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ORIGINAL RESEARCH

Four Dilemmas of the "Superstring theory" and new responses from the "Singularity theory" in the view of Information Ontology

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Abstract
Modern cosmology has two competing theories of the origin of the universe: the "Singularity theory" and the "Superstring theory". Four Dilemmas of the "Superstring theory" are presented: the incompleteness of the eleven space–time dimensions, the inextricable dependence on the "Space–Time Background", the "Zero-Brane theory" admitting stuff smaller than the Planck scale, and the pure mathematical theory that cannot be falsified by experiments. Although the "Singularity theory" is faced with many critiques from the "Superstring theory", from the perspective of Information Ontology, treating the "Singularity" as "Origin Information" can dissolve these troubles well. For the "Singularity theory", the new philosophical thinking framework effectively explains the parameter problems of the universe, and gives satisfied response to the challenges from the "Superstring theory". As a result, the "Singularity theory" has a more competitive advantage on the origin of the universe.

Keywords Big Bang theory · Singularity theory · Superstring theory · Planck scale · Information Ontology

1 Introduction

1.1 Development of the standard model of the "Big Bang Theory"

The Big Bang universe model of modern cosmology originated in 1927, when the Belgian physicist Georges Lemaitre thought that the universe firstly originated from a dense "Origin". He proposed the concept of the Big Bang for the first time (Gilliland, 2015, p. 13). After a series of widely accepted scientific discoveries, the Standard

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Model of the Big Bang was gradually confirmed. Modern Big Bang Theory believes that the universe originated about 13.8 billion years ago (with an error of 37 million years), the "Singularity" with an infinitely high temperature (bigger than 10^{10} K) and an infinite density began to explode. Time and space no longer exist in the beginning. Hawking believes that the "Singularity" instantly expanded to create the universe. In the second stage, the universe evolved in the Planck era. After the explosion of $1/10^{43}$ second, the temperature of the universe arrived at 10^{32} K, and the density reached 10^{93} kg/m^3. According to the theory of Quantum Mechanics, quantum effects and gravity begin to emerge. The Planck time is the shortest time interval and the earliest moment of time. During the subsequent expansion, the universe continued to be cool down. In the third stage, the era of grand unification, the unified force of the universe split within $1/10^{35}$ second after the birth of the universe. The gravitational force was separated and released huge energy, which caused the universe to exponentially skyrocket within $1/10^{32}$ second. The universe expanded by 10^{78} times. Then, in a short time, the inflation of the universe subsided. After cooling, the first batch of matter particles (quarks, electrons, photons, neutrinos and antimatter twins) were gradually formed. Then the universe continued to cool down to form protons and medium. Electrons, the basic elements of the universe and stable atoms (Gilliland, 2015, pp. 34–39).

1.2 Proposal of "Superstring theory"

With the exploration of science, Hawking and some physicists began to question the possibility of the "Singularity" and doubted the completeness of the standard universe model in several aspects. First, the Standard Model fails to explain the source of gravity and cannot include gravity. Second, the Standard Model cannot explain the particularity of constant parameters that describe the mass, electric charge, and cosmological constants of elementary particles (Stein, 2011).[1] Third, the Standard Model cannot integrate the General Relativity and the Quantum Mechanics. In Quantum Mechanics, the appearance of the "Singularity" will cause serious contradiction between the above two theories. Because there will be dramatic quantum fluctuations in the spatial structure at the ultra-micro scale (less than the Planck length). The huge quantum fluctuations break the concept of smooth and curved geometry, which is the foundation of the General Relativity. These unresolved problems motivate people to seek a perfect theory of nature. In 1984, Michael Green of Queen Mary College and John Schwarz of California Institute of Technology proposed the "Superstring theory" as the alternative model (Greene, 2000, pp. 129–130).

Brian Greene, a famous American astrophysicist and one of the early founders of the "Superstring theory", wrote in his famous book “The Elegant Universe: Superstrings, Hidden Dimensions, and the Quest for the Ultimate Theory”: "String Theory is a modification of the standard universe model. In a way that can’t be explained clearly so far, the universe has a minimum scale. At the beginning of the universe, all the space in string theory was completely symmetrical. All curled up into a multi-dimensional

[1] According to James Stein, there will be 13 constants, namely, Gravitational constant, Light speed, Gas constant, Absolute zero, Avogadro constant, Boltzmann constant, Planck constant, Schwarzschild radius, Efficiency of hydrogen fusion, Chandrasekhar limit, and Hubble constant.

Planck-scale small universe. All the basics of the universe Particles are a closed string that vibrates." (Greene, 2000, p. 357). "String theory" was proposed in 1968. After the first innovation in 1974 and the second revolution in 1995, it has evolved into five equivalent "Superstring theory": Type I, Type IIA, Type IIB, Heterotic-O, Heterotic-E, summarized as M Theory" (Greene, 2000, p. 287). The proud advantage of the "Superstring theory" is that it combines the General Relativity with the Quantum Mechanics with its supersymmetric structure. It answers the original questions about the most basic structure and force of matter in nature (Greene, 2000, p. 18). From the view of Green, the "Superstring theory" becomes the most promising candidate for the grand unified theory. However, this paper proposes four critiques for the "Superstring theory" and attempts to argue that the "Singularity theory" has a more competitive advantage on the origin of the universe.

2 Four critiques to the "Superstring theory"

The first critique the integer dimensional space of "Superstring theory" fails to explain the large number of fractal dimensional space in the real world. After rigorous mathematical calculations, the String Theory requires eleven-dimensional space–time to prevent unreasonable probability values, including ten-dimensional space and one-dimensional time. The universe expands in three dimensions, and the other seven dimensions are curled up unexpanded space. However, there is a key challenge to the String theory: the existence of fractal space in the real world makes it difficult to explain the String theory in integer-dimensional space. The fractal dimensions prove that the "Superstring theory" of integer-dimensional space has obvious incompleteness.

The second critique the "Superstring theory" cannot form a self-sufficient system, and it requires space–time Background-Dependent. According to Bryan, the "Superstring theory" presupposes the space and time in which the strings vibrate back and forth. "Before the strings that make up the cosmic fabric engage in the orderly, coherent vibrational dance we are discussing, there is no realization of space or time. Even our language is too coarse to handle these ideas, for, in fact, there is even no notion of before. In a sense, it's as if individual strings are 'shards' of space and time, and only when they appropriately undergo sympathetic vibrations do the conventional notions of space and time emerge." (Greene, 2000, p. 364) How can these countless strings achieve proper resonance? Does the proper resonance occur suddenly? Therefore, the phenomenon that countless multiple strings resonate at the same time requires a more complicated mechanism to explain. Also, according to the law of scientific causality and the principles of systematic science, does the proper resonance of countless multi-strings require an external cause or force? If the answer is no, the string is a closed system. According to the system theory, the finite closed system is destined to perish.

The third critique the latest development of the "Superstring theory" still does not solve the problem of the disappearance of the traditional time and space at the beginning of the universe. But it has brought more difficult-to-explain problems. The latest development of the "Superstring theory" shows that "cutting-edge research on aspects of "M theory", spearheaded by Stephen Shenker, Edward Witten, Tom Banks, Willy Fischler, Leonard Susskind, and others too numerous to name, has shown that

something known as a 'Zero-Brane'—possibly the most fundamental ingredient in M theory. It may give us a glimpse of the spaceless and timeless realm. Their work has revealed that whereas strings show us that conventional notions of space cease to have relevance below the Planck scale. The zero-branes give essentially the same conclusion but also provide a tiny window on the new unconventional framework that takes over. Studies with these zero-branes indicate that ordinary geometry is replaced by something known as noncommutative geometry. In this geometrical framework, the conventional notions of space and of distance between points melt away…Through the study of M theory, a novel world is hidden under the Planck scale, where there may be no space and no time." (Greene, 2000, pp. 365–372) In other words, the "Zero-Brane", the latest development of the "Superstring theory", as the cornerstone of "M theory" has eliminated the traditional quantum space–time. It breaks through the minimum Planck scale and recognizes that there exists stuff smaller than the Planck scale. Just thinking about the original purpose of the Superstring theory, it rejects the smaller stuff than the Planck scale, and claims that the most basic composition of the universe is "eternal oscillating string". It is clear that the latest scientific development is contrary to its original intention. The theory contains a self-contradictory.

The fourth critique the "Superstring theory" is only a hypothesis in a purely mathematical model, and cannot be falsified by scientific experiments. "As the Planck length is some 17 orders of magnitude smaller than what we can currently access, using today's technology we would need an accelerator the size of the galaxy to see individual strings. In fact, Shmuel Nussinov of Tel Aviv University has shown that this rough estimate based on straightforward scaling is likely to be overly optimistic; his more careful study indicates that we would require an accelerator the size of the entire universe. As the U.S. Congress ultimately canceled funding for the Superconducting Supercollider don't hold your breath while waiting for the money for a Planck-probing accelerator." (Greene, 2000, p. 215) Strictly speaking, the String Theory is currently not experimental and there is not any direct or indirect evidences from observation or stimulation. It is classified as a mathematical hypothesis rather than science. Some scientists contend that the String Theory may not be falsifiable and has no predictive power. Yale University physicist Alan Chodos believes that the biggest weakness of the "Superstring theory" is that it can only be achieved at a distance that is more than 10^{56} times smaller than the nucleus particles in the book "*The American Scientist*" (Chodos and Thorn, 1974). Since experiments, indirect observations or stimulations cannot be falsifiable, more and more early string theory researchers have left this field.

In contrast, the "Singularity theory" of universe evolution is more self-consistency in logic, and more persuasive in theoretical explanation. More importantly, it acquires more and more convincing indirect but reasonable evidences, such as supercomputer stimulations and observations of the collapse of the galaxy.

The dimensions of the universe generated from the explosion of the "Singularity" can be either integer or fractal. This theory does not require a predetermined space–time Background-Dependent. All space–time is generated from the explosion of the "Singularity". And the supercomputer simulation experiment of the "Singularity" has caused more and more attention. In 2003, physicists studied the collapse of a spherically symmetrical heterogeneous nebula in high-dimensional space–time and concluded that naked singularities appear in the region close to the center under edge

constraints (Banerjee et al., 2003). In 2016, researchers from the University of Cambridge and Queen Mary University of London used a supercomputer to successfully simulate the dynamics of a circular black hole for the first time. This type of black hole will eventually rupture, leading to "Naked Singularities", and the results were published in the Journal of Physical Review Letters (Figueras et al., 2016). The ring black hole was found by theoretical physicists in 2002. Researchers from the University of Cambridge used the COSMOS supercomputer to successfully simulate a very thin ring black hole, which would produce a series of "Bumps." "Bumps" become thinner and thinner over time. These thin rings will eventually become so thin that they are squeezed into a series of miniature black holes. In most cases, the very unstable black rings collapse into a ball, so as to form a convex connected by thinner and thinner strings. It should eventually break and form a naked singularity. If the singularity of black holes is possible, the same reasoning can lead to the "Singularity" of the universe. In 2020, physicist Penrose won the Nobel Prize in Physics, as he proved the "Singularity Theorem" by the invention of Twistor Theory.[2] This indicates that the scientific community generally accepts the "Singularity Theorem" widely.

In summary, through the analysis of the four critiques of the "Superstring theory", it is more reasonable to choose the "Singularity theory" for the question of the origin of the universe. The "Superstring theory" attempts to eliminate the matter smaller than the Planck scale. But the emergence of the "Zero-Brane" in the "M theory" breaks the Planck's scale at last. The "Singularity theory" of the Standard Universe Model has become more influential.

3 Response to the three critiques of the "Singularity theory" from Information Ontology

We have briefly mentioned that the blames from the "Superstring theory" to the "Singularity theory". However, these "blames" can be dissolved effectively.

> Critique 1: the Standard Model cannot explain the particularity of constant parameters describing the mass, charge, and cosmological constant of elementary particles

The "Superstring theory" holds that the standard model of the universe fails to explain the special composition of the universe, the properties and parameters of elementary particles. From the opinion of Brian, the properties of the basic particles, masses, the four natural forces and related particles are so special that the specific numerical values describing the 19 quantities of particles and forces are not generated by accident. Brian thinks the Standard Model needs to adjust 19 parameters to keep the consistent between the theory and experimental measurements.

[2] Note: Penrose believes that one of the following three conditions exists in the space–time that satisfies the field equation, and there must be a singularity. (1) There is a closed trapped surface. (2) There is one compact and boundless non-sequential point set. (3) There is one point, through which the expansion scalar of the light-like geodesic harness in all future or past directions will eventually become negative.

It seems the attack from the “Superstring theory” on the Standard Model is justified. But after careful consideration, it is found that the above-mentioned attack on the Standard Model can also be applied to the “Superstring theory”. Brian believes that “the equations of string theory show that the universe has nine space dimensions and one time dimension, why is it that three space (and one time) dimensions are large and extended while all of the others are tiny and curled up? Why aren’t they all extended, or all curled up, or some other possibility in between? At present no one knows the answer to this question. If string theory is right, we should eventually be able to extract the answer, but as yet our understanding of the theory is not refined enough to achieve this goal.”(Greene, 2000, pp. 196–197) According to Brian’s logic, the Standard Model fails to explain the particularity of the universe parameter. Similarly, the “Superstring theory” can explain neither. Although these two theories have different explanatory scope, the String theory constructs a set of complex mechanisms to explain the source of elementary particles and their parameters. In the end, it is difficult to escape the question of the source of the particularity of space–time parameters. Both theories can use the same logic to attack each other. The challenge to the Standard Model is not fundamental.

However, the "Singularity theory" can explain the particularity of the universe parameters from a new thinking framework. According to the "Law of Energy Conservation", the energy at the moment of the Big Bang is the sum of all the energy of all existing universes. In the sight of contemporary Information Philosopher Professor Wu Kun, an objective reality is a composite of matter and information, a dual existence (Wu, 2013). The "Singularity" of the universe, as objective and material, is also an information existence. According to the Information Philosophy, the absolute amount of information in the universe is conserved in the process of change and transformation. Therefore, it can be reasonably inferred that the "precision" and "inevitability" special parameters of the universe in the subsequent evolution of the Big Bang actually come from the information contained in the "Singularity" before the Big Bang. In other words, according to the Law of Conservation of absolute amount of information, the "information amount" shown in subsequent universe evolution is equivalent to the amount of information in the "Singularity" state. Therefore, the initial "Singularity" of the evolution of the universe is not merely a point with infinite energy, but also carries all the "procedural information" of the subsequent evolution. From this perspective, we call the "Singularity" "Origin Information". From the perspective of the Law of Conservation, the question of the source of specific parameters was answered. Taking a step back, the "Singularity theory" can also answer the question of the eleven dimensions of space–time and the only three dimensions of space were extended in the “Superstring theory”. Therefore, the String Theory’s challenge to the “Singularity theory” is untenable.

Critique 2: The Standard Model cannot integrate the General Relativity and the Quantum Mechanics

From the view of the “Superstring theory”, the emergence of the “Singularity” has caused a serious contradiction between the General Relativity and Quantum Mechanics. Because there will be dramatic quantum fluctuations in the spatial structure at the ultra-micro scale (less than the Planck length). The huge quantum fluctuations break

the concept of smooth and curved geometry, which form the basis of the General Relativity. Proponents of the “Superstring theory” believe that they reconcile the principles of the General Relativity and Quantum Mechanics. However, the subsequent development of the "Zero-Brane Theory" still introduced a "novel world" smaller than Planck’s scale. It means that the latest development of the “Superstring theory” doesn’t integrate the General Relativity and Quantum Mechanics well. The “Superstring theory” has not achieved its claimed advantage.

According to the "Zero-Brane theory", at the stage before countless string resonances, time and space are fragments of strings. "There is no time and space" means that traditional quantum space–time do not exist. But it doesn’t indicate there is no other type "time" and "space". The quantum space–time was generated after the Planck ara. But before the Planck ear, the universe indeed “moved” from the beginning. This indicates that there shold be another type of "time" and "space", which is different from quantum space–time. The General Relativity and Quantum Mechanics are theories developed based on quantum space–time. Thus, we can easy understand that these two theories are not applicable to the “Singularity” in non-quantum space–time. This is a very reasonable judgment. Here, we resolve this blame to the Standard Model.

Critique 3: "Singularity theory" believes that "infinitely small points and infinite energy" cannot be explained by scientific rationality

The "Superstring theory" believes that strings are the most basic structure of the universe, which can explain the universe at the most micro level from a scientific and rational understanding. For the “Singularity theory”, it is believed that "the unification of the infinitely small points of nothingness and infinite energy" cannot be explained rationally. In fact, the key point is not that the “Singularity theory” cannot be explained by scientific rationality, but that it is necessary to change the thinking framework in the space–time domain.

According to the “Singularity theory”, we can divide the space–time of the overall evolution of the universe into two phases: the quantum space–time phase after the Planck era and the "space–time" stage before the Planck era. Just as Fig. 1 shows.

Indeed, the world consists of matter and information after the Planck time. According to the Information Ontology, the information and its carrier are the dual existence mode of one thing. The same theory for the status of “Singularity”. According to the "Law of Conservation" in energy and absolute amount of information, the “Origin Information” and infinite energy indeed exist. We cannot deny them. They are the dual existence mode of the “Singularity”. We acknowledge that infinite energy is the information carrier. According the Information Ontology, the direct existence of the “Singularity” also has three levels: the direct existence matter (non-quantum stuff), the direct existence mode (non-quantum space–time and movement), and the direct existence relation (non-quantum evolution and interaction).

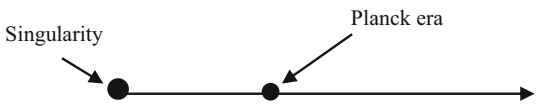

Fig. 1 Two phases of space–time of the evolution

As for how does the infinite energy exist or what is the structure of infinite energy, we want to say this special information carrier belongs to the non-quantum space–time. Maybe we need to propose a new set of mathematical principles of non-quantum space–time to explain the internal structure and movement status. But this is beyond our range. Maybe that is the new mission of theoretical physicists and mathematicians based on the “Cantor Infinite Set Theory”.

On the other hand, we acknowledge that the understanding of “Singularity” is beyond the quantum space–time science. But it still belongs to physical science, according to the "Law of Conservation" in energy and absolute amount of information. From the observable effects, we can conclude the “physical causes” of the “Singularity”. However, this “physical causes” is not the quantum causes. The scope of the definition of “physical” needs to be expanded. We may say the physical things are not just the real things that can be touched and seen, but also can cause the direct or indirect effects that can be touched and seen. This new definition contains the quantum space–time stuff and non-quantum stuff.

The non-quantum stuff also exists in the real world, just like the “Dark Matter and Energy”. Even people cannot “catch” or “observe” the “Dark Matter and Energy” directly. But from their physical effects to the world, they should exist, and have physical bodies. Maybe they are in the higher energy levels or non-quantum stuff. Scientific community cannot deny them. What we need to do is seeking new theoretical framework and advanced tools.

The "space–time" before the Planck era is an analogical explanation. At this stage, the “Singularity” began to "unfold" and "move" from the initial point to the Planck scale. Obviously, the time and space of these two phases are different. Let’s name the "hyper-spacetime" before the Planck era. All human concepts, thinking frameworks, and cognitive experiences are summaries and reflections of quantum time and space. People have never seen the evolution in "hyper-spacetime". Nevertheless, this does not mean "hyper-spacetime" belongs to non-existence. It is undoubtedly not a rigorous attitude of scientific rationality to deny the existence beyond the boundaries due to the limitations of human life, knowledge and reason. Therefore, in response to this critique, it is required to divide the evolution time in two phases and transform the space–time thinking mode. On the other hand, people need to understand the boundaries of their own cognition, and maintain a humble attitude towards the unknown world.

4 Conclusion

This article compares the “Singularity theory” and the “Superstring theory” of the origin of the universe, and criticizes the “Superstring theory” from four aspects. At the same time, from the perspective of the “Singularity theory”, three critiques from “Superstring theory” have effectively been replied to. Some of these critiques are the dilemmas faced by the “Superstring theory” itself, and some of them can be dissolved by dividing two different phases of the evolution of the universe. From the perspective of Information Ontology, the “Singularity” is regarded as the "Origin Information", which contains the "procedural information" of subsequent spatiotemporal evolution.

It can effectively answer the source of precise cosmic parameters of quantum spatiotemporal evolution. In short, compared to the "Superstring theory", the "Singularity theory" is a more competitive theory of the origin of the universe.

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Declarations

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