Connecting the Dots: Science, Philosophy, and the Great Mysteries of the Universe

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Abstract

This study examines how the great mysteries of the universe—such as what existed before the Big Bang, the concept of infinity, and the possible existence of a first or ultimate cause of the cosmos—can be answered in a specific way. Despite their importance, these topics have received limited attention within the academic community. The study highlights the complexity of the ongoing debate surrounding issues such as the beginning and end of the universe and the origin of life, which has led to numerous hypotheses in recent decades. The study reveals that these mysteries may be unraveled using tools such as artificial intelligence, contact with extraterrestrial civilizations, and the in-depth study of cosmological mathematics and information. These findings demonstrate that science and philosophy can answer questions about the cosmos that humanity has pondered for centuries.

Keywords: Universe; Life; Infinity; Technology; Philosophy of Science.[1]

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[1] Received on July 3, 2025. Accepted on December 31, 2025. Published on December 31, 2025.
doi: 10.23756/sp.v13i2.1697. ISSN 2282-7757; eISSN 2282-7765.

1. Introduction

The mysteries of the cosmos are highly debated in academia, primarily the following questions, which remain unanswered: What is the origin and the end of the universe? (Adams and Laughlin, 2000; Del Popolo, 2021; Hawking, 2002) Why does something exist rather than nothing? (Brenner, 2022; Carroll, 2021; Goldschmidt, 2014) Is the cosmos infinite or finite? (Barrow, 2005; Heller and Woodin, 2011; Rucker, 1984).

Hawking and Mlodinow (2010, p. 5) argued that historically, such questions were primarily examined through philosophy, which has since lost relevance over the past century; the idea of science and philosophy together analyzing the physical processes of the universe was rejected and today, science alone dominates the quest to unravel cosmic mysteries (Hawking and Mlodinow, 2010).

Gödel's (1990) incompleteness theorems may be linked to questions regarding the possibility of discovering the mysteries of the cosmos. He argued that certain mathematical truths may never be discovered because they lie beyond human comprehension, demonstrating that mathematics cannot establish its own consistency. Penrose (2004, pp. 17–23) has used Gödel's theories to assert that since mathematics cannot analyze everything in science, certain physical processes related to the cosmos will remain undiscoverable. Consequently, science will always have limitations in comprehensively unveiling cosmic mysteries.

In contrast to these ideas, the present study argues that while science drives humanity toward discovering the universe's enigmas, philosophy is fundamental to gaining a deeper understanding of the cosmos. The following sections discuss the mysteries of the universe that emerged after the Big Bang, highlighting the debates and hypotheses surrounding physical laws, universal constants, the origin of life, the theory of everything, and extraterrestrial life.

Furthermore, this study explores questions about the origin and ultimate fate of the universe, emphasizing the complexities that continue to hinder the formulation of valid answers. Additionally, it examines whether concepts such as infinity and the first and ultimate causes can be applied to recent theories—such as the existence of the multiverse, the cyclic universe, the universe-from-nothing, and the holographic universe—as well as the ultimate fate of the universe. Finally, the study addresses whether all questions concerning the universe can ever be answered. This study highlights a possibility rarely explored in academia—that future human civilization might uncover cosmic mysteries.

2. Great Mysteries of the Universe: The Big Bang, Physical Laws, Universal Constants, and the Theory of Everything

The Big Bang represents the first great mystery of the universe. The fact that a universe with a precise and ordered space-time suitable for sustaining life emerged from a tiny primordial energy core continues to provoke lively academic debates. Scientifically, one might expect a void- or energy-dominated universe to emerge from the primordial energy core. Instead, our cosmos comprises various elements—ordinary matter, dark matter, and dark energy—that form the foundation of life.

The Big Bang theory raises the first fundamental question posed by Leibniz (1898) centuries ago: “Why is there something rather than nothing?” To date, no definitive answer has been obtained. The only certainty is that since the Big Bang, a sequence of components emerged, prompting new questions concerning, for example, the existence of physical laws[2] within the cosmos. Over the centuries, Isaac Newton, Albert Einstein, and Max Planck formulated fundamental laws such as gravity, relativity, and quantum mechanics.

A distinctive characteristic of physical laws is their precision and order. If the physical laws had been even slightly different, life would have been impossible; the cosmos would have collapsed billions of years ago, exploded immediately after the Big Bang, or be dominated solely by energy. Einstein argued that presence of the laws of nature in the cosmos should not be undervalued (Solovine and Einstein, 1987, p. 118), and that chaos or disorder was far more likely to have prevailed in the universe, necessitating human intervention to impose order on it. He stated that the physical laws are so perfect and precise that they were not meant to emerge in the cosmos.

Einstein reasoned that the universe is endowed with natural laws compatible with the possibility of life developing on a planet, leading scientists to question the existence of such laws. Furthermore, one wonders why these particular laws (that allowed the development of life), rather than other laws, exist. Closely related to the question of natural laws is “the theory of everything,”[3] which unifies all known physical phenomena. Throughout the history of science, new physical theories have emerged based on Newton’s gravity in modern quantum models. The problem lies in whether this sequence of laws has an endpoint, and whether, at some stage, a theory of everything capable of

[2] Physicist Feynman (1965) addressed the nature of physical laws.

[3] Weinberg (1993), Barrow (1991), and Close (2017) addressed the possibility of (not) discovering a theory of everything that unifies all the physical processes of the universe into a single structure.

unifying all physical laws will emerge. The main obstacle is the apparent incompatibility between relativity and quantum mechanics. Relativity focuses solely on gravity to describe the universe on a considerably large scale corresponding to the observable universe. Conversely, quantum mechanics focuses on three non-gravitational forces (electromagnetism, strong nuclear force, and weak nuclear force) to explain phenomena that occur at extremely small scales, down to millionths of a centimeter.

Gödel's (1990) argument that any mathematical model is inherently incomplete further makes the development of a theory of everything challenging. Consequently, uniting all known phenomena within a single framework is unattainable because any proposed theory of everything would necessarily be a mathematical model.

Several theories of everything have emerged in recent decades, including string theory (Kaku, 1999), loop quantum gravity (Bojowald, 2010), causal fermion systems (Finster, 2006), causal set theory (Surya, 2019), causal dynamical triangulation (Ambjorn et al., 2010), and ER=EPR (Maldacena and Susskind, 2013).

These theories are classified as quantum-gravity theories because they attempt to reconcile two seemingly irreconcilable frameworks explaining our universe: relativity and quantum mechanics. Hawking (2016, p. 201) outlines three possibilities for the theory of everything: (1) such a theory exists, and humanity will eventually discover it; (2) it does not exist because there are an infinite number of theories; (3) it does not exist because events occur in a fundamentally causal manner.

Another issue related to the laws of nature is the universal constants.[4] Similar to physical laws, if the constants of nature were slightly different from those we observe, life on Earth might never have emerged. According to a British astronomer, the cosmos revolves around six fundamental constants: the ratio between the strength of the electric forces that hold atoms together and the gravitational force acting between them; the strength of the binding force between atomic nuclei and the process by which all atoms on Earth are formed; the amount of dark matter in the universe, including galaxies, diffuse gas, and dark matter; cosmic antigravity; the fabric of the universe; and the number of spatial dimensions. If any of these values differed slightly, the world as we know it would not exist (Rees, 1999, p. 2).

The most prominent constant, notable for its precision, is epsilon (i.e., the strength of the bond between atomic nuclei and the process by which all atoms on Earth are formed). It has a value of 0.007. A value of 0.006 or 0.008 would prevent the development of life in the universe. This reasoning applies to many other constants, including those governing the strong, weak, and electromagnetic nuclear forces, alongside the fine-structure and

[4] Eddington (1956) and Barrow (2002) demonstrated that universal constants have been the subject of lively debate in the academic world.

cosmological constants. One possible explanation for this finely tuned universe[5] is that the physical laws and universal constants change over time and space.

Even if this hypothesis cannot be ruled out, the question remains: why were the physical laws and universal constants necessary for life established in a particular region of the universe and not in other regions? Thus, the fine-tuning of universal constants and the existence of laws of nature conducive to life are some of the greatest mysteries of the universe.

3. From Post-Big Bang Phenomena to the Emergence of Life: A Journey Through the Evolution of the Universe

A topical issue in academia is the sequence of events following the Big Bang. Immediately after the initial explosion, the symmetry caused by the Higgs field created the conditions necessary for the formation of mass in the universe. The superforce that originated from the Big Bang was subsequently divided into four fundamental forces: gravity, electromagnetism, weak nuclear force, and strong nuclear force. Furthermore, the universe underwent a rapid expansion known as inflation, during which small quantum fluctuations resulted in the formation of galaxies, stars, and planets.

Subsequently, among the quarks and particles produced by the mass of the universe, quarks grouped into triplets to form protons and neutrons, which then combined into nuclei. These processes are essential for the creation of atoms and constitute the backbone of the universe. Hydrogen and helium, fundamental elements for the emergence of life, were formed through primordial nucleosynthesis. Although matter and antimatter were initially present in equal amounts in the early cosmos, a small imbalance caused by an unknown physical phenomenon led to the predominance of matter over antimatter. These events, which occurred within the first three minutes of the Big Bang, raise the question of a fine-tuned universe, given their essential role in the emergence of life in the cosmos (Weinberg, 1977).

As the gravitational force took control, the elements formed during the first three minutes of the Big Bang created the conditions necessary for the formation of early stars, galaxies, and numerous physical elements. The formation of early stars was particularly significant because, upon explosion, they dispersed the chemical elements essential for life on other planets and galaxies. The phases that followed the Big Bang raise important

[5] Regarding the finely-tuned universe, see Dicke (1961), Davies (2007), and Gribbin and Rees (1989).

questions about why they were all fine-tuned to facilitate the emergence of life in the cosmos (Singh, 2004).

Among the most fundamental concepts is the arrow of time, which explains why time appears to have a specific direction in which every physical event evolves from state X in the past to state Y in the future. Furthermore, the cosmos we inhabit comprises 4.9% ordinary matter, 26.8% dark matter, and 68.3% dark energy. However, because the nature of dark matter and dark energy remains unknown, we understand only 4.9% of the universe (Sloan, 2020).

Regarding the origin of life on Earth, statistically improbable phenomena have been observed. The disc of matter around the sun facilitated the creation of the Earth and other planets in the solar system. The Earth is in a habitable zone, positioned neither too far nor too close to the sun—a location essential for the creation of water, the fundamental ingredient that supports life. Furthermore, Earth benefits from its near-circular orbit, which allows the planet to remain in the habitable zone. If the Earth's orbit were excessively elliptical, it would remain in the habitable zone for short periods only, rendering the emergence of life impossible (Lewis and Barnes, 2016).

Several other factors ensured favorable conditions for life on Earth, such as the presence of Jupiter and the Earth's natural satellite, the Moon. Jupiter occupies a strategic position as it attracts most asteroids that would otherwise frequently collide with Earth, thereby destroying life. Similarly, the Moon stabilizes the Earth's axis of rotation, enabling a stable environment conducive to life.

The phenomena described above are fundamental for establishing the foundations of life on Earth and are represented by elements such as carbon, iron, oxygen, and nitrogen. However, what led to the origin of life on Earth approximately four billion years ago is unknown. The most significant event in this context is the primordial cell formation. Two principal theories exist regarding the origin of life: (1) terrestrial abiogenesis—life arose as a result of physical and chemical processes on Earth (Bernal, 1951; Haldane, 1929; Oparin, 1924); (2) panspermia—life originated when a comet carrying the seeds of life crashed into Earth (Wickramasinghe, 2011). However, proponents of terrestrial abiogenesis cannot explain how inanimate matter transformed into life through the primordial cell, while panspermia is constrained by the improbability of a primordial cell inside a comet surviving the radiation of space.

Darwinian evolution emerged following the emergence of life on Earth. The central premise of Darwin's (1859) theory is natural selection, which asserts that individuals that best adapt to their environment survive, whereas others do not. Evolution led to the emergence of prokaryotic and eukaryotic cells, living organisms, and intelligent species.

Nevertheless, evolution also has limitations. Evolution has been governed by a set of laws that facilitated the emergence of all species on Earth over millions of years. These Darwinian laws, akin to physical laws, require an explanation for their existence in the universe, as they appear to promote biological diversity and, ultimately, the development of intelligence capable of comprehending the cosmos' mechanisms.

Another longstanding issue related to evolution concerns consciousness[6]—the difficulty in understanding why humans possess an awareness that enables them to reason, feel, and comprehend the reality around them. Furthermore, this consciousness belongs to all beings who have lived, are living, and will live on Earth.

Hameroff and Penrose's (2014) Orchestrated Objective Reduction (Orch-OR) theory suggests that consciousness arises from quantum processes. However, this hypothesis cannot explain the presence of quantum laws in the cosmos, which are not inherently destined to exist in our universe, yet may have enabled the emergence of consciousness.

Therefore, the existence of consciousness remains an unresolved enigma.

To address the mystery of life on Earth, scientists have proposed the anthropic principle (Barrow and Tipler, 1986; Carter, 1974), which asserts that the universe must exhibit conditions required for conscious life to emerge and observe its properties. In other words, we exist and can observe the universe because its conditions are suitable for life.

However, the anthropic principle does not explain the cause or reasons for these specific characteristics in the universe or why the universe is structured in a way that permits the existence of life. Consequently, it is often viewed as a superficial observation rather than a significant contribution to our understanding of cosmology and the physical laws governing the universe.

Another question arises: did the processes that occurred on Earth happen in other parts of the cosmos? Physicist Enrico Fermi's paradox, "If the universe and our galaxy are teeming with advanced civilisations, where are they?" has been extensively studied in recent decades. Webb (2015, pp. XIII–XV) highlighted the intense debate around extraterrestrial life and proposed 75 scientifically plausible solutions to the Fermi paradox, highlighting three principal options: "they are or have been here"; "they exist, but we have yet to see or hear from them"; and "they do not exist."

We do not yet understand the extent to which life on Earth can be replicated elsewhere, nor whether the development of primordial cells, prokaryotic cells, eukaryotic

[6] Topics related to consciousness are extensively discussed among scientists and philosophers (Schneider and Velmans, 2017; Seth, 2021; Dennett, 1992; Penrose, 1989; 1994; Searle, 1997; Chalmers, 1995).

cells, living species, or intelligent species is a frequent, rare, or unique event that occurred only on Earth.

Another challenge concerning extraterrestrial life is the uncertainty regarding the number of galaxies in the universe. Current estimates suggest billions or even trillions. This distinction is crucial in resolving the Fermi paradox: If there are "only" billions of galaxies, the notions that we are alone in the universe and Earth is the only planet on which life has emerged are conceivable. Conversely, if there are trillions of galaxies, the existence of life and intelligence in the cosmos would be inevitable given the colossal number of potentially habitable planets.

Regarding the nature of life, most biologists and chemists argue that only carbon can give rise to life. Sagan (1973, p. 47) strongly criticized this notion, coining the term "carbon chauvinism" to describe this assumption. However, this hypothesis cannot be ruled out because we are unfamiliar with the biochemistry of planets that might harbor life. In billions or trillions of galaxies, silicon-based life may exist as an alternative. Furthermore, if there are other universes with physical laws different from ours, life forms could arise from currently unknown elements.

4. Hypotheses on the Origin and Ultimate Fate of the Universe: Beyond the Big Bang

The origin of the universe is a great scientific mystery.[7] Until the early twentieth century, the universe was believed to be eternal. However, the discovery of relativity and the expansion of the universe overturned this concept. Jesuit physicist Lemaître (1931) was the first to theorize that as we trace time backwards, the universe becomes increasingly smaller until it is reduced to a minuscule primordial atom, and that the implosion of this primordial atom (later known as the Big Bang) led to the formation of the cosmos and all its elements.

The Big Bang theory was confirmed in 1964 with the discovery of cosmic background radiation and reconfirmed in 1992 through measurements taken by the Cosmic Background Explorer (COBE) satellite. The realization that the cosmos originated 13.7 billion years ago has fundamentally altered the perspectives of physics and cosmology. When the universe was assumed to be eternal, questioning its origin seemed unnecessary. However, the recognition of a cosmic beginning raised fundamental

[7] Vaas (2011) is a comprehensive source for understanding issues related to phenomena before the Big Bang.

questions: What existed before this beginning? What caused the Big Bang? How did the implosion of the primordial energy core give rise to a universe capable of sustaining life?

Four principal hypotheses attempt to explain the origins of the universe: the multiverse, the cyclic universe, the universe-from-nothing, and the holographic universe. The multiverse theory posits the existence of multiple universes beyond the cosmos. In recent decades, various multiverse models have been developed, including the many-worlds interpretation (Everett, 1957), eternal inflation (Guth, 2007), black hole cosmology (Good, 1972), and cosmological natural selection (Smolin, 1997).

Tegmark (2014) identified four levels of the multiverse: ergodic universe, eternal inflation, many-worlds interpretation, and universes with different physical laws. Greene (2011) proposes nine categories of the multiverse: quilted, inflationary, brane, cyclic, landscape, quantum, holographic, simulated, and ultimate. Mersini–Houghton (2011) divides the multiverse into three categories of universes based on different physical laws, universal constants, and spatial dimensions.

Contrary to multiverse theories, cyclic universe models have recently gained renewed interest, particularly because of a lack of empirical evidence for inflation, which is fundamental to multiverse models.

Five main theories related to the oscillating universe are considered plausible: the quasi-steady-state universe (Hoyle et al., 1993), the Big Bounce (Ashtekar et al., 2006), the ekpyrotic universe (Steinhardt and Turok, 2007), the Baum-Frampton model (Baum and Frampton, 2008), and conformal cyclic cosmology (Penrose, 2010). The first four models suggest that each cycle of the universe may exhibit different physical laws and constants. By contrast, Penrose's conformal cyclic cosmology postulates that each cosmic cycle is governed by the same physical laws and universal constants.

The potential existence of a multiverse or cyclic universe raises scientific and philosophical questions. These two models can explain why a universe with physical laws and constants is suitable for life. Given the "lottery" of possible universes that could have emerged, the creation of a cosmos such as ours would be inevitable. However, even if this hypothesis cannot be ruled out, the question remains why at least one universe with life-sustaining physical laws came into being, given that any cosmos that emerged within the multiverse or cyclic universe could have lacked natural laws.

If the set of universal constants that could arise from the multiverse or cyclic universe were finite rather than infinite, why did these constants develop within a finite range rather than extending to infinity?

A more philosophical question regarding the multiverse and the cyclic universe concerns the existence of both possible and impossible worlds. Lewis (1986) and Nozick (1981), using modal realism and the principle of fecundity, argued that all possible universes are as real as our own. Conversely, Kripke (1965) and Berto and Jago (2019) explored impossible worlds such as the existence of round squares. As the multiverse and the cyclic universe are posited as possible theories, questioning whether possible and impossible worlds exist within them is reasonable. Greene's (2011) extreme multiverse theory, asserting that all possible universes exist, renders plausible the idea that every scientifically feasible event occurs somewhere in the multiverse. Hence, there could be universes in which Hitler won the Second World War, Trump was not elected the president of the United States in 2016, and Mussolini never existed. Any universe with a greater-than-zero probability of existence is part of Greene's extreme multiverse theory.

In Tegmark's (2014) level four multiverse, impossible worlds, such as round squares, finite numbers, or the Greek pi being equal to 10 could become possible, owing to the potential existence of different physical laws. Moreover, possible and impossible worlds are real within cyclic universe models involving the same or different physical laws. Therefore, everything is possible in a multiverse and cyclic universe because the set of physical laws makes all types of universes viable.

Conversely, proponents of the universe-from-nothing and the holographic universe models support a single universe possibility. The universe-from-nothing hypothesis suggests that before the Big Bang, the cosmos underwent a quantum transition in a quantum vacuum, leading to its emergence. Major models include the Hartle-Hawking state (Hartle and Hawking, 1983), the emergent universe (Ellis and Maartens, 2003), the Big Bang from quantum foam theory (Tryon, 1973), and quantum potential cosmology (Ali and Das, 2015).

However, holographic universe theory (Hertog, 2023) posits that the cosmos emerged from nothing through the implosion of the primordial energy core, and that physical laws subsequently evolved according to Darwinian logic.

Nevertheless, asserting that the cosmos emerged from nothing—when, in fact, a quantum fluctuation before the Big Bang triggered the birth of the primordial energy core—may be conceptually flawed. A quantum fluctuation does not represent nothingness but is a real phenomenon that theoretically predated the Big Bang. The holographic universe model addresses the same issues as the universe-from-nothing hypothesis. Even if the cosmos did not emerge from quantum processes preceding the Big Bang, it originated from the implosion of the primordial energy core, which was not nothingness.

Defining various universe-from-nothing models as vacuum universes or cosmoses arising from a primordial energy core would be more appropriate because, as Parmenides argued, "Nothing comes from nothing" (Empiricus, 1933).

Three main theories exist regarding the universe's ultimate fate[8]: the Big Freeze, the Big Crunch, and the Big Rip. The Big Freeze theory (Thomson, 1852) posits that the universe will continue to expand indefinitely, rendering the cosmos a dark, cold place where life will perish. The Big Crunch theory (Friedman, 1922) posits that the universe will eventually stop expanding, and will begin to contract back into the primordial energy core that caused the Big Bang. The Big Rip theory (Caldwell et al., 2003) suggests that if dark energy exceeds a certain threshold, the universe will be torn apart, and all matter destroyed.

There are other cosmological hypotheses. The Big Decay theory (Leslie, 1996) proposes that the vacuum state we inhabit is not stable but metastable, and the cosmos will consequently be "burned alive" at some point; the Big Hit theory (Starobinsky, 2000) suggests that our universe will undergo a space-time singularity that will precipitate its destruction; and the Big Brunch theory (Kiefer and Zeh, 1995) argues that the arrow of time will reverse while the universe is in its contraction phase, causing its destruction before gravitational singularity is reached.

Mars et al. (2008) suggest that time is slowing and will eventually stop; consequently, everything will appear frozen in an eternal freeze frame.

Several hypotheses exist regarding life at the end of the universe.

The first suggests that despite humanity's future technological capabilities or those of potential alien species, various theories regarding the ultimate fate of the universe preclude the survival of any form of life. In this scenario, humans, extraterrestrials, animals, and unknown life forms may be overpowered by the physical processes governing the end of the cosmos, leading to the ultimate extinction of all species.

The second hypothesis posits that billions of years from now, the technological capabilities of our civilization or those of alien civilizations will be advanced enough to afford continuous survival. Through technological advancements, civilization could manipulate space-time and physical laws or even create new laws of nature to prevent the destruction of the cosmos by obtaining the necessary energy and components to perpetuate life and intelligence. Additionally, wormholes[9] in black holes could be exploited, or even created through technological advances, to relocate our civilization and all living beings to a different place in the universe or another universe (if there are other Hubble volumes or universes) to escape the death of the cosmos. Finally, if time travel[10] were possible, each civilization could construct a time machine to return to the past

[8] Davies (1994) and Mack (2020) precisely and clearly address the end of the universe.
[9] Einstein and Rosen (1935) theorized the possible scientific existence of wormholes.
[10] Davies (2002) states that time travel to the past and the future is possible.

repeatedly, preventing the occurrence of processes that cause cosmic destruction or implosion.

5. The First and Ultimate Causes and the Infinite: Philosophical and Scientific Considerations

One of the greatest mysteries of the cosmos is whether the universe has finite or infinite dimensions. The observable universe has a radius of forty-six billion light-years and a diameter of ninety-three billion light-years. The cosmos is larger than the observable universe; however, as a whole, it can be infinite.

To understand this enigma, determining the extent to which the cosmos expands during cosmic inflation, assuming that it is finite, is crucial. However, it is possible that the universe expanded infinitely into space during the implosion of the primordial energy core. The multiverse and the cyclic universe require further investigation.

Greene's extreme multiverse (2011) and Tegmark's level four multiverse (2014) suggest that an infinite number of possible histories exist. The multiverse could have infinite physical laws, space-time dimensions, theories of everything, and universal constants, as well as infinite types of abiogenesis, species evolution, extraterrestrial civilizations, and countless hypotheses regarding the eternity, origin, and end of the universe, each generating an infinite number of events.

Moreover, infinite copies of ourselves in the multiverse would generate infinite histories, as each of our clones could think of a different number throughout their lives, thus developing an unlimited number of events. This reasoning can be applied to the infinite possible and impossible worlds in Greene's extreme or Tegmark's level four multiverse. However, the concept of infinity is limited if the number of possible and impossible histories in a multiverse is finite. If the number of physical laws or events that can occur is large but not limitless, as Tegmark and Greene argued, then infinity would partially fall short.

Thus, if cosmic inflation is eternal, a finite number of possible histories will occur an infinite number of times in an infinite multiverse. One infinity can be greater than another. For example, a frequently occurring event, such as the Brazilian soccer team winning the World Cup, inevitably appears more often than the Faroe Islands soccer team winning the World Cup. However, both histories would occur an infinite number of times in the extreme multiverse; yet, the infinity associated with Brazil would manifest more frequently and with greater density than that associated with the Faroe Islands.

Following this reasoning, while both the multiverse and the cyclic universe would generate infinite possible histories, the multiverse would produce greater infinity than the serially arranged universes of the cyclic universe by creating continuous universes.

In terms of time, models of the multiverse and the cyclic universe can generate infinite regressions and replications. Every possible or impossible event would have occurred or will occur infinitely.

Frampton (2007), Aguirre and Gratton (2002), and Carroll and Chen's (2004) models predict that the cyclic universe and inflation have an eternal past. Furthermore, infinite regression can be applied to all models that postulate a quantum vacuum before the Big Bang. According to de Lavoisier's (1789) principle—"Nothing is created, nothing is destroyed, everything is transformed"—, the quantum energy that existed before the Big Bang was created by something unknown, continuing ad infinitum into the past.

The infinite replication in the multiverse and cyclic universe theories enables the existence of Nietzsche's (1896) philosophical concept of eternal return, which posits that the same events repeat an infinite number of times. Contrary to infinity, the possibility remains that the universe, the multiverse, and the cyclic universe could have a first cause and an ultimate cause. For instance, our universe had a definite beginning 13.7 billion years ago. If the theory of the holographic universe is correct, then the gravitational singularity of the primordial energy core would be the primary cause of the cosmos. The same reasoning applies to the multiverse, cyclic universe, and vacuum universe. Borde et al.'s model (2003) proposes that inflation has not been eternal. Mithani and Vilenkin (2012) later revised this theorem, arguing that the multiverse, cyclic, and emergent universes can have an origin. Consequently, these universes may have a first cause, which could be represented by gravitational singularity. Furthermore, the ultimate cause is scientifically plausible and applicable to various models concerning the ultimate fate of the universe, particularly if humanity or alien species fail to survive. For instance, the Big Crunch predicts that the universe will contract to the gravitational singularity from which the Big Bang originated. Thus, this singularity could represent the ultimate cause of the cosmos. Mars et al.'s (2008) model predicts that time will eventually halt. The universe will stop in an eternal freeze frame that could represent its ultimate cause. Conversely, the Big Freeze suggests that in billions of years, the universe will become a dark and desolate place from which life will disappear. However, this dark universe may not always consist of nothingness. Quantum energy is the only entity that could persist even after an infinite number of years, because no physical process could destroy it. Therefore, this energy could be the ultimate source of our cosmos. The ultimate cause of the multiverse and the cyclic universe is complex. Physicists posit that the physical processes linked to the multiverse and cyclic universe could generate an infinite number of universes in the future. However, the processes leading to the formation of the multiverse or cyclic universe, such as inflation or the Big Bounce, might lose their ability to continue forming such universes in the long term, causing the multiverse and cyclic universe to cease to exist. Consequently, the ultimate cause, represented by the quantum energy present in each universe at the end of its existence, is a plausible possibility.

6. Towards Understanding: Means and Methods for Unveiling Cosmic Mysteries

Humankind will possibly eventually uncover all the mysteries discussed earlier. Therefore, to understand the enigmas of the cosmos, it is essential to study the information present in the universe and on Earth. Seife (2007), Wheeler (1990), and Lloyd (2006) suggest that the cosmos is merely a collection of information that determines the laws of physics, initial parameters, and differential equations. Even the mechanisms governing life in the universe and the evolution of species are reduced to information. By studying these informational patterns, humanity may be able to answer any question and solve every mystery related to the cosmos.

Moreover, mathematics could help decipher the equations that govern the cosmos, identify a theory of everything, and determine whether our universe is unique or infinite, whether other universes exist, whether our universe is cyclic, and what its ultimate fate.

Technological advancements can help us understand our place in the universe. Kurzweil (2005) argues that human technological development is progressing exponentially and will eventually accelerate beyond our ability to comprehend and predict. From this perspective, the development of super-intelligent robots and computers facilitated by artificial intelligence (Luger and Stubblefield, 2004; Rich et al., 2010; Russell and Norvig, 2021) could be crucial in deciphering the fundamental mechanisms of the cosmos and life on Earth. This latter aspect could be further explored through technology, for instance, by implanting microchips in the human brain capable of performing billions of operations simultaneously, or transforming individuals into super-intelligent cyborgs (Clark, 2004; Gray, 1995; Mann and Niedzviecki, 2001) capable of unlocking cosmic mysteries.

The discovery of mysteries related to the cosmos could happen through contact with extraterrestrial civilizations. SETI continues to play a vital role in the search for intelligent life in the universe (Montebugnoli et al., 2022). Future technological advancements will enable SETI to build powerful satellites and space probes capable of detecting the number of galaxies in the observable universe, discover alien life, and potentially establish contact with it.

Vinge (1993) argues that extraterrestrial civilizations could reach technological singularity, while Smart (2012) emphasizes that in the future, aliens might transcend the fabric of spacetime. Based on Vinge and Smart's theories, if alien civilizations exist, once contact is made, humans could ask them for information about the results of the Big Bang or the multiverse. Presumed to be significantly more advanced than humans, they could potentially explain some of the universe's greatest mysteries.

Agnosticism (the legitimate suspension of judgement) should be applied to the origin and fate of the universe, the origin and evolution of life, life at the end of the universe, the concept of infinity, the first cause, the ultimate cause, and the fine-tuning of the universe. Presently, we do not know whether multiple universes exist or what caused the Big Bang. However, these questions could be answered in the future through the technological and mathematical capabilities of humans. Agnosticism concerning great scientific and philosophical questions is not definitive, but temporary.

7. Conclusion

Unlike Hawking and Mlodinow's (2010) argument that only science can solve the great mysteries of the universe, this article highlights that numerous cosmic enigmas remain unresolved—spanning both scientific and philosophical domains. Understanding why a primordial energy core imploded 13.7 billion years ago, giving rise to a cosmos of immense, if not infinite, dimensions, and "Why is there something rather than nothing?" are the two fundamental unresolved scientific and philosophical concerns.

This article highlighted that each phase or process in the history of the universe raises questions and generates hypotheses that are yet to be confirmed or refuted. Despite significant scientific advancements over the past century, including the discoveries of relativity, quantum mechanics, and the Big Bang, we do not understand why the laws of physics, universal constants, and the Big Bang favored the emergence of life. Whether a single theory can unify all physical phenomena into one equation also remains ambiguous.

Furthermore, the origin of life and consciousness and the potential existence of extraterrestrial life have given rise to several scientifically plausible, unconfirmed hypotheses. Furthermore, Darwinian evolution raises questions about why evolutionary laws permit the emergence of countless species, including those endowed with consciousness.

More complex questions have arisen concerning the origin and ultimate fate of the universe. Science has produced proliferative hypotheses, suggesting that something existed before the Big Bang or that new physical processes will occur at the end of the cosmos; however, no definitive evidence supports these claims. The existence of parallel, cyclic, or quantum-vacuum universes has introduced new questions regarding infinity, the first cause, and the ultimate cause. Concepts such as infinite possible histories, infinite regression, and infinite replication are plausible, particularly if one of the multiverse, cyclic, or vacuum universe theories is correct.

Whether a singular cosmos or a multiverse, cyclic, or vacuum universe exists, the potential existence of a first and ultimate cause, enabled by mathematical and physical laws, remains ambiguous.

This study is limited in that the topics discussed here remain unresolved due to technological constraints and an incomplete understanding of the cosmos. However, unlike Penrose's (2005) thesis, which argues that humans cannot discover every mystery of the cosmos because not everything can be revealed through mathematics, this study emphasizes that tools that can uncover the secrets of the universe exist.

Solving any cosmic enigma requires mathematics, technology, and, if possible, contact with extraterrestrial civilizations. Future research could explore interdisciplinary approaches—combining advances in physics, cosmology, technology, and philosophy—to the issues under study.

Consequently, this study advocates the application of temporary agnosticism to the philosophical and scientific mysteries of the universe, given humanity's potential to unveil every aspect of its nature.

This study paves the way for a future in which the mysteries of the universe could be unveiled using artificial intelligence, encounters with extraterrestrial civilizations, and an in-depth exploration of cosmological mathematics and information. Furthermore, it encourages researchers to pursue the unknown with boldness and creativity, echoing Einstein and Infeld's (1938, p. 83) assertion, "To pose new questions, new possibilities, and to consider old problems from a new angle requires creative imagination and marks a real progress in science."

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