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The Problem of Logical Self-Circulation in Modern Scientific Theories and Its Resolution

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This paper adopts a meta-scientific method to point out that the three major obstacles hindering the formation of a unified system theory in modern science are inconsistent concepts, conflicting basic assumptions, and differences in the selection of mathematical languages. It focuses on the issue of "selection of basic assumptions/axioms" for in-depth research. The paper analyzes the widespread problem of logical self-circulation in core theories across multiple fields of modern science, arguing that this problem is also an important reason for theoretical stagnation and the inability to explain phenomena in depth, and may lead to consequences in practical applications. In response, the paper reflects on the limitations of revolutionary methods and proposes a generalization method as a solution. The core of this method is to inherit the reasonable parts of Newtonian mechanics, reconstruct the physical theory of complex systems based on the latest cognition, adhere to clear concepts, logical self-consistency, and unrefuted axioms, and select axioms based on the criterion of supporting the sustainable development of human society. Finally, it points out that future research can be conducted in three directions: interdisciplinary research, new perspectives in the philosophy of science, and optimization of the logical structure of theories, so as to promote the improvement and development of scientific theories.

Keywords: logical self-circulation, metascience, generalization method, scientific theory, basic assumption, sustainable development

Introduction

The tremendous progress of modern science over the past 300 years is reflected in its precise decoding of natural laws and in-depth penetration into practical applications. From the establishment of the classical physics framework by Newtonian mechanics (Newton, 1846) to the revelation of the mysteries of the microcosmic and macrocosmic worlds by quantum mechanics (Fitzpatrick, 2015) and relativity theory (Einstein, 1916); from the discovery of penicillin overcoming the challenges of infectious diseases (ACS, 1999) to the reconstruction of production and lifestyle patterns by artificial intelligence technology (Baily,

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Brynjolfsson, & Korinek, 2023), science has effectively driven the leap in productivity and expanded the boundaries of human cognition.

However, problems behind these achievements have gradually become prominent. On the one hand, theories in different disciplines or even within the same discipline are difficult to unify, forming a fragmented pattern where each speaks its own language (Bianconi et al., 2023; Castellani & Gerrits, 2021); on the other hand, the logical rigor of some scientific research has been questioned, prompting the birth of metascience, which focuses on studying science itself (Schooler, 2014; Fortunato et al., 2018). As expressed by Ioannidis, one of the founders of metascience, on his various publications that science is the best thing that ever happened to humans, but it can be better (e.g., Ioannidis, 2005). This opinion not only affirms the value of science but also clarifies the mission of metascience—to promote the evolution of science toward greater perfection through systematic examination of its development.

By re-examining the history of human scientific development using meta-scientific methods, we have identified three key obstacles hindering the formation of a unified system theory in modern science: inconsistent concepts, conflicting basic assumptions, and differences in the selection of mathematical languages (Cheng & Cui, 2024). These obstacles restrict the integration and expansion of theories at a fundamental level, as noted by Morrison (2000), who argues that conflicts between theories stem from incompatible foundational axioms and mathematical structures.

Among various scientific issues, this paper focuses on the problem of "selection of basic assumptions/axioms". This issue is essentially a philosophical one, and the answers to philosophical questions cannot be judged as true or false. The correct approach is to conduct in-depth comparisons of several possible options and ultimately select a theory that is beneficial to the sustainable development of human society. The fundamental purpose of passing any theory on to future generations is to make human life better and enable the sustainable development of human society (Planetary Boundaries Science, 2025). However, our research (Cheng & Cui, 2024) has found that many theory builders fail to adhere to this principle. Instead, they prematurely adopt a preconceived stance, construct mathematical models based on this stance, retain several undetermined model parameters to be calibrated using real physical scenarios, and finally make predictions about several possible future scenarios (Bishop & Trout, 2002). Once the predictions for these scenarios are found to be consistent with observations, the theory is deemed highly reliable, and people then believe it to be the truth, applying it for unlimited extrapolation.

In fact, the proof process of such theories inherently contains the problem of logical self-circulation. As Cartwright (1983) points out, fundamental physical laws often rely on idealized assumptions that are not directly validated by empirical data, leading to "explanatory circularity" where laws are used to interpret evidence that is then cited to confirm the laws. Because many mathematical functions possess a certain degree of interpolation and extrapolation capability, it is entirely normal that predictions for working conditions around these observed cases align well after calibrating model parameters using a few actual observations. This is a capability inherent in mathematical functions and does not indicate that we have truly discovered the operating laws of the world. Figure 1 provides an illustrative demonstration of solving problems using system models. Based on several limited observation points, we found a linear function that fits these observations extremely well. We then made predictions about several possible future outcomes, and after a period of observation, these predictions were also found to be accurate. Consequently, we developed confidence in this model and used this linear law to predict the past and future operation of the world, obtaining a limited past and a limited future which is completely wrong. From this illustration one may induce that any mathematical function may be an approximate to the real world operation within a certain range of space and time as the real operating laws of the world are so complex that they may not be possible to be described by one mathematical function. Of course the validity of this induced law needs to be tested.

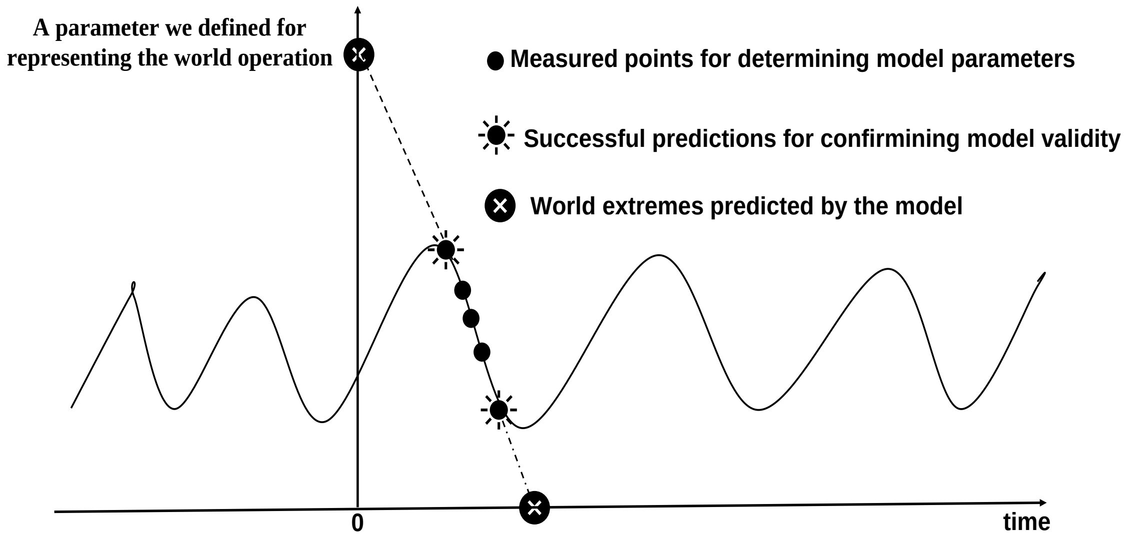

Figure 1. An illustration of any simple mathematical equation may only reveal the world operation in a limited region.

From the grand narrative of the universe's birth to the mysterious exploration of the origin of life, from the bizarre properties of the microscopic quantum world to the operating laws of the macroscopic universe, the problem of logical self-circulation is like a tiny crack hidden in the foundation of the scientific edifice. Though not easily detectable, it may exert a profound impact on the stability of scientific theories.

Take the Big Bang theory of cosmic origin as an example (Uzan, 2015). This theory assumes that the universe originated from an extremely high-temperature, high-density singularity that exploded at a certain moment, after which matter and energy began to expand outward and evolve, gradually forming the universe we see today. However, when we further inquire about the source of the singularity's initial conditions, we fall into a predicament. As Earman (1995) argues, the Big Bang's "singularity problem" (unexplained initial conditions) is a form of "explanatory circularity". Current theories cannot account for the physical processes before the singularity's formation, as if the singularity is an existence "from nothing", forming a kind of logical self-circulation. Explaining the origin of the universe relies on the singularity, yet the origin of the singularity itself cannot be reasonably explained by existing theories and can only be taken as a presupposed starting point.

The Big Bang theory also harbors another extremely serious logical self-circulation: It materializes spacetime from the outset, conflating spacetime with matter. Unlike classical mechanics, which clearly identifies observable objects as the objects of study, time and space are introduced as coordinate systems to describe the motion and changes of objects. Consequently, the concepts of time, space, matter, and energy used in contemporary cosmology (Hawking, 1988; Hertog, 2023) are entirely different from those in classical mechanics. The inconsistency of these four fundamental concepts was not realized even in a recent breakthrough paper (Faizal, Krauss, Shabir, & Marino, 2025).

We believe that studying the problem of logical self-circulation in modern science holds extremely important practical significance. It can help us gain an in-depth understanding of the nature and limitations of scientific theories. Scientific theories are human interpretations and descriptions of natural phenomena, but due to the finiteness of human cognition and the constraints of experimental technology, the theories we establish often contain inconsistencies. Through researching logical self-circulation, we can more clearly recognize the boundaries of scientific theories, avoid blindly applying them beyond their scope of applicability, and thus promote the continuous improvement and development of scientific theories. Moreover, studying logical self-circulation can stimulate scientific innovation. When we discover logical flaws in existing theories, it often prompts scientists to seek new theories and methods to address these issues. As Kuhn noted, many major scientific breakthroughs emerged from questioning and challenging traditional theories. In-depth research on logical self-circulation is expected to provide opportunities for the birth of new scientific theories, drive progress in science and technology, and bring new perspectives and methods for humanity to understand and transform the world (Kuhn, 1962; Kooi, 2024). Therefore, we contend that examining the problem of logical self-circulation in each scientific theory should be an important mission of metascience.

This paper intends to adopt a case study approach to conduct in-depth analyses of typical theories in fields such as cosmic origin, origin and evolution of life, classical physics, and quantum mechanics, elaborating on the specific manifestations and inherent logical relationships of logical self-circulation within them. Through in-depth analysis of these specific cases, we hope to gain a more intuitive and profound understanding of the universality and complexity of logical self-circulation in modern science. On this basis, combining the three previously identified reasons for the inability to unify numerous theories—inconsistent concepts, conflicting basic assumptions, and differences in the selection of mathematical languages (Cheng & Cui, 2024)—we propose a relatively universal method to resolve this problem: abandoning revolutionizing classical mechanics and instead using its generalization to construct new scientific theories. This could ensure that important basic concepts remain consistent throughout. In the selection of fundamental assumptions, the worldview and values implied by these assumptions must support the collective well-being and sustainable development of human society. Otherwise, the government should prohibit the spread of those theories which are harmful to the sustainable development of human society. The selection of mathematical theories should be based on the criterion of simplicity.

This paper is divided into nine sections. Section 2 briefly elaborates on the problem of logical self-circulation, its causes, and manifestations. Sections 3 to 7 mainly analyze logical self-circulation in theories of cosmic origin, origin of life, evolution of life, fundamental theories of physics, and quantum mechanics. Section 8 proposes a new method to solve the problem of logical self-circulation. Finally, a brief summary together with future prospects is given.

A Brief Elaboration on the Problem of Logical Self-Circulation

Definition and Connotation of Logical Self-Circulation

Logical self-circulation refers to a closed, self-referential cyclic structure in a theoretical system or argumentation process, where the premises of the argument depend on the conclusion, or the conclusion in turn proves the premises. This results in the argument lacking an external, independent basis and failing to truly establish the reliability and validity of the theory (Kooi, 2024).

Essentially, logical self-circulation violates normal logical reasoning rules. Normal logical reasoning should start from known, reliable premises and derive unknown conclusions through reasonable reasoning steps. In contrast, logical self-circulation blurs the relationship between premises and conclusions, leading to mutual dependence and an inescapable cyclic dilemma.

In scientific theories, logical self-circulation often manifests in multiple forms (Kooi, 2024):

- Self-verification: A typical form where some scientific theories, when attempting to prove their correctness, rely on the theory's internal assumptions and definitions rather than external objective facts or widely accepted principles. For example, when defining basic concepts, some theories frame the concepts such that their understanding and application depend on the theory's own conclusions, forming a self-verifying cycle.
- Using assumptions as evidence to prove the assumptions themselves: A common form of self-verification. For instance, in studying a physical phenomenon, an unknown force is hypothesized to explain the phenomenon; then, a theory is built based on this hypothetical force to further prove the force's existence—yet there is no independent experimental or observational evidence to support this hypothetical force. The introduction of dark matter and dark energy to supplement the Big Bang theory falls into this category.
- Circular argumentation: A key manifestation of logical self-circulation. In scientific research, it typically involves using one proposition to prove another, while the proven proposition in turn serves as the basis for proving the first. For example, in some theories of biological evolution, natural selection is hypothesized as the main driver of evolution to explain the adaptive traits of species (claiming that species with adaptive traits are more likely to survive and reproduce). However, when proving the existence and role of natural selection, the adaptive traits of species are cited as evidence—arguing that natural selection must be at work because species have these traits. This circular argumentation weakens the theory's logical rigor: It fails to truly explain the causal relationship between natural selection and species adaptability, merely going in circles without substantially advancing the understanding of biological evolution mechanisms. As Sober (1993) notes, this circularity arises from conflating definition (fitness as survival) with explanation (why some traits enhance survival). Circular argumentation also frequently occurs in the derivation of some mathematical and physical theories. In certain mathematical proofs, a lemma dependent on a theorem is used to prove the theorem itself, while the proof of the lemma requires the original theorem—forming a circular argument and invalidating the entire proof process.

The pursuit of completeness is another important cause of logical self-circulation. Take a dictionary as an example: When defining Concept A, Concepts B and C might be used. If the editor claims that "all concepts in this dictionary have definitions", then when defining Concept Z, it will inevitably rely on previous concepts. Newton made this mistake in his Mathematical Principles of Natural Philosophy (Newton, 1846) when defining the mass of matter: mass = density × volume, yet density is defined as density = mass/volume. As Lange (2005) analyzes, such circular reasoning emerges in justifying mathematical axioms and their application to scientific theories. Modern Newtonian mechanics has rectified this error by defining mass operationally through inertia ($F = ma$) or gravitation (Jammer, 2000). Einstein and Bohr once debated fiercely over whether quantum mechanics is a complete theory (Einstein, Podolsky, & Rosen, 1935; Bohr, 1935; Whitaker, 2006). In fact, Hilbert's pursuit of completeness proposed in 1900 (Hilbert, 1902) was already refuted by Gödel in 1931—completeness and logical consistency are sometimes contradictory (Gödel, 1931). In such cases, it is obvious that we should abandon the pursuit of completeness and uphold logical consistency (Cui, Li, & Pan, 2023). However, this issue was not aware even in the recent breakthrough papers which wish to have a complete and logically consistent theory (Faizal et al., 2025). As humans cannot observe the whole universe, our knowledge of the world is relatively true, and we can never prove a theory to be complete.

The Impact of Logical Self-Circulation in Scientific Research

Logical self-circulation hinders the development of scientific theories in multiple ways:

Leading to theoretical stagnation. When a scientific theory falls into logical self-circulation, it lacks external, independent verification and support, making it difficult to achieve substantive breakthroughs and progress. When scientists attempt to improve and expand the theory, they repeatedly find themselves returning to the starting point, reiterating the same arguments and assumptions, and are unable to fundamentally address the theory's inherent problems.

Take the steady-state cosmology theory as an example: It assumes that the universe is homogeneous and unchanging on a large scale, with matter continuously being created to maintain this steady state. However, to prove the continuous creation of matter, the theory relies on the assumption of the universe's steady state—forming a logical self-circulation. Faced with new observational evidence (such as the discovery of cosmic microwave background radiation), the steady-state theory could not provide a reasonable explanation, nor could it be further developed and improved. Eventually, it was replaced by the Big Bang theory (Uzan, 2015; Hawking, 1988; Hertog, 2023).

Preventing in-depth explanation of phenomena. The purpose of science is to reveal the essence and laws behind natural phenomena and provide in-depth understanding of the world. However, logical self-circulation traps theories in superficial assumptions and arguments, preventing them from touching the core of phenomena.

In the study of the origin of life, some early theories hypothesized that life originated from simple organic molecules through random chemical reactions. Yet when explaining how these organic molecules were produced in the early Earth's environment, the theories relied on conditions necessary for life (such as suitable temperature and pH)—which are themselves outcomes of life's existence, forming a circular argument. As Cleland (2002) argues, theories of life's origin are "historical sciences" that rely on retrodiction, and circularity arises when present-day experiments are used to "prove" past conditions. Such theories fail to deeply explain the real process of life's origin; they merely circle between known phenomena and assumptions without providing deeper insights. Similarly, using past observations to predict future is also not so reliable and this problem was noted by Hume as early as in 1739 in Book I of *A Treatise of Human Nature* and later in its revised version, *An Enquiry Concerning Human Understanding*, in 1748. This argument is also known as "Hume's problem" and Howson (2000) believed that David Hume's argument is sound.

An even more extreme example is the geocentrism-like mindset: People initially assumed that life exists only on Earth, and then built various theories to explain how life could arise from inanimate matter. In contrast, if we assume that "all complex structural objects in the universe are designed and manufactured by living beings", and since the Earth is a complex structural object, it follows that the Earth was also designed and manufactured by some cosmic beings—this assumption can explain many phenomena well. As for whether life or the Earth came first in the universe, there is already much scientific evidence suggesting that "life preceding the Earth" is far more reasonable (Wickramasinghe, 2022). Although humans have not observed extraterrestrial life with the naked eye, telescopes, or microscopes, we must question: Is human observational ability limited to the naked eye? Do other potentials reported in some religions actually exist? For example, Li Sicen has devoted 25 years to the scientific empirical study of extraordinary abilities such as "finger reading" and "psychokinesis". He found that using sacred religious terms like "God", "Buddha", "Bodhisattva", and "Jesus" enables individuals with high psychic abilities to "see" visions on their "mental screen". He also claimed that these individuals can communicate with highly intelligent beings in the spiritual world through consciousness (Lee, 2018). These questions require in-depth exploration. The mindset of equating “unobserved by humans” directly with “non-existent” has already been proven incorrect.

Logical Self-Circulation in Theories of Cosmic Origin

Logical Dilemma of the Big Bang Theory

As the current mainstream theory of cosmic origin, the Big Bang theory posits that the universe originated from a singularity characterized by infinitely high temperature and density with an extremely small volume. Approximately 13.8 billion years ago, this singularity underwent a violent explosion, giving birth to time and space, while matter and energy began to expand outward. In the fleeting moments after the explosion, the universe underwent exponential expansion, a phenomenon known as the inflationary phase. Subsequently, as the universe continued to expand and cool, matter gradually aggregated to form stars, planets, and other celestial bodies, eventually evolving into the universe we observe today (Uzan, 2015; Hawking, 1988).

The mainstream astronomical community currently believes that this theory is supported by multiple lines of observational evidence (Rees, 2009). Some argue that the discovery of cosmic microwave background radiation (CMBR) provides crucial evidence for the Big Bang theory. This faint electromagnetic radiation, uniformly distributed throughout cosmic space with a temperature of approximately 2.725 K, is regarded as the residual “afterglow” of the Big Bang and a relic of the high-temperature state of the early universe. Others point to the abundance of light elements in the universe—such as the relative proportions of hydrogen, helium, and trace amounts of lithium—which align with the element abundances predicted by the Big Bang theory to have formed via nucleosynthesis in the high-temperature, high-density environment of the early universe. More importantly, cosmic expansion is considered another key piece of evidence: Hubble’s law, which states that the recession velocity of galaxies is proportional to their distance from Earth, implies that the universe is continuously expanding. However, as Cartwright (1983) points out, the interpretation of CMBR relies on the Big Bang theory’s own assumptions, leading to explanatory circularity. All these pieces of evidence can be more satisfactorily explained within the model of an infinite universe consisting of infinite number of cyclical finite worlds (Cui, 2019a; 2019b).

Interpreting what we observe through the Hubble Telescope as the entire universe rather than a single world within the universe has, from today’s perspective, clearly been falsified. We should distinguish between the concepts of “universe” and “world”: The spatiotemporal range and celestial bodies observable via our telescopes should be termed a “world,” while the universe refers to the largest conceivable spatiotemporal framework and all celestial bodies it contains. In this sense, a world naturally becomes a finite spatiotemporal region within the universe.

Some assumptions about the early universe in the Big Bang theory also suffer from logical flaws. To explain the uniformity of the CMBR, the theory incorporates inflation theory, which posits that the universe underwent an exponential expansion phase in the immediate aftermath of its birth, allowing regions once far apart to rapidly achieve uniformity. However, inflation theory itself relies on unproven assumptions, such as the existence of an inflaton field with unique properties. The existence and nature of this inflaton field lack direct observational evidence and were proposed solely to resolve inconsistencies in the Big Bang theory (Burago, 2017). This logical self-circulation weakens the Big Bang theory’s ability to explain early cosmic phenomena, limiting our in-depth understanding of cosmic origin and early evolution.

A key counterargument to our critique is the mainstream view that the Big Bang theory's singularity is a valid starting point given the limits of current physics. However, Earman (1995) refutes this by arguing that the singularity problem is a fundamental logical flaw, as the theory cannot explain the initial conditions that give rise to the singularity itself. Without resolving this circularity, the Big Bang theory remains incomplete as an explanation of cosmic origin.

Analysis of Self-Circulation in Cyclic Cosmology

Roger Penrose's cyclic cosmology, known as Conformal Cyclic Cosmology (CCC), offers a novel perspective on cosmic origin and evolution (Penrose, 2012). The theory proposes that the universe is not defined by a single Big Bang and expansion but exists in an infinite cycle of "aeons". At the end of each aeon, the universe undergoes heat death: All matter is gradually exhausted, leaving only massless particles, and the universe's entropy reaches a maximum. Through a conformal transformation, the universe's scale is contracted to an infinitesimal size, a state that serves as the singularity for the next aeon, triggering a new Big Bang and cosmic evolution.

Conformal transformation plays a pivotal role in cyclic cosmology. As a mathematical transformation that preserves angles while altering an object's scale and shape, it connects the start and end of different aeons, enabling a smooth transition between them. Through conformal transformation, the infinitely expanding universe at the end of one aeon is converted into a finite-sized state resembling an initial singularity, setting the stage for the next Big Bang. This assumption aims to resolve traditional cosmological puzzles regarding the universe's origin and end, offering a model of eternal cosmic cycles.

However, Conformal Cyclic Cosmology faces issues of logical consistency in explaining cosmic cycles. The theory is grounded in the assumption of conformal transformation, but its valid application to cosmic cycles requires extremely strict conditions: Both the universe's initial and final states must be "conformally invariant", meaning their physical properties and geometric structures must meet specific requirements to ensure the transformation's validity. Currently, there is no conclusive evidence that the universe satisfies such stringent conditions in these states. This assumption, lacking sufficient theoretical and observational support, is largely proposed to make the theory self-consistent, forming a logical self-circulation. As Sklar (1981) notes, background assumptions often shape theory acceptance, even when alternative axioms are empirically viable. In contrast, a model of an infinite universe with finite cyclic worlds can explain observed phenomena without relying on the conformal transformation assumption (Cui, 2019a; 2019b).

Penrose's proposed "Hawking points" as evidence for CCC are also controversial. Hawking points are purported to be traces left in the CMBR by evaporating black holes; Penrose claims to have identified approximately 30 such points in CMBR maps, citing them as evidence for cosmic cycles (Penrose, 2012). However, most scientists dispute the existence of Hawking points, arguing that these alleged "black hole evaporation traces" are likely random noise and cannot serve as reliable evidence for cosmic cycles (Bodnia et al., 2024). A major counterargument to CCC is the entropy increase problem: Each cycle should accumulate entropy, making subsequent cycles impossible. While Penrose proposes that entropy is reset during conformal transformation, this mechanism lacks empirical support, reinforcing the theory's circular reliance on unproven assumptions. In using Hawking points to prove cosmic cycles, cyclic cosmology falls into a circular argument: Without confirming the authenticity of Hawking points or their connection to cosmic cycles, theoretical deductions based on them lack a solid foundation, merely forming a self-sustaining loop between theoretical assumptions and purported evidence that fails to genuinely prove the existence of cosmic cycles.

Logical Self-Circulation in Theories of the Origin of Life

Logical Flaws in the Theory of Spontaneous Generation

The theory of spontaneous generation is an ancient and once widely accepted theory of life's origin. Its core proposition holds that life can arise naturally from non-living matter, without relying on the reproduction of pre-existing organisms. In ancient times, people observed phenomena such as lice breeding on unwashed clothes, mosquitoes emerging from stagnant, dirty water, insects thriving in filthy garbage, and maggots growing on feces or rotten corpses. These intuitive observations kept the theory of spontaneous generation deeply rooted in people's minds for a long time.

The theory reached its peak in the 18th and 19th centuries, with some scientists conducting experiments to support it. In 1745, J. T. Needham—a British Catholic priest and microscopist—sterilized various infusions only to find that microorganisms still appeared. He thus insisted on the validity of spontaneous generation. His view was supported by the French naturalist G.-L. de Buffon, causing a sensation in the scientific community (Bergman, 1993).

However, this theory has obvious logical flaws in its internal structure. The core circularity lies in its reliance on superficial observational phenomena as both evidence and conclusion. Proponents observed life forms appearing in non-living matter and concluded that life spontaneously generated, without investigating alternative explanations. For example, upon observing maggots on rotting meat, they assumed maggots originated from the meat itself, rather than from external sources like fly eggs. This failure to test alternative hypotheses led to a circular argument where the observation of life in non-living environments was used to prove the theory, while the theory was used to explain the observations.

The logical contradictions of spontaneous generation became even more apparent when faced with challenges from scientific experiments. In 1688, F. Redi—an Italian court physician and member of the Accademia del Cimento (Florence Experimental Academy)—proved through experiments that maggots on rotting meat are the result of fly eggs, directly challenging the theory of spontaneous generation (Redi, Bigelow, & Bigelow, 1909). Later, many scientists conducted similar experiments, all demonstrating that the emergence of life is not as simple as the theory of spontaneous generation describes.

In 1860-1861, the French microbiologist L. Pasteur used cotton wool and S-shaped flasks in his experiments. He proved that dust in the air carries various microorganisms, and the number of microorganisms in the air varies with location and altitude. When he conducted experiments in high mountains—where the air is clean and contains fewer microorganisms and spores—the yeast infusions were far less likely to be contaminated (Pasteur, 1862). Pasteur's experiments strongly refuted the theory of spontaneous generation, exposing the fallacy of its core claim: It failed to recognize that life requires specific conditions and the transmission of genetic material, rather than arising randomly from non-living matter.

Analysis of Self-Circulation in the Chemical Origin Theory

The chemical origin theory is currently the most widely accepted hypothesis for life's origin among scholars. The theory posits that life on Earth emerged gradually over an extremely long period—after Earth's temperature gradually dropped—through an extraordinarily complex chemical process, evolving step by step from non-living matter. This process is generally divided into four stages:

1. The formation of small organic molecules from small inorganic molecules;
2. The formation of large biological molecules from small organic molecules;

3. The assembly of large biological molecules into multi-molecular systems;

4. The evolution of organic multi-molecular systems into primitive life.

However, this theory exhibits a clear circular structure in its logical framework, with each stage relying on assumptions that are only validated by the theory's final conclusion.

First, the theory is constructed on the premise that "the Earth existed before life in the universe" when building its models. This assumption is challenged now (Wickramasinghe, 2022). The first stage assumes that inorganic molecules could form organic molecules in the early Earth's environment, but the conditions required for this process (e.g., specific atmospheric composition, energy sources) are inferred from the need to produce organic molecules, rather than from independent geological evidence.

Second, even if chemists can create living organisms in laboratories through chemical experiments, these experiments cannot reveal the true origin of life. As Cleland (2002) argues, historical sciences like the study of life's origin rely on retrodiction, and laboratory experiments cannot replicate the exact conditions of the early Earth. The experiments rely on highly controlled conditions artificially created by humans, and the probability of such harsh conditions being naturally satisfied is extremely low.

Third, we still cannot prove whether the living organisms created by chemists are "complete living beings" (as per the materialist monistic view of life) or merely "physical bodies" (as per the mind-body dualistic view of life in Buddhism) (Ma & Cui, 2021).

Compared to the chemical origin theory, panspermia theory avoids some circularity by proposing that life originated elsewhere in the universe and was transported to Earth. This theory does not rely on the unproven assumption of life arising from non-living matter on Earth, instead shifting the origin question to cosmic processes. While panspermia does not fully resolve the origin of life itself, it avoids the chemical origin theory's circular reliance on Earth-specific conditions to explain life's emergence.

Logical Self-Circulation in the Theory of Biological Evolution

Logical Issues in the Theory of Natural Selection

Darwin's theory of natural selection (Darwin, 1859), as the core of modern evolutionary theory, provides a crucial framework for explaining biological diversity and adaptability. The theory posits that all organisms have a tendency toward overproduction, while resources are limited—leading to intense struggles for existence between organisms and between organisms and their environment. In this struggle, individuals with favorable variations are more likely to survive and reproduce, while those with unfavorable variations are eliminated; this is known as "survival of the fittest". Over long periods of natural selection, small favorable variations accumulate gradually, driving biological evolution.

A critical logical flaw in the theory lies in the circular definition of its core concept, "survival of the fittest". "The fittest" are defined as individuals that survive and reproduce successfully in the struggle for existence, yet "survival" itself is used as the criterion to determine whether an individual is "fit". This creates a circular argument: An individual is fit because it survived, and it survived because it is fit. As Sober (1993) clarifies, this circularity arises from conflating the definition of fitness (survival and reproduction) with the explanation of why some individuals are fit. Modern evolutionary biology has attempted to address this by defining fitness based on relative reproductive success rather than survival alone, but this still relies on the outcome of reproduction to measure fitness, maintaining a degree of circularity. This circular definition undermines the theory's ability to explain the causes of biological evolution. It fails to genuinely account for why some individuals survive while others do not, merely oscillating between the concepts of “fitness” and “survival” without revealing the underlying mechanisms of biological adaptation and evolution.

Second, the theory of survival of the fittest emphasizes competition as a driver of individual evolution but completely ignores cooperation as an alternative survival strategy among living organisms (Axelrod, 1984). Collective behavior in the animal kingdom is now a well-documented fact—from cells, ants, and fish schools to bird flocks—where highly coordinated group activities are underpinned by complex survival rules and regulatory mechanisms (Parrish & Edelstein-Keshet, 1999). Humans are a quintessential example of a biological system where competition and cooperation co-exist: Competition enhances individual capabilities and accelerates the elimination of weaker individuals (one path to survival), while uniting multiple weaker individuals to ensure survival represents another path. Thus, some conclusions of the survival-of-the-fittest theory are also products of logical self-circulation.

The theory of natural selection often falls into logical dilemmas when discussing adaptive evolution. For instance, to explain the long neck of giraffes (an adaptive trait), the theory argues that the long neck evolved via natural selection—allowing giraffes to reach leaves high in trees, gain an advantage in the struggle for survival, and thus survive and reproduce. Yet this is merely an inference based on observations; it does not fundamentally explain how the long neck gradually evolved under natural selection or the specific causal link between long necks and survival. The circularity here lies in using the existence of the adaptive trait to prove natural selection, while using natural selection to explain the trait’s origin.

Self-Circulation in the Interpretation of Evolutionary Evidence

Fossil records are among the most important evidence for biological evolution, providing direct clues to understand the evolutionary history of organisms. By studying fossils from different geological eras, we can observe gradual changes in biological morphology and structure, thereby inferring evolutionary trends. However, when interpreting fossil records, circular reasoning often arises due to pre-existing assumptions about evolutionary theory. As Howson (2000) notes, inductive reasoning in science often relies on circular justifications, using past success to validate future predictions. When a new fossil is discovered, scientists use existing evolutionary theory to determine its position on the evolutionary tree, and then cite this position as evidence to support the theory. If a fossil with features intermediate between two known species is found, it is interpreted as a transitional form between the two—used to prove the continuity of evolution. This interpretation, however, relies on the pre-assumed evolutionary theory that organisms evolve gradually and that transitional forms exist. From an alternative perspective, such fossils could also be viewed as unique biological forms with no inherent connection to evolution. This circular reliance on presupposed evolutionary theory in fossil interpretation undermines the objectivity and independence of our analysis of fossil evidence.

Biogeographic distribution is also widely cited as evidence for biological evolution. Significant differences exist in species distribution across regions, and these differences are closely linked to geographical environments and geological history. By studying biogeographic distribution, we can infer the migration and evolutionary paths of organisms. Yet circular reasoning persists in interpreting such distribution: When a region’s organisms exhibit unique traits, they are attributed to environmental selection—claiming that the environment drove the evolution of traits adapted to local conditions. However, judgments about the environment’s selective role depend on the adaptive traits the organisms already exhibit (Warren, Cardillo, Rosauer, & Bolnick, 2014). For example, to explain Australia’s unique biota, the theory argues that Australia’s long-term isolation from other continents created a unique geographical environment, leading to the independent evolution of endemic species. This explanation, however, is based on the pre-assumed evolutionary theory that the environment influences biological evolution. From another angle, one could argue that these organisms inherently possessed these traits, with no connection to environmental selection. This circular reliance on presupposed evolutionary theory in interpreting biogeographic distribution creates logical flaws in our analysis of such evidence.

Logical Self-Circulation in Fundamental Theories of Physics

Logical Circulation in the Definition of Mass in Newtonian Mechanics

Within the framework of Newtonian mechanics, the definition of mass and Newton's second law exhibit a close yet subtle logical circular relationship. In Philosophiæ Naturalis Principia Mathematica (Newton, 1846), Newton defined mass as "the quantity of matter", determined jointly by density and volume—expressed by the formula ($m = \rho V$) (mass equals density multiplied by volume). However, a deeper inquiry reveals that density itself is defined in terms of mass: Density is the mass per unit volume, i.e., ($\rho = m/V$) (Newton, 1846). This forms a circular definition: Mass is defined using density, while density depends on mass, leaving the definition of mass without an independent, solid foundation. As Lange (2005) analyzes, such circular reasoning is common in the justification of mathematical axioms and their application to physical theories. This is the fundamental reason for the subsequent emergence of multiple concepts of mass (Jammer, 2000). Similar logical self-circulation issues exist in the definitions of heat, information, and entropy (Pan & Cui, 2022).

Newton's second law, $F = ma$ (where F is the net force on an object, m is its mass, and a is its acceleration), occupies a central position in Newtonian mechanics. The problem of logical circulation becomes prominent when applying this law to measure mass. To measure an object's mass, the common method is to apply a known force F, measure the resulting acceleration a, and calculate mass using ($m = F/a$). However, this approach presupposes both the concept of mass and the validity of Newton's second law. Here, mass measurement relies on the second law, while the law's validity requires a coherent definition of mass—forming a classic logical loop.

This logical circulation impacts Newtonian mechanics in several ways. Theoretically, it weakens the framework's logical rigor: Scientific theories should rest on solid, consistent logical foundations, but the circularity between mass definition and the second law introduces contradictions at the most basic conceptual and law-based levels. It is analogous to a crack in the foundation of a building—though the structure may appear functional, its long-term stability and reliability are severely compromised. In extreme scenarios or high-precision research, these issues may amplify, causing discrepancies between theory and observations. Newtonian mechanics' applicability diminishes in the microscopic world, where the logical problems in mass definition and the second law limit its development. When explaining the motion of subatomic particles—whose mass and behavior differ drastically from macroscopic objects—the ambiguity in Newtonian mass definitions and the limitations of the second law become glaring, rendering the theory unable to accurately describe or explain microscopic phenomena.

In our view, the elimination of the logical problems in mass definition and the second law is very easy. We can simply define mass as the quantity of matter and its unit of measure is defined by an authority. Actually, the fundamental flaw of Newtonian mechanics lies in its reliance on inertial coordinate systems and in treating living organisms as inanimate objects (Cui, Li, & Pan, 2024). For human observers, the Earth-fixed coordinate system—a non-inertial system—serves as the basis; other planetary or vehicle-based coordinate systems must be compared against it, with so-called "inertial frames" defined as those moving linearly relative to the Earth-fixed frame.

Living organisms, in their animate state, can generate active forces with magnitudes and directions determined by free will. The failure to account for such forces leaves many physical phenomena unexplained. Introducing these active forces would allow classical mechanics to explain the motion and changes of all observable objects (Cui et al., 2024).

Exploration of Self-Circulation in Relativity's Spacetime Concepts

Relativity, a cornerstone of modern physics, revolutionized traditional notions of spacetime (Einstein, 1916). In relativity, spacetime is no longer an absolute, independent entity but an interconnected whole with matter—the so-called "spacetime continuum". Special relativity rests on two postulates: the principle of relativity (physical laws take the same form in all inertial frames) and the constancy of the speed of light (the speed of light in a vacuum is constant across all inertial frames, independent of the relative motion of the source and observer). General relativity further interprets gravity as spacetime curvature, asserting that the distribution of matter and energy alters spacetime's geometric structure; objects move along geodesics in this curved spacetime, manifesting as the gravitational effects we observe.

Relativity exhibits a degree of logical self-circulation when explaining spacetime curvature. According to general relativity, gravity is a manifestation of spacetime curvature, which is itself caused by the distribution of matter and energy. As Friedman (1999) argues, scientific theories rely on "constitutive axioms" that define the framework for empirical testing, but these axioms are often chosen for coherence rather than direct empirical support. When explaining why a massive object (e.g., a star) generates gravity, we argue that its mass curves surrounding spacetime, and other objects' motion in this curved spacetime appears as gravitational attraction. Yet when pressed to confirm spacetime curvature, we return to gravitational phenomena themselves: We infer curvature from objects' trajectories in gravitational fields, and then attribute these trajectory anomalies to curvature—forming a circular argument. We use spacetime curvature to explain gravity and cite gravitational phenomena to prove curvature, lacking independent, external evidence to break this loop. In explaining Mercury's perihelion precession, general relativity attributes the effect to spacetime curvature around the Sun, altering Mercury's orbit. However, our primary evidence for this curvature is the precession itself, making the explanation logically unsound. Ryckman (2005) traces how Einstein's general relativity shifted from empirical testing to "conceptual necessity", leading to this circular reasoning.

Spacetime measurement in relativity also faces logical dilemmas. Time and space measurements are interdependent and dependent on the observer's motion. Special relativity's time dilation and length contraction imply that a moving object experiences slower time flow and shorter length, relative to the observer's frame. Measuring the length of a fast-moving object requires simultaneously determining the positions of its ends, but "simultaneity" is relative—different observers define it differently, complicating measurements. A length measured in one frame may differ in another. Determining spacetime transformations between frames relies on assuming the constancy of light speed and pre-established relativistic spacetime concepts, creating another logical loop: We measure spacetime using the relativistic framework, which itself depends on assumptions and definitions about spacetime measurement, trapping us in self-reliance when validating relativistic spacetime concepts.

Logical Self-Circulation in the Complex Number Description of Quantum Mechanics

There are numerous examples of logical self-circulation in quantum mechanics; here, we focus solely on the role of complex numbers in this field. In quantum mechanics, the wave function is a core concept for describing the state of a quantum system, and it is typically a complex-valued function. The Schrödinger equation—the fundamental dynamical equation of quantum mechanics—explicitly incorporates the imaginary unit i, with its mathematical form expressed as:

$$i\hbar \frac{\partial \Psi(x,t)}{\partial t} = H\Psi(x,t) \tag{1}$$

where $\hbar$ denotes the reduced Planck constant and H represents the Hamiltonian operator. The Schrödinger equation describes the time evolution of the wave function. The presence of the imaginary unit i endows the time evolution with oscillatory and wave-like properties, which are closely linked to wave-particle duality. This ensures that the wave function’s time evolution is continuous and predictable while preserving probability conservation, imbuing the quantum state’s time evolution with wave characteristics. These wave properties are among the key features that distinguish quantum mechanics from classical physics, explaining how the probability distribution of a particle’s presence at different positions changes over time (Fitzpatrick, 2015).

Mainstream quantum scientists today argue that complex numbers are indispensable in quantum mechanics, thereby supporting the claim that “the microscopic world is fundamentally different from the macroscopic world”. In 2022, Physical Review Letters published two papers simultaneously (Chen et al., 2022; Li et al., 2022), which claimed to rigorously prove this conclusion through Bell-type experiments. However, the first author of this paper specifically wrote an article pointing out that this is a result of circular logical reasoning (Cui & Pan, 2022).

The first author made the following key arguments:

1. The reasoning in the two papers (Chen et al., 2022; Li et al., 2022) relies on the four fundamental axioms of orthodox quantum mechanics: (1) Pure quantum systems are described by unit vectors in a complex Hilbert space; (2) the state space of a composite system is the tensor product of the state spaces of its components; (3) the dynamics of a closed system obeys unitary evolution; (4) observables correspond to Hermitian operators, and measurements follow the Born rule. These four axioms themselves already implicitly presuppose a “complex number framework”—amounting to “using a theory premised on complex numbers to prove the necessity of complex numbers”. This is essentially logical self-circulation, rather than a deduction from independent physical facts.

2. Studies supporting the “necessity of complex numbers” assume by default that “real numbers can fully describe all classical phenomena”. However, the author argues that this assumption itself cannot be verified: Humans cannot exhaust all classical phenomena, nor can they prove that “the description of classical phenomena using real numbers is complete”. Therefore, the comparative claim that “real numbers describe classical systems and complex numbers describe quantum systems” is inherently invalid, and it is even more impossible to infer from this that “the microscopic and macroscopic worlds are fundamentally different”.

3. From the perspective of the New General Systems Theory (NGST) (Cui et al., 2023), the author points out that all four fundamental axioms of standard quantum mechanics have flaws: (1) There is no such thing as a “pure quantum system”—the definition of “pure” depends on the coexistence of “impure”, which aligns with the “axiom of relativity of simultaneity”. (2) The “tensor product assumption for composite systems” excludes nonlinearity and is merely an approximation of real physical systems. (3) “Closed systems” do not exist in reality (e.g., the existence of dark matter and dark energy breaks the closure of systems). (4) “Hermitian operators and the Born rule” are artificially defined mathematical tools, not inevitable reflections of physical reality.

Maudlin (2019) supports this critique by arguing that complex numbers in quantum mechanics are a mathematical convenience, not an ontological claim about the microscopic world’s uniqueness. This reinforces our view that the supposed "proof" of complex numbers' necessity relies on circular reasoning, as the quantum axioms already presuppose complex numbers.

Approaches and Methods for Resolving Logical Self-Circulation

Reflection on Revolutionary Methods

Throughout the history of scientific development, revolutionary methods have played a pivotal role in advancing human understanding of the world, driving paradigm-shifting leaps in knowledge. Einstein's theory of relativity stands as a quintessential example of such a revolutionary approach. In the early 20th century, classical physics faced insurmountable challenges in explaining phenomena involving high-speed motion and strong gravitational fields—Newtonian mechanics and Maxwell's electromagnetic theory failed to provide coherent explanations. Breaking free from the constraints of traditional thinking, Einstein proposed special relativity and general relativity. Special relativity, grounded in the principle of relativity and the constancy of the speed of light, revolutionized the concepts of time and space, revealing their relativity and inherent connection to material motion. General relativity further redefined gravity as the curvature of spacetime, fundamentally altering humanity's classical understanding of gravitational forces. Beyond successfully explaining phenomena that confounded classical physics (e.g., the precession of Mercury's perihelion), this theory also predicted new physical phenomena such as gravitational waves, laying the foundation for modern cosmology.

From a historical perspective, revolutionary methods often prove decisive at critical junctures in scientific progress. When established theoretical frameworks fail to account for new experimental observations or face severe logical contradictions, revolutionary approaches shatter the shackles of conventional thinking, opening new avenues for scientific inquiry. Copernicus' heliocentric theory dismantled the long-dominant geocentric worldview, offering a radical new understanding of cosmic structure. The birth of quantum mechanics overturned classical notions of continuity and determinism, unveiling the quantum properties of the microscopic world. These revolutionary theoretical transformations propelled scientific development by leaps and bounds, deepening humanity's comprehension of nature.

Nevertheless, the application of revolutionary methods in science, while fostering cognitive breakthroughs, is accompanied by a series of unintended consequences, summarized as follows:

1. Subversion of fundamental conceptual systems and communication barriers: Revolutionary methods often reconstruct core traditional concepts such as time, space, matter, and energy (e.g., relativity's challenge to absolute spacetime, quantum mechanics' questioning of "determinism"), rendering familiar conceptual frameworks obsolete. Conflicts between old and new conceptual systems disrupt long-established consensus within the scientific community, creating barriers to theoretical discussion and interpretation of findings due to divergent concept definitions. This even leads to "paradigm incommensurability"—for instance, classical and quantum physics hold incompatible understandings of "particle position"—impeding the smooth transmission of knowledge.

2. Risk of one-sided negation of traditional theories: Enthralled by the innovation of revolutionary theories, some researchers fall into an "either/or" mindset. They focus exclusively on the limitations of old theories (e.g., Newtonian mechanics' inadequacy in high-speed/microscopic scenarios) while ignoring their validity and rationality in specific domains (the macroscopic, low-speed world). This leads to the reckless abandonment of experimentally verified core logic, research methods, or data accumulation from traditional theories—a stance that violates the principle of "inheritable development" in science, risking waste of research resources or redundant exploration of fundamental issues.

3. Dilemma of unifying multiple revolutionary theories: Revolutionary theories in different fields (e.g., general relativity and quantum field theory) often harbor deep-seated contradictions due to divergent foundational logics: (a) fragmentation of basic concept meanings (e.g., the conflict between "continuous spacetime" in relativity and "quantized spacetime" in quantum theory); (b) mutual exclusivity of core assumptions (e.g., "determinism" in classical mechanics vs. "probabilism" in quantum mechanics); (c) incompatibility of mathematical languages (e.g., relativity relying on Riemannian geometry, quantum theory on Hilbert spaces). These discrepancies pose immense technical and logical obstacles to theoretical unification (e.g., the pursuit of a "Theory of Everything"), making it difficult to form a unified framework for describing the physical world (Morrison, 2000).

4. Limitations of new theories' scope of application and their "flawed" nature: Revolutionary breakthroughs typically emerge from explaining specific new phenomena (e.g., black-body radiation, gravitational lensing), and their validity is often confined to narrow scenarios or parameter ranges. They may exhibit obvious flaws in other domains (e.g., quantum mechanics cannot directly explain gravitational phenomena; general relativity fails at the microscopic scale). Over-absoluteizing such theories obscures their essence as "stage-specific cognition"—new theories are not "ultimate truths" but revisions and extensions of old ones, still requiring refinement. Misjudging them as "perfect theories" may hinder the exploration of deeper underlying laws.

It is important to acknowledge that revolutionary methods have irreplaceable value in solving problems that traditional theories cannot explain. For example, relativity successfully addresses high-speed motion and strong gravitational field phenomena that Newtonian mechanics cannot account for. The key is to recognize that revolutionary and generalization methods are not mutually exclusive but can complement each other. In scenarios where traditional theories face insurmountable logical contradictions or cannot explain new phenomena, revolutionary methods can break through existing frameworks. In contrast, when theories suffer from logical self-circulation within their scope of application, the generalization method can refine and expand them while retaining valid components.

Existing revolutionary theories still suffer from logical self-circulation, and in some cases, the problem is even more severe. This is because the scientific community has not fully recognized this issue in classical physics, resulting in its neglect in the development of new theories. The long-standing dualistic oppositional thinking in Western philosophy leads scientists to adopt positions on philosophical issues arbitrarily, rather than making choices through in-depth comparisons of two or more possible perspectives. Additionally, some new assumptions proposed by revolutionary methods contradict everyday human experience. For example, the velocity of any object is relative to the observer—different observers will measure different velocities for the same object. A train has a specific velocity relative to an Earth-fixed observer, but appears stationary to a passenger on board. In relativity, however, the speed of light is independent of the observer, arbitrarily opposing light to all other objects.

Exploration of Generalization Methods

From the above analysis of existing theories, we find that the implicit logical self-circulation in classical mechanics has long been overlooked. Consequently, subsequent revolutionary theories failed to address this issue, merely offering solutions to other problems—resulting in an increasingly severe logical self-circulation in current revolutionary theories.

The generalization method emphasized by Unified Complex System Theory (UCST) (Cui et al., 2024) provides a novel idea and direction for resolving logical self-circulation. At its core, the generalization method advocates inheriting the sound axiomatic system and mathematical formulation of Newtonian mechanics. While reductionism—breaking complex problems into simpler components—remains valuable, system properties are not always the sum of the properties of their subsystems. Due to historical limitations in understanding the universe and “worlds”, some basic concepts suffer from logical self-circulation, certain fundamental assumptions have been falsified, and the oversimplification of treating living organisms as inanimate objects is no longer applicable in the information age. These issues must therefore be addressed holistically as part of a systems engineering effort.

Specifically, the method involves leveraging cutting-edge contemporary knowledge to “return” to the initial state of Newton’s construction of classical mechanics, thereby reconstructing a new physical theory applicable to all complex systems. It clarifies that the object of scientific research is observable objects; its primary goal is to uncover the laws governing the motion and change of objects within the observable “world”, enabling more accurate future predictions, informed decisions to avoid harm and pursue benefit, and ultimately ensuring science truly serves humanity.

To demonstrate the practical application of the generalization method, we take the optimization of Newtonian mechanics’ mass definition as an example:

1. Inherit the reasonable part: Retain Newtonian mechanics’ focus on observable objects and the basic framework of motion description.

2. Resolve logical self-circulation: Define mass operationally as “the inertial resistance of an object to changes in its motion state”, measured by comparing the acceleration of a standard object and the target object under the same force (avoiding the circular definition of mass and density).

3. Mathematical formulation: Maintain the use of Euclidean space and calculus, retaining $F = ma$ while clarifying that mass is an independently defined physical quantity.

Another example is the optimization of the Big Bang theory’s singularity assumption:

1. Inherit the reasonable part: Retain observational evidence such as cosmic expansion and CMBR but reinterpret them within the framework of an infinite universe with finite cyclic worlds.

2. Resolve logical self-circulation: Abandon the singularity assumption and propose that the observable “world” (e.g., the Milky Way) originated from the evolution of a prior cyclic world, avoiding the unexplained “from nothing” singularity.

3. Axiom selection: Adopt the axiom that “the universe is infinite and eternal, consisting of infinite cyclic worlds”, which supports the sustainable development of human society by emphasizing the continuity of cosmic evolution.

Core Principles of the Generalization Method for Resolving Logical Self-Circulation

The core principles of this approach stem from our key insight: Completeness and logical consistency are mutually contradictory in some theories. To uphold logical consistency (i.e., eliminate logical self-circulation), a theory must abandon claims of completeness (Cheng & Cui, 2024). However, this was not adopted by Faizal et al. (2025) who proposed that “a deeper description, expressed not in terms of information but in terms of non-algorithmic understanding, is required for a complete and consistent theory of everything”.

Second is the pairing of all concepts. All concepts and theories are products of human discriminative thinking; the most basic logic humans use is binary logic. Defining a Concept “A” requires the existence of a complementary Concept “non-A”—without “non-A”, “A” itself cannot be established. Thus, any monistic philosophy is ontologically incomplete, and we must use this axiom to supplement and perfect essential concepts.

Third is the recognition of limitations in human cognition. To clarify a concept, we must attribute what cannot be clearly explained to its complement. This necessitates distinguishing between “universe” and “world”:

- Universe: The largest spatiotemporal framework imaginable by humans, defined as infinite and eternal, containing infinite “worlds”.
- World: The largest observable spatiotemporal domain, with “observable” referring to the maximum range detectable by current or future human observational tools (including telescopes, microscopes, and other technological extensions). The boundary of the world is determined by the limit of human observational capabilities, which expands with technological progress but remains finite at any given time.

We must accept the fact that “humans cannot observe the entire universe”. This realization makes it clear that the historical interpretation of “treating Hubble Telescope observations as the shape of the entire universe” was erroneous: The receding celestial bodies and relics of stellar explosion shockwaves (e.g., cosmic microwave background radiation) we observe are properties of our world, not the entire universe.

If we define the “universe” as the largest spatiotemporal domain imaginable by humans, and the “world” as the largest observable spatiotemporal domain, it becomes evident that whether the universe is finite or infinite is a question forever unanswerable by scientific means. However, since the universe is defined by human imagination, and we already possess the mathematical concepts of “infinity” and “infinitesimal”, we may ascribe these properties to the universe—this avoids wasting time on unresolvable debates. Defining the universe as boundless and eternal eliminates the need to discuss its size or center. We further propose that the universe comprises infinite number of “worlds”, transitioning from the infinite (universe) to the finite (world). Crucially, the “world” studied by science is our observable world—merely one of infinitely many in the universe, with boundaries defined by humans. Systems theory teaches that the definition of a system’s scope and its surrounding environment significantly impacts system properties (Bertalanffy, 1968); thus, to discuss a system’s properties, we must clearly define its boundaries and the extent of its environment.

Regarding the composition of systems, the axiom of “the relativity of simultaneity” (Cui et al., 2023) dictates that for every visible existence, there exists an invisible counterpart; for every material entity, there exists a non-material one. We define non-material existence as “mind” (retaining the term to align with Descartes’ mind-body problem) and invisible material existence as “ether” (consistent with electromagnetic wave theory). Ether serves as the material foundation for all physical fields and all forms of matter. Using a binary classification, we further divide visible objects into “living organisms” and “inanimate objects”:

- Living organisms: Possess the ability for active motion, composed of “mind-body”.
- Inanimate objects: Lack active motion, composed solely of ether.

Microscopic particles in ether (molecules, atoms, subatomic particles) and celestial bodies are all living organisms. Living plants, animals, and humans are living organisms; their deceased forms are inanimate. These definitions are clear and measurable, explicitly distinguishing between living and inanimate objects, and between the living and deceased states of organisms. By extending the basic assumptions of classical mechanics (and discarding falsified ones), we construct an extensional theory: the unified theory of complex systems (Cui et al., 2024). Throughout its development, this theory adheres to three requirements—clear concepts, logical consistency, and unfalsified axioms—and only requires Euclidean space and calculus for mathematical formulation.

The generalization method offers distinct advantages in resolving logical self-circulation:

- It effectively avoids logical confusion and knowledge discontinuities caused by the total rejection of old theories. By preserving valid components of existing theories, it ensures the continuity and stability of scientific knowledge, enabling researchers to build on established foundations.
- It fully leverages existing experimental data and theoretical achievements, reducing unnecessary redundant research and assumptions. When revising and extending theories, it draws on proven research experience and methods, improving efficiency and lowering costs.
- It emphasizes empirical verification: By applying theories to new domains, it continuously validates and refines them, preventing over-reliance on conceptual assumptions or mathematical deductions that lead to logical self-circulation (Kuorikoski 2021).

For axiom selection, the method proposes a unique criterion: Compare the worldviews and values implicit in each axiom to determine if they support altruistic behavior and the sustainable development of human society. As Douglas (2016) argues, scientific axiom selection cannot be "value-free" and should explicitly incorporate societal values. This criterion is operationalized through three steps:

1. Identify the implicit worldview and values of the axiom (e.g., materialist axioms emphasize individual competition, while Buddhist mind-body dualism emphasizes altruism).

2. Evaluate the alignment of these values with sustainable development goals (e.g., altruism promotes cooperation, which is essential for addressing global challenges like climate change).

3. Prioritize axioms that have positive societal impacts and avoid those that lead to harmful consequences (e.g., rejecting axioms that justify exploitation of resources or other species).

Take Descartes' mind-body problem as an example—three possible positions exist:

1. Materialist philosophy: The body is fundamental; the mind is a function of the brain. This philosophy does not support altruism or the concept of "humanity as a community with a shared future" (Mathew, Deepa, Karthick, & Sakshi, 2016).

2. Idealist philosophy: The mind is fundamental; the body is a creation of the mind. This conflicts with the reality of material scarcity and competition.

3. Buddhist philosophy: The mind and body are distinct entities—the body has material properties (reducible to ether), while the mind has non-material properties. In Buddhism, the essence of living organisms is the mind (not the impermanent body); the mind is eternal and reincarnates through successive bodies (Harvey, 2013). Thus, eliminating bodies through war only fosters hatred and fails to resolve conflicts between living organisms. True reconciliation requires treating all other living beings as past-life relatives or future kin, embracing them with love and tolerance. Buddhist philosophy therefore supports altruism, emphasizing that "altruism is inherently self-benefit", and recognizes humanity (and all living organisms) as a community with a shared future (Harvey, 2013)—aligning closely with deep ecology (Naess, 1973) and strongly supporting the sustainable development of human society.

The renowned contemporary philosopher Wolfgang Stegmüller wrote in *Main Currents in Contemporary Philosophy*:

> Future generations will one day ask: What was the mistake of the 20th century? Their answer will be: In the 20th century, on the one hand, materialist philosophy—which asserts that matter is the only true reality—not only became part of the official worldview in many countries but also often dominated Western philosophy, even in discussions of the mind-body problem. On the other hand, precisely this concept of "matter" remained the most difficult, intractable, and incomprehensible concept for the science of that century. (Stegmüller, 1992, p. 536)

The famous British historian Arnold Toynbee had expressed the following conclusion in *Prospects for the 21st Century* that Only Confucianism and Mahayana Buddhism of China can save human society in the 21st century (Daisaku & Toynbee, 1999).

Conclusions and Prospects

This paper conducts an in-depth analysis of the logical self-circulation issues present in several pivotal theories of modern science. From cosmic origin theories (the Big Bang theory and cyclic cosmology) and theories of life's origin (the theory of spontaneous generation and chemical origin theory), to the theory of natural selection in biological evolution, fundamental physical theories (Newtonian mechanics and relativity), and even the application of complex number descriptions in quantum mechanics, core theories across these fields exhibit varying degrees of self-circulatory flaws in their logical frameworks. These issues severely hinder the further development of scientific theories, creating bottlenecks in explaining natural phenomena and expanding the boundaries of human cognition.

Resolving logical self-circulation is crucial for scientific progress; it is the key to breaking existing limitations and achieving leapfrog development in scientific theories. Only by escaping the constraints of logical self-circulation can scientific theories be built on a more solid logical foundation, enabling more accurate explanations of natural phenomena and predictions of unknown events. This paper proposes a novel approach to address logical self-circulation: first, conduct in-depth comparisons of multiple possible options for philosophical issues underlying basic assumptions, and select those aligned with human expectations; second, provide clear definitions for essential basic concepts; third, uphold logical consistency while abandoning claims of completeness during theory construction. Addressing logical self-circulation will also drive innovation and improvement in scientific research methods, prompting scientists to examine problems from diverse perspectives, explore new research ideas and approaches, and thereby enhance the efficiency and quality of scientific research—providing more robust theoretical support for humanity to understand and transform the world.

Future research on logical self-circulation can be advanced through interdisciplinary efforts. As science evolves, the boundaries between disciplines are increasingly blurred, and many complex scientific problems require collaborative, interdisciplinary solutions. In astronomical research, for instance, we must abandon the "origin of the universe" and reframe it as the "origin of the world"—such as the origin of the Milky Way. For humanity, clarifying the origin of the Milky Way is sufficiently valuable, and this endeavor can integrate knowledge and methods from physics, astronomy, mathematics, philosophy, and other disciplines. Physics and astronomy provide observational data and theoretical models for system evolution; mathematics offers precise calculation and deduction tools for these models; and philosophy enables in-depth analysis of theoretical assumptions and arguments from logical and epistemological perspectives—helping identify and resolve logical self-circulation. Interdisciplinary approaches are expected to break the limitations of single disciplines, examine scientific theories from multiple dimensions, and thus more comprehensively and deeply reveal the essence of logical self-circulation while identifying effective solutions.

New perspectives in the philosophy of science also represent a critical direction for future research. The philosophy of science provides a profound epistemological and methodological foundation for scientific inquiry (Johansson, 2016); introducing new philosophical viewpoints and methods can offer fresh ideas for addressing logical self-circulation. Additionally, in-depth examination of whether the worldviews and values implicit in the philosophy of science align with mainstream social expectations can provide a new lens for comparing the social value of different scientific theories. This helps prioritize the positive role of theories in promoting the sustainable development of human society while minimizing or eliminating the negative impacts of science and technology during theory construction and refinement.

In-depth analysis and optimization of the logical structure of scientific theories will also be a focus of future research. By applying modern logical tools and methods, we can conduct rigorous logical reviews of the axiomatic systems, inference rules, and concept definitions of scientific theories—identifying potential logical loopholes and self-circulation issues, and implementing targeted optimizations and improvements. In mathematics, the development of axiomatic methods has made the logical structure of mathematical theories clearer and more rigorous; this approach can be adapted to other scientific fields to help scientists build more robust theoretical frameworks. Using formal logic and mathematical logic to formalize and deduce scientific theories will more accurately reveal logical relationships within theories, enable timely detection and resolution of logical self-circulation, and drive scientific theories toward greater sophistication and maturity.

Author Contributions

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The original contributions presented in this study are included in the article. Further inquiries can be directed to the corresponding author CUI Weicheng.

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Conflicts of Interest

The authors declare no conflicts of interest. The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript; or in the decision to publish the results.

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