimum" and its "quantitative" reference standard can be known.



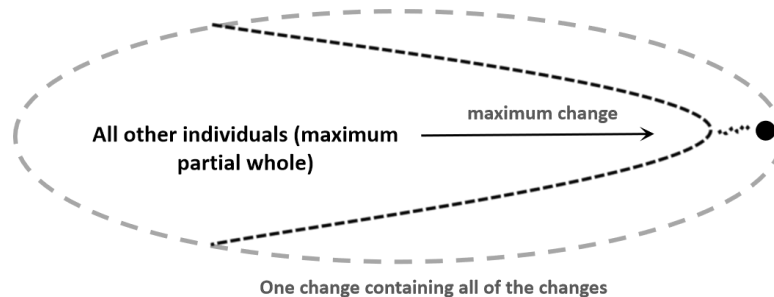
This aligns with the mechanism of the principle of least action. To avoid initial relative invariance (which corresponds to a non-equilibrium or unstable state), the system's entire evolutionary trajectory follows the path that minimizes the global change quantity. For instance, the refraction of light at a medium interface results from the light's selection of the "shortest optical path" to connect two points within a fixed time. This can be interpreted as light adhering to the principle of minimal change during propagation, achieving state transitions through minimal geometric path variations. The path is defined and selected among all possible variations.

1.2. Maximum action principle

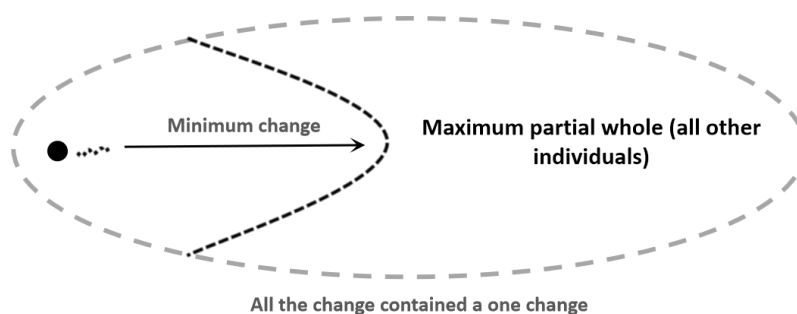
There are two scenarios that lead to systemic changes in the system. One is to

observe the process of individuals evolving from the initial state to the final state in the context of the whole. The other is to evolve the whole process with local individuals as the reference.

When a system evolves with a fixed reference point (i.e., a stationary reference point), its dynamics increasingly resemble cybernetic principles. In such cases, as evolution spans the entire system, all individuals must undergo relative changes with respect to this reference. To satisfy this requirement, there must exist a "single transformative process that encompasses all relative changes" — a mechanism allowing all individuals to exhibit variations relative to the reference point. Among all possible relative changes, only the most significant transformation can fulfill this essential condition.



First, consider the distinction between this concept and the minimum variation in the principle of least action. Minimum variation refers to "the variation that encompasses all variations," while the maximum variation described here is "a variation that contains all variations." It becomes evident that this maximum variation is also a global quantity, and it maintains a close relationship with minimum variation. Essentially, these two concepts represent manifestations of the same mechanism along different evolutionary paths.



Since the application of the maximum action principle is limited, we use the same example to understand the relationship between the two. In front of us, we use the shortest path to understand the minimum action principle, and light always finds the shortest path between two points.

However, the "shortest optical path" described in Fermat's theorem is an observation and understanding based on all possible paths, meaning it examines local evolution against the backdrop of the entire path ensemble. From a wave-like perspective, light's temporal evolution must traverse all possible paths to find the shortest one. The wave-like nature that encompasses "all paths yet does not manifest each path individually" precisely embodies the "maximum" path.

The maximum path is the result of considering the integrity (fluctuation) of evolution with the initial state or light source as a fixed point, which is consistent with our definition of maximum change.

The simultaneous emergence of a system's maximum and minimum variations within the same relative framework could potentially resolve numerous physics challenges. Consider the paradox of vacuum energy density: experimental measurements differ by 122 orders of magnitude from theoretical calculations. If vacuum zero-point energy is interpreted as the smallest measurable variation in the observable universe, this framework would imply that such variation simultaneously corresponds to the system's maximum observable change. However, the mathematical framework's inherent relativity and self-referential nature make this duality fundamentally incompatible, resulting in irreconcilable contradictions.

1.3. Minimum energy principle and system stability

The principle of least action primarily concerns defining the minimum, whereas the principle of minimum energy focuses on the dynamic pursuit of this minimum during evolutionary processes.

The principle of minimum energy states asserts that isolated systems or those in

contact with a constant-temperature heat source spontaneously evolve toward stable configurations with the lowest possible energy or free energy. This phenomenon can be understood as systems naturally transitioning to states with reduced "potential" through energy dissipation or reorganization of internal degrees of freedom. This process embodies the principle of minimal change: systems do not undergo random transformations but seek a final state that minimizes internal dynamic processes. Examples include water flowing downhill, electrons occupying lower energy levels in atoms, and chemical reactions tending toward equilibrium – all manifestations of systems dynamically pursuing energy minimization.

The minimum action principle and the maximum action principle can be collectively referred to as the steady action principle in evolution, which indicates that the steady state to which the system eventually returns will exhibit extremal conditions in terms of action. Why is this so?

In the problem of consistency of system change, "the whole is invariant relative to the individuals it contains", that is, the whole is invariant relative to the local evolution. In terms of dynamic evolution of time, the characteristics of wholeness are stable and maintain invariance relative to the local evolution.

The analysis in the first two sections shows that the minimum and maximum changes are globally defined, meaning their definitions involve the whole. As described in the critical mechanism, when evolution traverses the entire system, these local states simultaneously exhibit holistic characteristics. Therefore, both states maintain stability relative to local evolution.

But this seems to contradict the description of the critical mechanism, how can a system in a critical state be stable when it is abnormally sensitive?

It should be noted that the principle of minimum variation, which relates to the principles of minimum action and minimum energy, does not merely refer to the minimum in critical states. Instead, it implies that any local part of the system strives for 'minimum'. However, only in critical states does its 'sensitivity value' reveal the system's permissible 'minimum' size, thereby determining the metric approach.

The stability of the minimum in the action is due to its definition involving the whole, while the system's whole exhibits invariance relative to its parts. Similarly, maximum variation also demonstrates invariance relative to the system, but differs in that it only occurs when the system's ergodic evolution reaches its terminal state.

In this context, the system must be analyzed through two distinct perspectives. For hierarchical open systems, when they reach the critical state of maximum variation, emergent phenomena will inevitably arise. At this stage, the maximum variation loses stability as the entire system undergoes transformation. The conventional definition of "intersection" for minimal variation only serves to reduce its magnitude, while additional changes will continue to amplify the maximum variation.

However, in the case of a closed, isolated system, or a boundary bound state, the maximum variation is relatively stable to the system, because the whole is no longer changing, it is certain. Because of the limited applicability of this situation, the application scenario of the maximum action principle is limited.

2、 Inertia principle

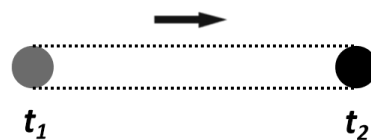
In the spontaneous hypothesis, when a relative change is produced, that is, the avoidance of invariance is achieved, and the ability to continue to change is lost, which means that the change has the ability to remain invariable. This ability is similar to the description of inertia, which refers to the ability of motion to remain invariable.

2.1 Systemic Mechanism

The system-wide conclusions derived in this paper are universal, applicable to

any system and any change, stemming from the arbitrary applicability of the vicious cycle principle underlying these inferences. Under this universality, all physical systems can be categorized into two types: one involves system changes constituted by different states of objects, representing the most common multi-body systems; the other involves system changes formed by different states of the same entity. The inertia discussed in this section specifically refers to this latter category of systems.

In kinematics, the concept of "inertial persistence" refers to the temporal sequence of a system's motion states, involving systematic changes in an object's motion patterns across different moments. Consider a two-body system: when an object moves from time t_1 to t_2 , if its motion state undergoes changes at these two moments, the interpretation of system consistency dictates that the combined motion state of these two instances would not demonstrate the observed change.



When no change in motion state is observed overall, it indicates the motion state of t_1 . Relative to the current t_2 state, it demonstrates the maintenance of the motion state from the previous t_1 moment, which is the inertia we aim to interpret.

Because in the same system, the characteristics of the whole and the local are inconsistent, so we can only obtain one of the two characteristics at the same time. At any given moment, we can not observe the inertia. Inertia is the holistic characteristic of continuous moments and the product of the process.

Inertia indicates a change in the state of motion of a body, and in the whole of these states there arises a characteristic that counteracts the change, manifested as the maintenance of the state of motion before the change.

2.2 The meaning of inertia and the general concept of inertia

Can inertia in classical physics be reconciled with this systems-theoretic interpretation? First, in classical mechanics, inertia is an inherent property of objects

independent of their motion state, measured by mass. This emphasis on inherent properties implies that even stationary objects possess inertia. When applying a small force to push a heavy box, its motion state remains unchanged, yet we still perceive an inertial "resistance".

However, this understanding is based on ignoring minor variations. If we disregard the "resistance" caused by other forces like friction, any external force acting on a box in a vacuum will inevitably cause displacement and alter its motion state, even if the change is minimal. Therefore, to reconcile with the systematic mechanism of inertia, we cannot ignore these subtle changes in motion states, as inertia itself originates precisely from such variations.

Without a change in motion, there is no emergence of inertia, and a heavy box corresponds perfectly to a small change, which cannot be ignored. Under this interpretation, a completely stationary object has no inertia.

Whenever motion states undergo changes, inertia emerges as a collective phenomenon. This conceptual framework implies that inertia transcends macroscopic motion, permeating all levels of motion. As there remains no unified theoretical interpretation of mass, we provisionally define this universal mechanism as a fundamental principle, with subsequent additions of measurement methods for inertia.

In this study, inertia manifests as the temporal emergence of systemic wholeness, while common emergent phenomena primarily demonstrate spatial emergence. Both processes play crucial evolutionary roles: The spatial coherence of distinct entities can coalesce them into a unified new substance, whereas the temporal emergence of identical entities enables these novel material properties to persist over time, thereby facilitating further evolution at a higher level.

In the natural environment, any observable feature of things is related to inertia, which provides time support for the interaction between microscopic things, and the continuous emergence of inertia from microscopic to macroscopic levels provides time support on a larger scale for the stability of the macroscopic world.

Every new understanding of inertia in human history has ushered in a new era of physics. The systematic definition of inertia reveals that an object's inertial properties encompass both present and past moments and positions, meaning its definition inherently involves temporal and spatial transformations. This system definition contains a self-reinforcing cycle, suggesting that changes in motion states and their emergent phenomena might allow us to redefine time and space through entirely new perspectives.

sum up

The principle of the vicious circle in set theory provides theoretical support and context for discussing general issues in systems theory. The core focus of this theory lies in rigorously interpreting the consistency of system changes based on the self-referential hypothesis, clarifying how systems become irreducible in relative transformations. Notably, while we can avoid self-reference in mathematics to ensure logical validity within formal systems, self-referentiality remains an inherent state in system evolution. This characteristic cannot be ignored or prohibited during continuous evolutionary processes.

Theoretical Application

1、 A primary definition of space-time

1.1 Emerging space

The state of motion in the definition of inertia includes time and space, so the cyclic definition contained in this system definition can be used to define time and space in reverse.

The problem of consistency of system change applies to any system and any type of change. It can be divided into two categories for discussion. One is the system change composed of different states of different objects and the other is the system change composed of different states of the same object.

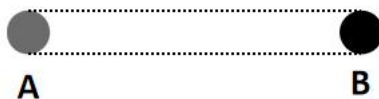
Multi-body systems composed of different states of objects are the most familiar systems to us. Thermodynamic systems, microscopic systems, and macroscopic systems mainly describe the changes of systems composed of different objects. To describe the nature of space involves the changes of systems composed of different states of the same object.

To interpret space, there is no pre-existing spatial background to reference. Thus, any object's motion must be understood in relation to its own position. This involves system transformations arising from different positions of the same object. When an object moves, it undergoes positional changes relative to its original position. This phenomenon mirrors the motion along a timeline in the single-electron universe hypothesis.

Consider a two-body system at a given position. When the system undergoes changes that are inconsistent across the whole, it creates a holistic feature in the transition from position A to B, where the overall change is not reflected. This results in the object still displaying its previous position A while showing the current position B.

It is valid to extend the two-body system of position to the multi-body system, that is, no matter how many positions are traversed by continuous motion, the relative

changes between local positions are not considered in the whole, and only all positions of the motion process are expressed at the same time. This simultaneous expression of different positions is defined as space.



According to the rigorous interpretation of system consistency, this characteristic inherently exists during actual motion processes without any artificial constructs. The positional degrees of freedom within self-referential holistic features can be infinite. Even when continuous motion involves an infinite number of positions, all local variations (with infinitely many variables) at these positions won't diverge infinitely in space, as the system as a whole doesn't manifest these localized changes.

This definition directly links the infinite degrees of freedom of position to the overall finite space, without the need for mathematical reorganization. Conversely, the idea of reorganization that ignores local details coincides with the holistic nature of this lack of local variation.

From the perspective of irreducibility, space is the emergent feature of a system formed by different positions of the same thing, which is non-local relative to local motion. Space cannot be separated from the motion of matter, and it is not an independent background, but the inherent feature of the motion of things. Simply put, every thing has its own space.

In classical mechanics and relativity, relative motion can only be discussed when at least two objects are involved, or one object with a reference frame. The positional changes of an object relative to itself, from the perspective of system evolution, represent inherent local characteristics of the system itself — these are intrinsic properties unrelated to external objects. In theory, an object should remain stationary relative to external objects. This concept is somewhat abstract, as we are accustomed

to spatial existence. Therefore, we should strive to understand the following description.

Relativistic motion cannot exist without space. It is precisely through the emergence of space during motion that motion evolves from a local feature of a system to a holistic characteristic, thereby manifesting itself. In other words, the absolute motion of a single entity is simultaneously expressed as relative motion between different entities.

This is a very profound question. Motion is a feature, regarded as a basic concept of natural science, but how the relative motion of a thing to itself and the relative motion of a thing to the outside world are related has always been regarded as self-evident or philosophical.

1.2 Time definition and time arrow

The concept of time is used in the definition of space, but the time has not been defined, how can we assume the existence of time? Let us first define time, and then go back to understand this problem.

In reality, space enables the definition of time, and position allows the definition of motion. Space can be simply summarized as the simultaneous manifestation of different positions of the same object during motion. It is precisely this simultaneous manifestation of these positions that defines the sequence of an object appearing at positions A and B, thereby defining time — the process where the same object manifests at different locations.

Clearly, this definition of time presupposes the preexistence of space, while the definition of space inherently includes time as a prerequisite. Thus, causally speaking, time and space mutually define each other as prerequisites, forming a pair of causally self-referential concepts.

Space exhibits invariance through holistic-to-local transformations, while time demonstrates locality through local-to-holistic changes. These dual characteristics conflict within a unified system, causing spatial features emerging from motion to fail to manifest their inherent temporal dimensions. The temporal concept we employ is relative—defined through external objects as reference points in motion.

In this spacetime framework, our present spatial existence emerges through our own motion patterns, meaning the present is simultaneously defined by our physical presence and temporal continuity. This space arises from localized motion, encompassing the positions of past events. The inherent disconnect between local dynamics and global reality prevents us from traveling backward in time, as doing so would erase our current spatial existence.

Thus, the temporal-spatial incompatibility within the same system dictates that time can only flow from past to present, thereby manifesting only current characteristics. In the emergence of space-time, spatiality is an essential prerequisite for our existence, making the process inherently irreversible.

2、 Material hardness and generalized rigidity

Hardness, a macroscopic property in materials science, primarily describes a solid's resistance to deformation. However, the fundamental mechanisms behind this phenomenon — why materials exhibit hardness and resist deformation — transcend purely empirical observations. The lack of a unified explanation for hardness stems from multiple influencing factors, including molecular forces, chemical bonds, crystal structures, atomic arrangements, and external temperature and pressure. Essentially, any factor capable of inducing localized changes can affect a material's hardness.

However, when multiple factors are considered simultaneously, the "More is Different" problem emerges, where hardness becomes a complex issue—meaning a

material's hardness characteristics can not be reduced to the sum of all factors. When we attempt to probe the fundamental mechanisms of hardness at the basic level, the answer often reveals that its ultimate manifestation is a comprehensive, multi-body effect, and a holistic feature resulting from multi-scale synergy or coupling.

In this regard, hardness shares similarities with other macroscopic characteristics, as matter undergoes complex transformations from microscopic to macroscopic and from local to global scales that remain incompletely understood. Ultimately, we rely on the interpretation of emergent phenomena to reveal the system-level mechanisms underlying hardness.

In the interpretation of the consistency of system change, when the local change is contradictory in the whole, the local change can not be defined in the whole. That is to say, in the same system, the whole of the system has a strict and clear characteristic, that is, the whole of the system does not show the relative change of the local.

Let's clarify when contradictory changes occur as a system evolves. The description reveals that a system undergoes holistic transformation when the reference individual experiences relative changes with all other entities. From an evolutionary perspective, this means that when the reference individual's relative changes traverse all other entities, a systemic shift occurs where the overall system no longer reflects these localized changes.

With the theoretical part now complete, we turn to the specific process of measuring hardness. Hardness is a characteristic that is triggered or measured only when an external change is applied to a material.

With this understanding, let's conduct a standard hardness test. When striking a material's localized area with a hammer using moderate force, the impact pressure instantly induces mechanical changes within a specific zone. The affected area, defined by the impact point, triggers a mechanism that generates a characteristic feature. Crucially, this feature doesn't reflect the localized deformation itself.

This phenomenon involves two physical perspectives. When observing from a local-to-global perspective (i.e., from microscopic to macroscopic scales), we find that changes in a localized area produce macroscopic characteristics that do not reflect those changes. Instead, they manifest as features that maintain the original state of the local area. This is demonstrated by the fact that an individual cannot change relative to the whole that contains it.

On the other hand, if we look from the whole to the local direction and want to see the overall change of the local in an instant, we will find that the collision produces a kind of resistance to the macroscopic change caused by the local change, which is reflected as "an overall cannot change relative to an individual contained in it".

In this paper, this overall characteristic of resisting macroscopic changes or maintaining the original local state is defined as hardness. Hardness originates from the inconsistency between local and global changes in the same system, and is a contradictory feedback to external changes.

The fundamental paradox arises when materials are subjected to forceful hammering: the material's structural integrity is compromised, resulting in observable changes that appear to contradict the principle of overall invariance. Crucially, while the system's internal structure remains constant relative to its components, it can undergo transformations when interacting with external environments. This demonstrates that hardness constitutes an inherent property of a material system itself, defined within its own framework, whereas material damage or deformation represents a systemic alteration in response to external influences.

But why is it the material that is damaged, not the hammer that is damaged? This involves the question of hardness, which is a relative question.

During the process of striking, what is changed is not only the local part of the material, but also the local part and the whole of the hammer. The collision of the two is actually the interaction of the two systems, and the relative change of the two wholes.

It is reflected in the relative difference in the ability to maintain local invariance, which is mainly reflected in two points: one is the speed of holistic feedback, the other is the length of time to maintain the overall invariance. The hardness is mainly reflected in the speed of feedback, while the length of time to maintain the overall invariance is reflected in the strength of the material.

This reveals the systematic mechanism of hardness. Returning to the opening statement in the video: Why is hardness related to nearly all factors? Because any localized change triggers the material's ability to either maintain its original state or resist the alteration. By applying these material science factors to local components while considering the material's overall resistance capacity, the framework for understanding hardness becomes crystal clear. This approach eliminates confusion caused by excessive influencing factors, ensuring a coherent interpretation.

This systems theory framework differs from conventional hardness definitions. While traditional explanations attribute causality between factors and hardness, systems theory posits that these elements directly interact with localized changes. The actual hardness manifests as a contradictory feedback loop to these changes, representing the emergent properties of all local factors. It's crucial to recognize this distinction between the two perspectives.

The concept of "generalized rigidity" in condensed matter physics, which explains various phenomena, shares the same fundamental mechanism as the system-level rigidity discussed in this paper. This mechanism, which maintains local stability while resisting overall deformation, not only applies to understanding hardness but also explains other properties like softness, viscosity, and elasticity. The underlying principle of this generalized rigidity aligns with the system-level rigidity mechanism described here.

3、 The complexity interpretation of quantum mechanics

Here we attempt to interpret some fundamental concepts and phenomena of quantum mechanics through a unified framework of complexity. It should be noted that the mathematical framework of quantum mechanics has been repeatedly validated, so this theory does not challenge the framework itself, but rather questions whether the physical significance behind it is related to the self-reference of the system.

3.1 Volatility Emerges

To understand the wave nature of quantum mechanics, one must consider the system changes formed by different states of the same thing, such as the system changes formed by the continuous motion of a point particle.

Based on the spontaneous hypothesis, the particle's position evolves spontaneously relative to its initial state. According to the interpretation of emergent phenomena, over a given period, the collective trajectory of all positions traversed by continuous particle motion exhibits a distinctive characteristic: the system as a whole does not demonstrate localized changes. This simple system exhibits only two types of local variations: spatial displacement and temporal progression. These observations lead to the following conclusions:

1、 The singularity of time. For a point particle, traversing all possible positions within a given spatial range is evidently the most challenging task, involving infinity. When considering observational capabilities, even if a particle possesses a minimal size, the number of positions it could theoretically traverse within the observable universe remains nearly infinite. From a local perspective, attempting to conceptualize the emergence of holistic properties across such vast temporal scales proves fundamentally meaningless.

The remarkable phenomenon lies in how, once this holistic emergence occurs, it ceases to exhibit localized temporal variations – effectively making local time

"disappear" within the system. This implies that within the same spatial framework traversed by the particle, the system's holistic characteristics coexist with the particle's instantaneous state at any given moment. As this constitutes a system describing "the same entity," particles at any given instant not only maintain their current motion states but also possess an inherent holistic dimension.

The motion states in our daily lives are inherently "local", making this holistic nature counterintuitive. It demonstrates that the emergent wholeness of particle motion across all temporal scales holds significance. Even the holistic emergence throughout the observable universe's entire space-time remains meaningful, as it consistently corresponds to current particle states. This holistic characteristic doesn't exhibit localized temporal variations, even when approaching infinity.

More remarkably, this simultaneous correspondence between holistic integrity and localized states implies that not only point particles, but any entity capable of existing as an independent object—such as a cup, a fruit, or a car—currently embodies this holistic nature. We need not concern ourselves with whether these objects will fragment or decompose in the next moment, as the holistic integrity remains eternally aligned with the present independent object without manifesting temporal changes in its localized aspects. This paper posits that the temporal manifestation of such holistic integrity constitutes the temporal characteristic of matter waves.

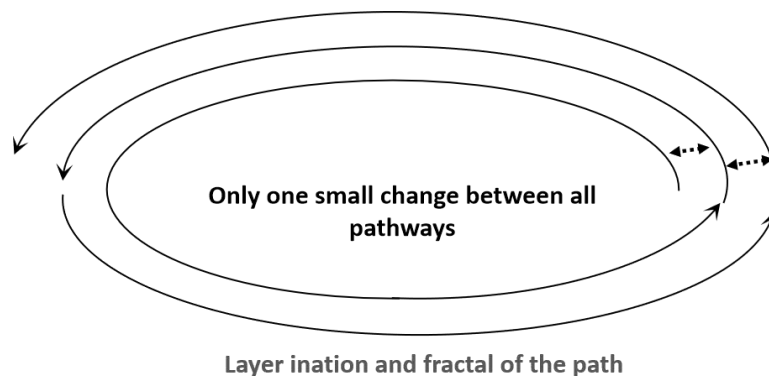
2、 Mutual Exclusivity of Characteristics. Within a system, relative changes are inconsistent between local and global perspectives, exhibiting two contradictory characteristics: changes manifested locally cannot be reflected globally, and vice versa. Therefore, a particle's local state and the emergent holistic characteristics can only manifest one at a time. When measuring local properties, the holistic nature remains unmanifested; conversely, when measuring holistic properties, the local state becomes unobservable.

The most puzzling core phenomenon in quantum mechanics is wave-particle duality. Why does the particle nature disappear when the wave nature is manifested, and why does the wave nature disappear when the particle nature is manifested? This paper believes that the physical mechanism is caused by the inconsistency between

local and global changes in the system, which is the two inconsistent characteristics of the same system.

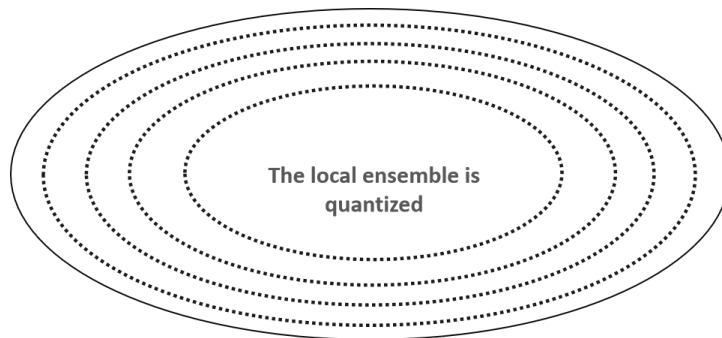
3、 Determinism and Uncertainty. The collective positioning of all locations does not reveal local positional variations. The holistic positional characteristics maintain statistical normality relative to localized changes. Regardless of the uncertainty in particle localization, the probability sum across the entire system remains 1, demonstrating deterministic behavior. Conversely, when observing or representing local positions from a holistic perspective, the specific manifestation of any location becomes entirely uncertain. This is because the overall system lacks information about local positional relationships, and the actual representation of any position depends on the measurement method employed.

4、 Hierarchical Quantization. In the interpretation of chaotic attractors, the system's evolutionary path exhibits hierarchical progression. Each time the system traverses a specific state, this state undergoes a transformation relative to external observers. This localized modification instantly imposes a new global constraint on every individual within the system. By altering the boundary conditions governing each entity's movement, it subsequently reshapes the trajectory of local changes through feedback mechanisms. Consequently, no individual's evolutionary path ever repeats its original local trajectory, creating a hierarchical transformation of evolutionary pathways.



This holistic transformation relative to external factors indicates that there exists a fundamental change between two evolutionary paths within a system. This change and its quantification mechanism adhere to the principle of minimal variation, defined by the system's overall structure. Therefore, in a system's evolution, when constrained by specific boundary conditions of the "holistic" framework, all "partial systems" undergo minimal variations. The discontinuous hierarchical changes associated with

this minimal variation manifest distinct quantum characteristics between the two systems.



Only the differences between integrity are considered

The core challenge in this context lies in defining the "local-global" relationship and constraining boundary conditions. When interpreting chaotic attractors, the system demonstrates both divergence and attraction across all regions. This phenomenon arises from continuous nonlinear feedback between global and local components, where holistic transformations occur everywhere. The critical factor is how we "define" the global boundary. The omnipresence of the whole implies that its boundary is inherently defined: within this boundary lies the local, while discontinuous changes occur only along its edges.

Since holistic change is relative to external objects, the "division" of the whole is determined by the measurement method of external objects. More precisely, in the process of particle motion, the holism of the process is mainly defined by time, so the "division" of the whole is defined by the "time interval" contained in the external measurement behavior.

If you interpret volatility in terms of chaotic systems, what is diverging in the emergence of volatility?

Unlike multi-body systems composed of different entities, the system formed by the motion state of a single particle undergoes distinct transformations. Here, "individual" refers to the particle's state at each moment, where local changes involve positional shifts between discrete time points. The holistic change, however, represents the collective evolution of all positions. As this constitutes a unified entity, it only manifests variations in the current particle's state. Since the overall system doesn't exhibit localized changes, this holistic transformation must differ

fundamentally from partial positional alterations. Specifically, its directional changes must diverge from all individual directional variations.

Therefore, disregarding other factors, the particle's motion undergoes at least two dimensional transformations both locally and globally. The spatial dimension's additional directional change introduces a new orientation beyond all local directions. This spatial alteration is nonlinear relative to local changes, causing the space itself to diverge during this process.

In conclusion, this paper posits that the holistic interpretation of material motion emerges as the source of wave-like properties. This holistic characteristic arises from the system formed by different motion states of the same entity, representing two distinct features of the same system compared to localized states. The inconsistency primarily manifests in the local and non-local aspects of spacetime. The peculiarity lies in the position of particles corresponding to each localized time, as the "disappearance" of time in the whole simultaneously manifests all positions.

3.2 Nonlocality principle

The emergence of quantum mechanical fluctuations inherently encompasses core principles such as the exclusion of features and non-locality of spacetime. These characteristics manifest entanglement phenomena in multi-particle interactions, where the system as a whole exhibits no localized temporal or spatial variations. Instead, it demonstrates a unique property where global characteristics and local changes coexist within the same system while remaining mutually exclusive. Although entanglement manifests in more complex forms, this article will not delve into such complexities.

This framework elucidates the fundamental principles of volatility and entanglement. Within this paradigm, there exists no clear demarcation between microscopic and macroscopic phenomena. Any entity capable of independent existence inherently possesses volatility, and all such entities can form entangled relationships. The measurability of volatility or entanglement hinges on whether measurement actions "interfere" with localized systems. If such interference occurs, the material system fails to exhibit holistic characteristics. Conversely, when

interactions or measurement behaviors can "transcend" local constraints, holistic properties emerge.

All measurements of fluctuations and entanglement must follow this principle.

sum up

The current application of this theory primarily focuses on defining spacetime, exploring macroscopic characteristics, and providing elementary interpretations of quantum mechanics, laying the groundwork for future extensions to include relativity, condensed matter physics, and quantum mechanics. In upcoming iterations, the theory will investigate the emergence of gravity and mass within spacetime's hierarchical structure, aiming to reconcile inconsistencies between relativity and quantum mechanics. At the theoretical foundation level, additional core concepts will be introduced, such as rigorously defining "observation" through systematic academic interpretations. This approach seeks to understand the unique nature of human observation and re-examine the origins of complexity from an observational perspective.

References

[1] Russell, B., & Whitehead, A. N. (1910). *Principia Mathematica* (Vol. 1). Cambridge University Press.