NARRATIVE OF UNIVERSE ON THE BASE OF CONCEPT OF SCIENTISTS AND IN CONTEST OF SCIENCE

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Abstract

As we know the universe is 13.8 billion years old and that emerging from a hot, dense singularity in the Big Bang and has been expanding ever since. The majority of physics theories about the universe's formation and development are based on General Relativity (GR). Humanity's viewpoint has gradually changed from one of a deterministic, predictable cosmoses to one of probabilistic outcomes and inherent uncertainty due to the successive development of physics theories. This change is mostly caused by the transition from classical to contemporary physics, which has a significant impact on hypotheses regarding the universe's formation and future predictions. The generally accepted Big Bang hypothesis resulted from the integration of relativity with astronomical evidence, including as Edwin Hubble's discovery of an expanding cosmos and the detection of cosmic microwave background radiation. The cosmic microwave background's small quantum fluctuations from the early cosmos may be studied to find "fingerprints of creation" that eventually developed into the large-scale structures we see today. The Big Bang, Cosmic Inflation, and Quantum Foam are all included in the universe's genesis framework. However, things like the exact form and behavior of dark energy, which is speeding up the universe's expansion, make the future mostly uncertain. The Big Freeze, Big Bounce, Big Crunch, and Big Rip ideas of the universe's end do not fully account for the replies of the future. The future is therefore still uncertain and mostly unpredictable. This voyage through uncertainty reveals physics as an ever-evolving subject that has transitioned from the pursuit of flawless prediction to an embrace of probability and the dynamic, open-ended character of cosmic research. Based on contemporary concept of physics and ideas of scientists, this research investigates the universe's genesis and future. With the chronological development of physics theories, an attempt has been made to educate and analyses the universe's formation and consequences as well in a story.

Keyords: Big bang, black hole, GR, QR, JWST, LQG, CCC, CMB, Theory of Everything

1. Introduction

The scientific narrative of the universe is a dynamic, constantly evolving story rooted in evidence-based, testable hypotheses (cosmology), as opposed to mythical or static narratives. Casement of scientific discovery is unparalleled, whether one is seeing a novel phenomenon or unravelling a long-standing riddle. Physicists have continuously investigated the cosmos to discover because physics offers the basic rules that control all matter and energy, from the smallest subatomic particles to the greatest cosmic structures, it is crucial to comprehend the future of life and the universe. The principles of physics govern how life itself functions. One of humanity's most noble pursuits is the quest to comprehend the cosmos and our environment. The most basic science, physics, is essential to these endeavors. Scientists like Einstein, Max Planck, Niels Bohr, Newton, and Archimedes have led challenges and achieved ground-breaking discoveries throughout history. These groundbreaking discoveries and cutting-edge hypotheses are what give physics its excitement.[1] The exert scientific mysteries, using their creativity and logic to unearth basic and unexpected hypotheses about nature.[2] Improving our comprehension of the cosmos is one of physics' most important accomplishments. Scientists have investigated the beginnings of the universe, the formation of stars and galaxies, and the fundamental characteristics of space and time by using physical principles.[3] Regardless of their level of notoriety, all physicists play a vital role in advancing our knowledge by presenting and answering these fundamental questions about creation, life, the cosmos, and the future. Physics has roots in ancient civilizations and is different from current understanding, even though it was formerly limited to astronomy.

The stars in the universe were well understood by the ancient Greeks, Egyptians, Mesopotamians, and new world cultures like the Maya and Aztecs.[4] Each of them studied the sky to observe and forecast the path of the sun, moon, and stars in order to track the seasons and gain a basic grasp of the universe.[5] Their mathematics was occasionally amazing and accurate, despite the fact that they lacked the tools and understanding of the sky to fully comprehend these concepts. Every major civilization practiced some form of sun worship or devotion, and some of these practices were strikingly similar despite their lack of contact with contemporary technology. [6] In a few of instances, their math's was

[1] https://physics.wvu.edu/undergraduate-students/major-in-physics/why-study-physics, accessed on 13 Jan 2026
[2] https://www.linkedin.com/pulse/importance-physics-man-society-dr-muhammad-attique-khan-shahid, accessed on 13 Jan 2026
[3] https://cehsweb.health.umt.edu/sites/default/files/webform/steer/transcripts/Importance-of-Physics.pdf#:~:text=, accessed on 13 Jan 2026
[4] http://blog.nmai.si.edu/main/2017/08/indian-beliefs-eclipse.html, accessed on 13 Jan 2026
[5] http://galileoandeinstein.physics.virginia.edu/lectures/thales.html, accessed on 13 Jan 2026
[6] https://explorable.com/ancient-physics, accessed on 13 Jan 2026

amazing and accurate, but they lacked the tools and the knowledge necessary to fully understand these concepts. Surprisingly, some of the customs of sun worship and devotion were quite similar across all major civilizations, even in the absence of contemporary technology.[7] Particularly with theories like general relativity and quantum mechanics, modern physics has questioned traditional ideas of reality and determinism, raising the possibility that the universe is considerably more complicated and bizarre than previously thought.[8] The attempt to combine quantum mechanics, which governs particle behavior at the smallest scales, with general relativity, which explains gravity and the universe's large-scale structure, is one of physics' biggest unsolved problems.[9]

One of the most fascinating areas of physics is still the search for a Theory of Everything (ToE). If successful, it would provide a cohesive framework for comprehending all physical phenomenon, from particle interactions to the behavior of galaxies. This research examines the relationship between Einstein's theory of relativity and quantum mechanics to investigate the nature of time, reality, and the future.[10] Relativity implies a deterministic universe by introducing the idea of a four-dimensional space-time continuum and the "block universe," where all events—past, present, and future exist simultaneously. However, the probabilistic behavior of particles and the notion that results only become certain upon measurement in quantum mechanics cast doubt on this determinism. Different interpretations of this quantum indeterminacy exist: the Many-Worlds interpretation restores determinism by proposing branching realities for every potential result, whereas the Copenhagen interpretation proposes a fundamentally random reality. The discussion is further enhanced by other ideas like decoherence, entanglement, and the shortcomings of rival theories like pilot-wave mechanics. Therefore, the history of physics is fascinating and fascinating, and the future of human civilization is yet unknown. Nearly a century ago, it was established that the universe is expanding. However, it wasn't until the 1990s, with the advent of powerful telescopes, particularly orbital ones, and the era of precise cosmology, that scientists realized exactly how this happened.[11]

Nonetheless, the most widely accepted account of human civilization and the modern world is the Big Bang theory. The universe began with the Big Bang, which happened around 13.8 billion years ago. From a very heated and dense condition, it began to expand and grow. Fundamental particles emerged as the cosmos cooled, giving rise to hydrogen and helium. Gravitational forces brought these gases together into stars and galaxies over millions of years, sparking nuclear fusion. This process produced heavier elements, which are briefly described in the cosmic calendar and eventually helped build planets and life. The idea that sentient life originated from something random may be a fundamental flaw in the big bang theory. Similarly, Einstein's well-known formula, $E=mc^2$, may be called into doubt since, provided it is matter or has mass, trash may likewise be used in place of radioactive material to create atom bombs. Some people also wonder how the big bang came to be in the first place. And everything that is or will ever be came from nothing. The study also examines how our perception of the "present" is complicated by awareness and the relativity of simultaneity, posing profound queries about whether the future is fixed or still developing. Spacetime is not smooth at Planck scales (very tiny), but rather a chaotic, fluctuating "foam" where virtual particles appear and disappear, implying that everything has a quantum origin. According to the Big Bang theory, the universe began to expand from a very hot, dense singularity around 13.8 billion years ago, as shown by CMB, element abundances, and expansion. Stretching quantum fluctuations into cosmic seeds for structure and resolving Big Bang paradoxes (such as flatness/horizon difficulties) is a fast, exponential growth phase that occurs shortly after the Planck period (about 10^{-32} to 10^{-31} seconds). Consequently, three dominant theories of physics that are compatible emerge. First, String Theory suggests that basic particles are vibrating strings, which might unite gravity with other forces, need more dimensions, and provide methods for characterizing the quantum gravity regime close to the Big Bang/Singularity.[12]

The anti-de Sitter/conformal field theory connection (AdS/CFT correspondence), which links string theory to another kind of physical theory known as a quantum field theory, was discovered by theorists in late 1997.[13] The fact that the complete theory lacks a proper definition in every situation is one of the difficulties with string theory.[14] Second, the singularity problem is resolved by Loop Quantum Gravity (LQG), which quantizes spacetime into discrete "loops," implying that the Big Bang was a "Big Bounce" from an earlier contracting universe rather than a singularity.[15] By arguing that spacetime is quantized—that is, composed

[7] http://www.desy.de/user/projects/Physics/Relativity/SR/light_mass.html, accessed on 17 Jan 2026

[8] http://hyperphysics.phy-astr.gsu.edu/hbase/Forces/qed.html, accessed on 17 Jan 2026

[9] https://cehsweb.health.umt.edu/sites/default/files/webform/steer/transcripts/Importance-of-Physics.pdf, accessed on 17 Jan 2026

[10] Hossain K A, (2026), Evaluation of Creation and Future of Universe on the Basis of Contemporary Theories of Physics, Journal of Liberal Arts and Humanities (JLAH) Issue: Vol. 7; No. 1; January 2026 (pp. 1-93) ISSN 2690-070X (Print) 2690-0718, Doi: 10.48150/jlah.v7no1. 2026.a1, accessed on 30 Jan 2026

[11] https://scitechdaily.com/astrophysicists-developed-a-new-theory-to-explain-dark-energy/, accessed on 03 Nov 2025

[12] Duff, Michael (1998). "The theory formerly known as strings". Scientific American. 278 (2): 64–9. Bibcode:1998SciAm.278b..64D. doi:10.1038/scientificamerican0298-64, accessed on 30 Jan 2026

[13] Maldacena, Juan (2005). "The Illusion of Gravity" (PDF). Scientific American. 293 (5): 56–63. Bibcode:2005SciAm.293e..56M. doi:10.1038/scientificamerican1105-56. PMID 16318027, accessed on 17 Jan 2026

[14] Smolin, Lee (2006). The Trouble with Physics: The Rise of String Theory, the Fall of a Science, and What Comes Next. New York: Houghton Mifflin Co. ISBN 978-0-618-55105-7, accessed on 17 Jan 2026

[15] Rovelli, Carlo (August 2008). "Loop Quantum Gravity" (PDF). Living Reviews in Relativity. 11 (1)

of discrete units—rather than continuous, LQG theory integrates quantum mechanics with general relativity.[16] Instead of being indefinitely split, it suggests that time and space are composed of fundamental, discrete units, such as pixels on a screen.[17] Conformal Cyclic Cosmology (CCC) comes in third. This hypothesis, proposed by Nobel laureate scientist Roger Penrose, holds that the cosmos continuously cycles through "aeons" in which a conformal change that effectively "squashes" spacetime connects the Big Bang of one aeon. This concept suggests that matter (photons principally) from a prior aeon develops the seeds for the new one, perhaps leaving "Hawking points" (circular patterns) in the Cosmic Microwave Background (CMB) as evidence, avoiding a traditional Big Bang singularity and the necessity for beginning conditions.[18] These ideas fit into the inflationary Big Bang story by attempting to connect General Relativity (GR) on a large scale with Quantum Mechanics (QM) on a tiny scale to explain the early moments of the universe.[19]

The enigmas surrounding the universe's beginnings have long piqued human interest and provoked thought throughout history. Humanity has attempted to solve the many mysteries of the universe that surrounds us, whether via the transmission of stories, space exploration, or the development of contemporary scientific theories. From at least Democritus and classical Greek philosophy to Newton and Bentley's discussions and the 21st century, the universe and its origin has been a philosophical topic that has led to advances in philosophy of science and physics. It has also inspired highly sophisticated technology, clever engineers, and a wide range of devices. Since Einstein offered both his well-known General Relativity theory and empirical and Gedanken experiments (thought experiments and conceptual scenarios, frequently in physics, used to explore theories, principles, or hypotheses by imagining outcomes, especially when real experiments are impossible or impractical, famously used by Einstein to develop relativity by envisioning riding light beams or falling freely, illuminating concepts like gravity, light speed, and quantum mechanics), pointing towards QM properties, the Standard Model and main theories have been deemed stuck or even gone astray due to incompatibilities between GR and QM, particularly with regard to the unification of the universe and its origin, such as galaxy formation and the CCP, Dark Matter and Dark Energy. Based on data-driven discovery and symbolic-regression, a state-of-the-art framework was proposed to address these problems that were made worse by JWST 2020–2025 results, the CCP, and naturally the other concerns, such as the unification between QM and GR. The findings led to three compatible leading hypotheses and a modest multiverse approach link with entropic formation of a unique, unstipulated or time-wise universe within a quantum foam, Big Bang, and inflation-based primaeval framework. String Theory, Loop Quantum Gravity, and Conformal Cyclic Cosmology are three complementary theories that investigate this and provide routes to a Theory of Everything (ToE). In order to explain and evaluate the sequential evolution of concepts and theories of physics in order to forecast and correlate the birth of the universe and its ultimate future, this analytical study has based on current concept of scientific theories and ideas of scientists.

2. Methodology and Literature Review

2.1. Basic Scientific Concept. Many cultures throughout the world created elaborate myths to explain how the cosmos came into being long before scientific investigation took the stage. These symbolic and metaphorical tales gave communities a framework for understanding the intricacies of their environment and their own importance. According to Egyptian theology, the cosmos originated from the primordial waters of Nun, the creator God, and these waters created an abyss with infinite possibilities. Atum, the sun god, was credited with using his creative abilities to give the universe shape and order. Similarly, ancient Greek cosmogeny describes how the cosmos was created by the primordial God Chaos, from which the gods Gaia (Earth), Uranus (Sky), and other primordial divinities emerged. These ancient myths provide cultural tales that reflect social values, beliefs, dreams, and ideas, but they don't provide an intelligible explanation for any of the natural happenings in our universe.

Through contemporary cosmology, the 20th century saw a shift in our comprehension of the universe's origins. Edwin Hubble's revolutionary finding of an expanding universe in the 1920s served as the foundation for the Big Bang Theory, which has fundamentally changed how we think about the evolution of the cosmos. According to the Center for Astrophysics, the Big Bang Theory suggests that the universe started from a dense, highly hot single place around 13.8 billion years ago. The "singularity," as it is called, is the point at which space, time, and matter as we know them now began.[20] Subatomic particles combined to become atoms as space cooled and expanded over time, and these atoms then developed into far-off galaxies, stars, and

5, doi:10.12942/lrr-2008-
5. PMC 5256093. PMID 28179822, accessed on 17 Jan 2026

[16] Muxin, H. (2011). "Cosmological constant in loop quantum gravity vertex amplitude". Physical Review D. 84 (6) 064010. arXiv:1105.2212, doi:10.1103/PhysRevD.84.064010, accessed on 17 Jan 2026

[17] Smolin, Lee (2006). "The Case for Background Independence". In Rickles, D.; French, S.; Saatsi, J. T. (eds.). The Structural Foundations of Quantum Gravity. Clarendon Press. pp. 196ff. arXiv:hep-th/0507235. Bibcode:2005hep.th....7235S. ISBN 978-0-19-926969-3, accessed on 17 Jan 2026

[18] Roger Penrose (2006). "Before the Big Bang: An Outrageous New Perspective and its Implications for Particle Physics" (PDF). Proceedings of the EPAC 2006, Edinburgh, Scotland: 2759–2762. Bibcode:2006epac.conf.2759R, accessed on 04 Nov 2025

[19] DeAbreu, A.; et al. (2015). "Searching for concentric low variance circles in the cosmic microwave background". Journal of Cosmology and Astroparticle Physics. 2015 (12): 031, doi:10.1088/1475-7516/2015/12/031, accessed on 17 Jan 2026

[20] Wollack, Edward J. (10 December 2010). "Cosmology: The Study of the Universe". Universe 101: Big Bang Theory. NASA. Archived from the original on 14 May 2011, accessed on 04 Nov 2025

planets.[21] In the end, it influenced the current structure of the cosmos including our own solar system. The Big Bang Theory has become the dominant model in cosmology due to its capacity to explain a wide range of data, including the distribution of galaxies and cosmic microwave background (CMB) radiation. However, the Big Bang Theory has its own drawbacks, just like any other theory, and has spurred continuous debates and investigations into other hypotheses of cosmic development.[22]

An astronomer by the name of Georges Lemaître had a brilliant notion in 1927. According to him, the cosmos began as a single point a very long time ago. He claimed that the cosmos may continue to grow and extend until it reached its current size. Edwin Hubble, an astronomer, discovered that other galaxies were eclipsing us only two years later. And that's not all. Galaxies that were further away were traveling more quickly than those that were nearer to us. This implied that, as Lemaître believed, the cosmos is continually expanding. Everything had been closed together a long time ago if things were drifting apart. The cosmos started out as a mixture of light and energy and hot, tiny particles. It was very different from what we see now. Everything cooled as it grew larger and occupied more space. The little particles clustered. They created atoms. These atoms then formed a group. Stars and galaxies are the result of atoms coming together over a very long period of time.[23] Larger atoms and clusters of atoms were produced by the earliest stars. More stars were born as a result. Galaxies were clumping together and colliding at the same moment. Asteroids, comets, planets, and black holes originated as a result of the birth and death of new stars. They refer to it as the "Big Bang." The cosmos is 13,800,000,000 years old, or 13.8 billion years old, according to current knowledge. That's a lengthy period.[24]

The Big Bang hypothesis is compelling and shows that, according to popular belief, the cosmos did not originate from a "primordial atom explosion," but rather from an extraordinarily hot and dense starting condition. Even However, the scientific community's widespread acceptance of it does not ensure that it has the last word about the universe's distant beginnings. Science has regarded this hypothesis as a legitimate paradigm for more than a century. However, a number of historical gaps remain, and as the idea spreads across academic and educational settings worldwide, fresh questions are raised. Its widespread acceptance does not prove that it is infallible or that the cosmos began precisely as it was suggested. A scientific hypothesis should also be backed up by the actual data that supports it. New ideas, like the "dead universe" notion covered in this article, may now be supported by the same data that originally supported the Big Bang. Unquestionably, the Big Bang hypothesis is a widely recognized model, yet the cosmological model of the dead universe theory could end up being the most likely. Technological developments and mathematical computations in the field of quantum computing may provide a clearer proof of this new theory's validity than the efforts of astrophysicists seeking accuracy to support the theory alone.

However, Alexander Friedmann and Georges Lemaître had already established the theoretical foundation that would challenge conventional wisdom about the universe before Edwin Hubble solidified his place in the study of the cosmos. A Russian mathematician named Friedmann was the first to use the theory of relativity's equations to forecast an expanding universe in 1922. At first, this hypothesis was viewed with suspicion. Simultaneously, in 1927, the Belgian astronomer and priest Georges Lemaître separately put out a similar concept that contained the idea of a "primeval atom" and the theoretical forerunner of the Big Bang. Edwin Hubble became a transformational figure in the environment that these creative minds had constructed. He devoted his professional life to the study of galaxies' redshifts, a phenomenon he himself brought to light via careful studies. Hubble presented his findings in 1929, supporting and extending Friedmann and Lemaître's hypotheses by demonstrating a direct correlation between a galaxy's apparent brightness and redshift.

The idea of the universe's expansion was elevated from a mathematical abstraction to an experimentally provable fact by this finding, which is now known as Hubble's Law. In addition to supporting the work of his forebears, Hubble's contribution marked the beginning of a new era in cosmology, when the notion of a dynamic and expanding cosmos became a fundamental component of the contemporary understanding of space and time. Hawking hypothesized in 1988 that Hubble's measurements suggested the cosmos was infinitely dense and infinitely tiny at a point known as the Big Bang. All scientific rules and, hence, any ability to forecast the future would be ineffective under such circumstances. Events that occurred before now might not have an impact on what is happening now. Since there would be no observable ramifications, their presence might be disregarded. According to Hawking (1988), it is possible to argue that time started at the Big Bang since there would have been no definition for prior periods.[25]

According to a scientific theory known as the "heat death of the universe" (also known as the "Big Chill" or "Big Freeze"), the universe will eventually reach a point where it has no more thermodynamic free energy and, having reached maximum entropy, will no

[21] Stone, M. (1977). "Semiclassical methods for unstable states". Phys. Lett. B. 67 (2): 186–188. Bibcode:1977PhLB...67.186S. doi:10.1016/0370-2693(77)90099-5, accessed on 03 Nov 2025

[22] Caldwell, Robert R.; Kamionkowski, Marc; Weinberg, Nevin N. (2003). "Phantom Energy and Cosmic Doomsday". Physical Review Letters. 91 (7) 071301, doi:10.1103/PhysRevLett.91.071301, accessed on 03 Nov 2025

[23] https://spaceplace.nasa.gov/dark-matter/en/, accessed on 17 Jan 2026

[24] https://spaceplace.nasa.gov/big-bang/en/#:~:text=, accessed on 17 Jan 2026

[25] Hawking, S. (1988) A Brief History of Time. Bantam Books, accessed on 17 Jan 2026

longer be able to support any more thermodynamic processes.[26],[27] Heat death simply means that temperature variations or other processes may no longer be used to do work; it does not indicate any specific absolute temperature. This is the point at which the cosmos enters thermodynamic equilibrium in the terminology of science. The universe will continue to expand indefinitely if its curvature is hyperbolic or flat, or if dark energy is a positive cosmological constant. After a long time, a heat death is predicted, in which the cosmos cools to near equilibrium at a very low temperature.[28] Discussion of the application of the first two principles of thermodynamics to universal processes is where the concept of the universe's heat death originates. Based on previous studies on the dynamical theory of heat, Lord Kelvin presented the idea in 1851 that "heat is not a substance, but a dynamical form of mechanical effect, we perceive that there must be an equivalency between mechanical work and heat, as between cause and effect."[29] It should be anticipated, nonetheless, that an isolated system broken up into subsystems would not always reach thermodynamic equilibrium and will instead stay in a non-equilibrium steady state. The second rule of thermodynamics is not violated since entropy will be transferred from one subsystem to another but its generation will be zero.[30],[31]

According to the "dead universe" idea, there once was an ancient universe that "died" and produced primordial black holes. This universe may have been more than a trillion times bigger than the cosmos as it is now. According to this view, the construction of our universe was not initiated by the first black holes after the collision. Rather, it suggests that only the finest particles of a dead cosmos make up the visible universe. In contrast to the Big Bang hypothesis, it proposes a novel model for the expansion process and a revolutionary cosmological model that provides a more thorough account of the universe's beginnings. Unlike the theory of universal expansion, which suggests an aggressive expansion that results in the breakdown of matter and the end of the universe, this theory really explains a simple separation of galaxies.

Astrophysicists cannot afford to be unfair about the universe-size views put out in this study, nor can they be trivial about the possibilities this technique offers with reference to the ancient universe's moribund state. This particular treatise retains the right to reject the notion of the cosmos as an information processor and multiverse theories, should the criticisms be sarcastic. According to this idea, our visible universe is influenced by the rules of a dead array of star bodies and other elements. Within the context of the "dead universe" idea, two theories are proposed. First, the word "dead" is reinterpreted to refer to a cosmos whose primary feature from the beginning is the inherent lack of light, going beyond the conventional idea of star extinction. According to this idea, light is a cosmic abnormality that results from supermassive bodies fusing and colliding in the vastness of a primordially black cosmos. Furthermore, according to this idea, the world in which we live was not created by fusions or black holes. According to the first theory, the fundamental elements of this primordial cosmos include things like supermassive black holes, dark energy, and dark matter. Interestingly, under some conditions, light appears—possibly as a result of intricate gravitational interactions—acting as a trigger for the shift to a lighted universe similar to what we see today. According to the second theory, the death that destroyed all galaxies and put out the light of a once-bright universe was caused by an ancestral universe that was far bigger than the universe as we know it now. Important proof of cosmic processes ending in the universe's present observable condition may be found in this previous universe.

The observable universe is thought to have been in a state of death trillions of years prior to the Big Bang. In the framework of known physics, the appearance of light, spurred by high activity in this dead world, would be comparable to the oddity of black holes. As a result, the cosmos and galaxies lived in the absence of light, immersed in the gloom of the dead universe yet kept organized by the rules of physics. According to this viewpoint, the cosmos has always existed, although initially in a condition of darkness, rather than just emerging. This idea describes a lengthy time after the Big Bang, but before the first stars formed, when the universe was engulfed in darkness. It draws comparisons to the "cosmic dark ages" postulated by the Big Bang theory. Galaxies and the cosmos therefore existed in the absence of light, immersed in the darkness of the dead universe, but maintained in a condition structured by the rules of physics. According to this viewpoint, the cosmos has always been in a condition of death, having previously existed in complete darkness, rather than having just emerged. This idea compares the Big Bang theory's "cosmic dark ages," which describe a protracted time following the Big Bang but before the first

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[26] https://map.gsfc.nasa.gov/universe/uni_fate.html, accessed on 17 Jan 2026

[27] Dyer, Alan (2007-07-24). Insiders: Space. Simon & Schuster Books for Young Readers. pp. 40–41. ISBN 978-1-4169-3860-6, accessed on 17 Jan 2026

[28] Plait, Philip (2008). Death from the Skies!. Viking Adult (published 16 October 2008). p. 259. ISBN 978-0-670-01997-7, accessed on 03 Nov 2025

[29] homson, Sir William. (1851). "On the Dynamical Theory of Heat, with numerical results deduced from Mr Joule's equivalent of a Thermal Unit, and M. Regnault's Observations on Steam" Excerpts. [§§1–14 & §§99–100], Transactions of the Royal Society of Edinburgh, March 1851, and Philosophical Magazine IV, 1852. This version from Mathematical and Physical Papers, vol. i, art. XLVIII, pp. 174, accessed on 03 Nov 2025

[30] Lemishko, Sergey S.; Lemishko, Alexander S. (2017). "Cu2+/Cu+ Redox Battery Utilizing Low-Potential External Heat for Recharge". The Journal of Physical Chemistry C. 121 (6) (published 30 January 2017): 3234–3240. doi:10.1021/acs.jpcc.6b12317, accessed on 17 Jan 2026

[31] Lemishko, Sergey S.; Lemishko, Alexander S. (2020). "Non-equilibrium steady state in closed system with reversible reactions: Mechanism, kinetics and its possible application for energy conversion". Results in Chemistry. 2 100031 (published 8 February 2020). doi:10.1016/j.rechem.2020.100031, accessed on 17 Jan 2026

stars formed, during which the universe was dominated by darkness. The light as a cosmic anomaly: what about it? A second hypothesis may be taken into consideration, which goes beyond the traditional perspective that upholds the natural paradigm of the cosmos in its present condition.

This second viewpoint offers a different explanation for celestial phenomena, such as star activity, and is based on the idea of the "Dead Universe." It's difficult to avoid thinking about the oddity of the Sun's and other stars' deceiving frenetic activity when we gaze at them. It may seem impossible to reconcile the idea of a dead and lifeless cosmos with the powerful light and radiation emissions from these celestial bodies. But if we accept the Dead Universe idea, we may see this activity as an aberration that led to the creation of the universe as we know it. There are two theories that dominate the Dead Universe idea. According to the first hypothesis, light would be seen as an extraterrestrial presence in the otherwise inert universe, which is in its natural state of death. The second hypothesis presents a more ambitious idea: a universe that is billions of times bigger than our own and has progressively descended into an eternal state of death. The whole nature of existence was changed in this vast galaxy of light and regular stars, resulting in a world where light and stellar occurrences were every-day.[32] We are forced to reevaluate our comprehension of cosmic occurrences by exploring these theories. They transform from simple anomalies into mysterious hints that allude to the deep complexities of the universe's creation and its death.

2.2 Dead Universe Theory. According to the Dead Universe idea, there would be no brilliant stars, solar flares, or any radiant energy in the universe, and it would be completely inactive. According to this paradigm, starlight and the energetic events that accompany it would be seen as anomalous disruptions in a cosmos that would otherwise continue to exist in an eternally peaceful state. We would view stellar events such as coronal mass ejections and solar flares as transient departures from the inert equilibrium that defines the Dead Universe. In this ostensibly unchanging cosmos, these expressions of tremendous energy activity would be seen as oddities that resulted from extraordinary circumstances or catastrophic occurrences. As a result, adopting the Dead Universe idea forces us to reconsider how we interpret starlight and other celestial phenomena. They become indicators of a fundamental rupture that gave origin to the universe as we know it, rather than being seen as natural features of the cosmos. This alternate viewpoint calls into question our preconceived notions and encourages us to investigate fresh approaches to comprehending the nature and genesis of the universe.

- Anomaly of Light: A key component of the physics of the world as we know it is light, a basic kind of electromagnetic energy. Invoking complexity is not all that is required to suggest that light is an aberration in this theory; rather, it provides solutions to some of the most important concerns in classical physics. This method offers a fresh perspective on the nature of the cosmos in addition to reinterpreting well-known physical ideas. Thermonuclear events in the cores of stars are the main source of light in this complicated process.
- Nuclear Fusion: Nuclear fusion is the main process by which stars produce light. Nuclear fusion is the process by which hydrogen atoms combine to generate helium in the stellar core, particularly in stars like the Sun. A little portion of the atoms' mass is transformed into energy during this fusion in accordance with Einstein's well-known equation, E = mc2. Heat and light are the products of this energy's release.
- Pressure of Radiation and Gravitational Pressure: Within a star, nuclear fusion generates massive quantities of energy in the form of radiation and high-energy particles. This radiation exerts an outward push in all directions. At the same time, the massive mass of the star creates a powerful gravitational attraction that attempts to compress it into the core. Hydrostatic equilibrium is established when these two forces—gravity inward and radiation pressure outward—balance each other.
- Fusion Cycle: The proton-proton cycle, which releases photons (light particles) when four hydrogen nuclei unite to produce a helium nucleus, is the main fusion mechanism in the sun and other stars of comparable size.
- Gravitational Pressure: Only in stars can nuclear fusion take place because of the tremendous gravitational pressure in their cores, which pushes the hydrogen nuclei closer together until they can overcome their electrical repulsion and fuse.
- Hydrostatic equilibrium: The force of gravity that is attempting to squeeze the star is balanced by the outward pressure created by the light produced by nuclear fusion. The star remains stable and in its present state because of this hydrostatic equilibrium.
- Pressure of radiation and gravitational pressure: Nuclear fusion produces enormous amounts of energy in the form of high-energy particles and radiation within a star. There is an outward pressure from this radiation in every direction. Concurrently, the star's enormous mass creates a strong gravitational pull that tries to compress it in the direction of the core. When these two forces—gravity inward and radiation pressure outward—balance one another, hydrostatic equilibrium is reached.
- Stellar stability: The star stabilizes when hydrostatic equilibrium is reached. The stellar structure will alter in response to any perturbation that results in an imbalance between radiation pressure and gravity. For instance, gravity will start to crush the star if radiation pressure drops, raising the core's warmth and pressure. In order to reestablish balance, this may cause the rate of nuclear fusion to accelerate. However, if radiation pressure is too high, it might overcome gravity and cause the star to expand, which could lead to an explosion or the ejection of stellar material.
- Stellar lifecycle: Understanding hydrostatic equilibrium is essential to comprehending the star's life

[32] Hossain K A, (2025), Emotional and Artificial Intelligence: Narrative of Human and Machine Relation, Transactions on Engineering and Computing Sciences - Vol. 13, No. 05 Publication Date: September 07, 2025 DOI:10.14738/tmlai.1305.19324, accessed on 07 Feb 2026

cycle. Stars maintain this balance for the most of their lifespan, staying steady and producing energy via nuclear fusion. But once nuclear fuel is used up, radiation pressure drops and gravity takes over. This may lead to a variety of outcomes, including transformation into a red giant, explosion, or even a black hole, depending on the star's mass.

- Dynamic equilibrium: It is crucial to remember that hydrostatic equilibrium is a dynamic balance rather than a static condition. Energy generation, stellar material migration, and other physical interactions cause conditions within a star to change continuously. To guarantee that these changes take place in a balanced and regulated way and maintain the star's relative stability across its lifetime, hydrostatic equilibrium is necessary. the idea that light did not exist at the beginning of the cosmos and was generated later. It is indisputable that darkness came before light, regardless of whether one supports the creationist theory—which holds that the cosmos was covered in darkness before God declared, "Let there be light"—or the scientific understanding of these early occurrences.
- Primitive Elements: Despite being well-established ideas in contemporary cosmology, black holes, dark matter, and dark energy are often seen as emerging phenomena rather than necessarily as the universe's original constituents. The dead universe idea, however, offers a tenable account for their genesis, identifying them as essential components of an earlier inactive universe. This hypothesis offers one of the first logical attempts to explain these mysterious phenomena, despite the fact that dark matter and dark energy are topics of great study and controversy, with their origins still up for question.
- Expansion of Cosmic Understanding: These concepts test our cosmic imagination and provide a rich environment for scholarly debates and imaginative fiction. These theoretical ideas aim to deepen our understanding of the universe's potential states and the underlying processes that shape its development and eventual finality, even if they are still far from the present consensus in science. Therefore, these claims permit speculative investigation based on alternative theories and hypotheses while acknowledging the limits of accepted scientific knowledge.

According to the Dead Universe hypothesis, the idea of star birth is flipped to universal death, and the universe as we know it is the remnant of a vastness that has long since vanished. According to this theory, black holes are the last resting place of a cosmos that has run out of energy rather than the sources of creation. These primordial black holes are the last gravitational lighthouses of a vanished universe, not generating singularities. Despite their seeming freshness, the galaxies and stars we see are really the remnants of a long-extinguished cosmic fire. The mysterious components of our cosmos, dark matter and dark energy, might be seen as a faint echo of this last catastrophic catastrophe. The ideas of the "Big Freeze," "Big Rip," "Big Crunch," and "Big Slurp" provide dramatic scenarios based on the ongoing expansion, contraction, or phase transitions of space-time, among other theories explaining the ultimate destiny of the universe. On the other hand, the "Dead Universe" idea offers a more tranquil and essentially different conclusion for the universe.

There is no explosive or catastrophic event that signifies the end of the universe, according to the Dead Universe idea. The cosmos just reverts to its normal state, which is devoid of the oddities that define the visible universe, in its place. According to this idea, light is an aberration that needs nuclear fusions and other energy processes to emerge rather than emerging on its own. According to this interpretation, the universe's primordial and perpetually black condition is momentarily disturbed by the presence of light. According to this viewpoint, if there were living things in this early cosmos, they would see light as odd, fascinating, or an invader in the eternal state of darkness. According to the hypothesis, the cosmos ends with a quiet and unavoidable return to darkness rather than a dramatic explosion, as is the case with star death. According to science, life as we know it may have originated from this aberration, from a sequence of mishaps and strong mergers in the early universe that would eventually pull the universe back to its original state. According to the hypothesis, the universe would eventually reabsorb everything back into its original form, devoid of light and life, where prevailing gravitational forces will enable this return to the primitive and dark state, just as light and life evolved from remarkable occurrences.

The Big Bang and other cosmological theories' common idea of continuous expansion is challenged by this hypothesis. It foretells a slow descent into a quiet equilibrium, when the universe gradually disappears into the shadowy backdrop of its primordial existence, eternally trapped in a cycle of fleeting brightness and ultimate darkness, rather than a violent or catastrophic end. Galaxies are moving apart at a pace proportionate to their distance from one another, as shown by the expansion of the cosmos, a phenomenon that has been seen and explained by Hubble's Law. This fundamental aspect of contemporary cosmology is consistent with the "Dead Universe" idea; however, the ramifications of this expansion are interpreted quite differently. According to the theory of the Dead Universe, the observed expansion is not the consequence of an initial impulse from an explosion, as in the Big Bang, but rather a straightforward separation of galaxies brought about by gravity and other as-yet-undiscovered laws arising from the Dead Universe's very nature. It is believed that this movement is an expression of the inherent and lingering characteristics of a universe that is no longer functioning in the conventional mind.

In other words, the idea of the Dead Universe aims to explain why we perceive things, while Hubble's Law explains what we see. It implies that the dynamics of the visible world are now governed by the unidentified rules of the Dead world, which might be remnants or echoes of a past cosmic reality. Galaxies may continue to separate long after the initial energy of the Big Bang should have dissipated due to factors that vary from the well-known classical gravity. The expansion would thus represent a slow return to the basic and quiescent condition of the Dead world, a final state of rest after the end of anomalies like light and the intricate structures that define our current world, rather than a sign of ongoing development or birth. As a result, the Dead

Universe idea provides an interesting alternative to accepted cosmological theories and sheds light on the ultimate destiny of the universe. Newton's law of universal gravitation, which states that mass-containing bodies attract one another gravitationally and that this force is directly proportional to the masses of the bodies and inversely proportional to the square of the distance between their centers, appears to be applied in this description. Gravity would be a key factor in determining how the observable world moves, according to the idea of the Dead world we are investigating. Taking this view, we can hypothesize that our visible universe is being pulled back to a more uniform and peaceful state by the gravitational pull of a Dead Universe that contains bodies of immeasurable mass. This would suggest that the gravity of such cosmic superstructures may ultimately oppose or even defeat the forces causing the universe's expansion, such as dark energy.

This idea differs from previous cosmological models and is incompatible with cyclic models of creation and rebirth, the Big Bang, and multiverse theories. In sharp contrast to the multiverse theory, it promotes the notion of a perpetually dying cosmos that produces smaller galaxies and sometimes some bigger ones as it dies. According to the many hypotheses, the universe will end dramatically in the future—possibly 200 billion years from now. The dead universe hypothesis, on the other hand, holds that this catastrophe has already happened and that the universe is just continuing on its path to complete extinction. These theories may be challenging because of how they approach the study of space and time. This new hypothesis is more in line with Penrose's theories (Penrose, 2004).[33] "Let us start by exploring the arena within which all the phenomena of the physical universe appear to take place: spacetime," said Penrose. For the most of the remainder of this book, Penrose's explanation of this idea is crucial. Spacetime was not Einstein's original concept, and he was not especially excited about it when he first heard of it, despite what seems to be the popular belief and his excellent use of it in his formulation of the general theory of relativity. First, we need to know why "spacetime" exists. What is wrong with seeing space and time as distinct concepts instead of trying to combine these apparently disparate ideas into a single one? Furthermore, when we reflect on the great earlier relativistic discoveries of Galileo and Newton, we see that they, too, may have benefited greatly from the spacetime viewpoint.

2.3 Additional Significant Concept. According to the theory of the Dead Universe, there is a vast and singular universe in which the process of death continues to have an impact on the observable universe. These particles can be thought of as the last remnants of the once-vigorous dead universe's energy, which continue to create galaxies as memories of death. But despite the formation of new galaxies, the universe is contracting rather than expanding, as suggested by the Big Bang and other accepted hypotheses. One analogy for our observable universe is a big balloon that is progressively losing its stellar vibrancy. The observable cosmos today only makes up a tiny portion of the once-active universe—roughly 0.001%—and is essentially nothing in comparison to its former splendor. Furthermore, the Dead Universe idea suggests that galaxies gradually shrink in size as a result of this fatal decay process. It is improbable that a galaxy bigger than the biggest ones we are aware of will appear in front of our sight. The Big Bang theory and the data that the James Webb Telescope will evaluate in the future stand in sharp contrast to this. On the edge of time, galaxies will undergo a period of complete and silent death. The Big Rip, Big Crunch, Big Freeze, and Big Bounce hypotheses of the universe's conclusion stand in stark contrast to this viewpoint.

- Big Rip: This theory suggests a catastrophic expansion that tears everything apart, from galaxies to atoms.
- Big Crunch: Proposes a scenario where the universe’s expansion reverses, leading to a collapse into a singularity.
- Big Freeze: Predicts a universe that expands forever, becoming increasingly cold and dark as stars burn out.
- Big Bounce: Suggests that the universe goes through infinite cycles of expansion and contraction.

However, the Dead Universe concept does not foreshadow a violent ending. Instead, it implies that the gradual and silent drifting away of galaxies is caused by the gravitational remnants of the dead universe. This delayed separation lacks the violent dynamics suggested by other hypotheses. The concepts of cosmic inflation and conventional expansion are replaced with the idea of a silent, steady detachment of galaxies, influenced by the decaying forces of a much larger, now mostly dead universe. Because it does not have the catastrophic elements that other models indicate, this smooth separation highlights a more tranquil finish. A gradual winding down of cosmic activity is also implied by the fading universe effect, leading to galaxies that becoming smaller and less active until complete cosmic silence is reached. The gravitational and creative remnants of the dead universe are thought to influence the formation of new galaxies inside our observable universe.

The unique aspect of the Dead cosmos hypothesis is that it rejects the conventional expansionist and inflationary theories in favor of a concept in which the fading leftovers of a much bigger cosmos control cosmic events and galaxy formation. As opposed to the violent or cyclic finishes suggested by other cosmological theories, this results in a slow, silent spread of matter and energy. Thus, this hypothesis offers a distinctive viewpoint on cosmic development, highlighting a gradual, tranquil fall and the birth of galaxies as a reminder of a once-living, now mostly destroyed world. This hypothesis proposes a cosmos that gradually disappears rather than terminating in a cataclysmic catastrophe, providing a fresh framework that contrasts with the more dramatic cosmological theories. To further this

[33] Penrose, R. (2004) The Road to Reality: A Complete Guide to the Laws of the Universe. AbeBooks, accessed on 07 Nov 2025

theory, it may additionally include the idea of a membrane (brane). As a kind of cosmic memory, the dead cosmos produces new galaxies as it decays. These galaxies are not random; rather, they are impacted by gravitational forces and the residual architecture of the collapsing universe. This mechanism promotes the ongoing production of galaxies inside a single universe rather than the creation of numerous universes.

Our world is neither growing, inflating, or going through cycles of rebirth, according to the Dead world idea. Rather, it has been in a state of deterioration for perhaps trillions of years and is progressively declining. According to this scenario, galaxies are constantly developing and then vanishing as a result of the dead universe's leftovers, indicating that the cosmos is gradually approaching complete death. Our universe is gradually winding down, heading toward a quiet and total end of cosmic activity, rather than expanding or renewing. It's possible that the whole visible universe is contained inside a unique brane floating in a higher-dimensional region. A portion of the dead cosmos that is approaching death is symbolized by this brane. Nonetheless, new galaxies may emerge inside this brane as a result of the creative leftovers of the dead universe. These galaxies arise when the leftovers of the dead cosmos continue to impact the formation of smaller and smaller galaxies. These new galaxies are formed in part by cosmic events like as explosions that occur during this fading phase (Randall, 2005).[34] "The universe may be governed by hidden dimensions, beyond the familiar three of space and one of time, opening up new avenues for exploration and understanding," said Randall.

Therefore, it is possible to hypothesize that our dead world is contained inside a brane that floats in a higher-level realm. Our world enters a condition of death inside this region, existing as a membrane separate from other possible realities. The physical principles and remains of the dead universe may have an impact on this brane, causing galaxies to continue to form. The interactions and residual energy of the dead universe's structures produce these galaxies, which are a component of the cosmic memory of the dead universe. According to this idea, the physics of the dead universe impacting the visible world is what causes the gravitational anomalies and the curvature of time and space that are seen in our universe. The structure and behavior of our visible universe are significantly shaped by the fading relics of the Dead Universe, especially supermassive bodies and dark energy. It would be fair to cite a number of established physical concepts and findings in order to support Dead Universe hypothesis:

- The foundation for comprehending gravity on a broad scale is Newton's Law of Universal Gravitation.
- The concept of gravity as the curvature of space-time was revised by Einstein's General Relativity. The "Dead Universe" might be used to examine the function of singularities and event horizons in black holes.
- The Hubble Space Telescope's observations and Hubble's Laws provide factual proof of the universe's expansion, which may be explained by the allure of a vast "Dead Universe."
- Quantum Cosmology: By examining the effects of quantum mechanics on cosmic scales, this field may provide light on how matter and energy in our universe may be affected by a "Dead Universe."
- Investigations into Dark Energy and Dark Matter: Research on these enigmatic elements of the cosmos may help us comprehend the forces that interact or compete with gravity in the "Dead Universe."
- The following notable scientists might be cited: Stephen Hawking: For his research on singularities and black hole characteristics.
- Alongside Hawking, Roger Penrose explored hypotheses on the nature of space-time.
- Three astronomers, Saul Perlmutter, Brian P. Schmidt, and Adam G. Riess, received the Nobel Prize for their discovery on the acceleration of the universe's expansion.
- Kip Thorne was a theoretical physicist who made important advances to our knowledge of gravity and gravitational waves.

2.4 Difficulties of Exicting Theories. When scientists look at the constancy and homogeneity of cosmic microwave background radiation, the horizon issue becomes clear. The thermal radiation from the creation of our universe, about 380,000 years ago, is known as CMB radiation. Soon after the Big Bang, when visible light was first able to travel freely and unhindered, this radiation took place.[35] The furthest regions of space were previously in thermal equilibrium, according to the apparent uniformity of CMB, which represents temperature fluctuations at a scale of one part in 100,000. Put another way, the temperature of the universe's farthest regions used to be the same, indicating that heat was dispersed equally in all directions. These areas are separated by great distances, nevertheless. Given the antiquity of the universe and the speed of light, which is around 186,000 miles per second, it should be physically impossible for these places to have ever been near enough to directly interact and equilibrate since the Big Bang. In other words, the horizon issue poses the intriguing question of how the far-flung regions of the cosmos may possibly have such identical temperatures and properties.[36]

The form and general curvature of the cosmos, however, are the subject of the flatness issue. Omega (Ω), a measure of curvature, describes how mass and

[34] Randall, L. (2005) Warped Passages: Unraveling the Mysteries of the Universe's Hidden Dimensions. HarperCollins Publishers, accessed on 17 Jan 2026

[35] Frampton, P. H. (1977). "Consequences of Vacuum Instability in Quantum Field Theory". Physical Review D. 15 (10): 2922–28. Bibcode:1977PhRvD.15.2922F. doi:10.1103/PhysRevD.15.2922, accessed on 07 Nov 2025

[36] Wang, Yun; Kratochvil, Jan Michael; Linde, Andrei; Shmakova, Marina (2004). "Current observational constraints on cosmic doomsday". Journal of Cosmology and Astro-Particle Physics. 2004 (12): 006. arXiv:astro-ph/0409264. Bibcode:2004JCAP...12.006W. doi:10.1088/1475-7516/2004/12/006, accessed on 17 Jan 2026

energy affect the form of the cosmos in accordance with Einstein's Theory of Relativity. A universe with "$\Omega = 1$" is flat, meaning it has no curvature and satisfies the critical density condition, which states that the expansion rate of the universe should ultimately slow down and get closer to zero without ever achieving it. It indicates that the universe's expansion is always slowing down. According to the original Big Bang Theory, the universe should have been extremely near to critical density ($\Omega = 1$/flat in form) just after the Big Bang. However, if the universe expanded, even a little departure from the critical density would become more pronounced over time, creating a highly curved cosmos that is either "open" ($\Omega < 1$) or "closed" ($\Omega > 1$). However, the cosmos as we now see it via scientific tools is flat. The issue then becomes: How is it even possible?

Modern cosmologists have proposed a number of hypotheses to better explain the characteristics and phenomena of the cosmos in order to address these types of issues.[37] The cosmic inflation idea, initially put out by physicist Alan Guth in the 1980s, is among the most sobering and scientifically supported hypotheses. A fraction of a second after the Big Bang, an exponential expansion occurred, in accordance with Guth's cosmic inflation hypothesis. The observable structure and composition of the cosmos that we see today were made possible by this inflationary phase. There is visible scientific data that supports Guth's idea. Additionally, it addresses a number of long-standing cosmological puzzles, like as the flatness and horizon problems. According to cosmic inflation theory, the universe expanded exponentially in the first fraction of a second after the Big Bang, which addresses the horizon issue. The cosmos was expanded beyond its observable horizon during this inflationary phase, which allowed far-off areas to reach thermal equilibrium and make causal touch. According to this hypothesis, the expansion made it possible for the far-flung regions of the cosmos to interact and affect one another, bringing them all to the same temperature. Stated differently, the current universe might have expanded faster than the speed of light during this early inflationary phase based on the physics explained by the cosmic inflation hypothesis.[38]

The issues of time and distance impeding thermal equilibrium would have been resolved. The scale factor of the universe, which establishes the relative sizes of spatial dimensions (the size of space itself), increased during the time of fast and massive expansion, according to cosmic inflation theory, which addresses the flatness issue. Therefore, during this inflationary phase, any little departures from a flat geometry in the early cosmos would have been significantly stretched out and weakened. Put differently, the universe would have been more evenly flat as a result of the fast expansion, which would have smoothed out these discrepancies. The energy density associated with the inflation field overtook other types of energy, like as radiation and matter, during the expansion of the universe. The geometry of the whole cosmos would have been leveled by this supremacy, approaching a flat shape. Therefore, inflationary cosmology since the 1980s offers convincing answers to these types of issues about the universe's formation. It establishes the groundwork for contemporary cosmological ideas and transforms our understanding of early dynamics. Researchers believe that quantum fluctuations in the space-time fabric, which are predicted by quantum physics, are what caused this inflation.[39] Tiny variations at these quantum levels are thought to have been amplified during inflation, introducing anomalies and differences that ultimately gave rise to the earliest galaxies, galaxy clusters, and macro-level cosmic structures.

The idea that our universe may just be one of many in a vast "multiverse" is being explored by scientists due to developments in cosmology. According to this hypothesis, there may be an endless number of universes, each with unique physical rules, constants, and traits. The multiverse theory offers an intriguing explanation for some of the most perplexing characteristics of the world, even if it is still theoretical and outside the scope of current empirical investigation. For instance, a multiverse scenario where each area has distinct features might justify the exact tuning of constants and parameters in our world to sustain life. In such scenario, life as we know it would not be supported by the design of our own universe, but would instead be the result of chance and happenstance.[40] Numerous other worlds in the multiverse may not be able to sustain this kind of life. After discussing the universe's early beginnings, you may be wondering, "How will it end?" Although scientists have some suggestions, there is no way to tell for sure. The Big Rip hypothesis, the Big Freeze theory, and the idea of rapid expansion all provide clues about the possible futures of the universe.

Researchers hypothesized that gravity will eventually halt the universe's expansion when all of the universe's stuff pulls on itself to rejoin once the Big Bang Theory for the universe's origin was solidly confirmed. They thought the expansion would finally be halted by gravity. After then, there would be a recoil, which would lead everything to gradually come back together—possibly all the way back to a single point. This notion was dubbed the Big Crunch by researchers. It even sparked the idea that the cosmos may undergo a recurring cycle of rebounds as it repeatedly expands and shrinks due to conflicting forces vying for supremacy. However, the pace of expansion of the cosmos is not slowing down, according to scientific observations.

[37] Kirshner, Robert P. (13 April 1999). "Supernovae, an accelerating universe and the cosmological constant". Proceedings of the National Academy of Sciences. 96 (8): 4224–4227. Bibcode:1999PNAS...96.4224K. doi:10.1073/pnas.96.8.4224, accessed on 07 Nov 2025

[38] Caldwell, Robert R.; Kamionkowski, Marc (2009). "The Physics of Cosmic Acceleration". Annu. Rev. Nucl. Part. Sci. 59 (1): 397–429. arXiv:0903.0866. Bibcode:2009ARNPS.59..397C. doi:10.1146/annurev-nucl-010709-151330, accessed on 17 Jan 2026

[39] Tegmark, Max (2014). Our Mathematical Universe: My Quest for the Ultimate Nature of Reality (1 ed.). Knopf. ISBN 978-0-307-59980-3, accessed on 17 Jan 2026

[40] Hawking, Stephen W. & Moss, I. G. (1982). "Supercooled phase transitions in the very early universe". Physics Letters B. 110 (1): 35–38. Bibcode:1982PhLB.110...35H. doi:10.1016/0370-2693(82)90946-7, accessed on 07 Nov 2025

Rather, it is really rising. This surprising discovery, which came from researching supernovae in the late 1990s, implies that a mysterious force known as dark energy is driving the expansion of the universe and resisting gravity on a cosmic scale. This fast expansion is driven by dark energy, which has important ramifications for the future of our universe. It implies that galaxies will keep separating at an accelerating rate.

The Big Rip Theory paints a striking and dramatic image of one possible outcome for our cosmos by following the universe's accelerated expansion to its ultimate end. According to this idea, the repelling force of dark energy intensifies with time and has the capacity to overcome all other forces, including the gravitational pull of stars, galaxies, and subatomic particles.[41] The Big Rip hypothesis predicts that galaxies will move apart as the universe expands at an ever-increasing rate, which is actually occurring now.[42] Dark energy may eventually overwhelm the gravitational forces that hold galaxies, stars, planets, and atoms together. Cosmic structures would be destroyed, matter would disintegrate into its constituent elements, and spacetime itself would be torn apart at the most fundamental level as a consequence of this cataclysmic catastrophe. In other words, everything in the cosmos would be "ripped" to bits by dark energy.

The Big Freeze Theory, often called the Heat Death Theory, predicts a slower and more muted end for the cosmos. The Big Freeze postulates that matter and energy will progressively thin out over eons while the cosmos continues to expand at an accelerating rate owing to dark energy. Existing stars will gradually burn out and new stars will cease to emerge as galaxies separate and the cosmos becomes colder and more arid. The cosmos will eventually attain a maximum entropy state, in which there is no possibility of matter interaction and all energy is evenly distributed.[43] The cosmos would turn into a chilly, black emptiness in this condition, which some physicists refer to as Heat Death. Life, light, and any distinguishable structure or activity would be absent.[44]

Cosmology still faces challenges, doubts, and unanswered questions despite advances in understanding the universe's beginnings and development. For instance, dark matter and dark energy together make up around 95% of the universe's total mass energy, yet current astrophysics and cosmology still don't fully understand these aspects of our world. We know very little about them, despite the fact that we can deduce their presence and even quantify them to some extent.[45] Researchers are also still perplexed by the singularity's enigmatic genesis, which is the apparent beginning point from whence the cosmos formed. In an effort to develop a cohesive description of the cosmos, modern scientific theories like loop quantum gravity and string theory have tried to combine Einstein's relativity with quantum mechanics. At best, this work is still unfinished.

One of humanity's riddles that has fascinated myths, philosophies, and scientific investigations is the origin of our universe. Our understanding of the origins of the universe has changed throughout time, moving from cosmological tales that portray primordial chaos to modern cosmological theories developed via complex mathematical analysis and computation. Our curiosity, inventiveness, and will to solve the puzzles of our own existence in the great universe are reflected in this development. The grandeur, complexity, and magnificence that characterize our ever-growing comprehension of the universe humble us as we dig further into cosmic dynamics via scientific investigation.[46] Every cosmological theory offers an intriguing view of the universe's creation and development, whether it is about the Big Bang, Cosmic Inflation, or the notion of a multiverse full of realities. Curiosity, awe, and a profound sense of interconnectedness with the universe and one another on Earth are all sparked by it. Therefore, we should keep trying to comprehend the cosmos and see where the truth takes us.[47]

According to the Dead Universe idea, our understanding of the universe is based on the remnants of an ancient reality whose splendor has long since vanished into the abyss. It's possible that the cosmos we live in is like a cosmic afterglow, a muted remnant of a once-bright and vast cosmic past. The black holes that fill our night sky are assumed to represent the remains of a past cosmic end, the cemeteries of galaxies and stars that have long ago died, rather than the initiators of genesis. Every star system and nebula that we can see with our telescopes may be an expression of cosmic memory, a faint echo from a cosmos that has passed its peak. According to this perspective, dark energy and dark matter are reinterpreted as the lingering characteristics of this ancient era, perhaps the last remnants of a once vibrant cosmic framework. The remnants of an earlier structure in a condition of stately and methodical breakdown are what give rise to the young galaxies that we see, rather than a vacuum. Our universe may have been partly

[41] Caldwell, Robert R. (2002). "A phantom menace? Cosmological consequences of a dark energy component with super-negative equation of state". Physics Letters B. 545 (1–2): 23–29. arXiv:astro-ph/9908168. Bibcode:2002PhLB.545...23C. doi:10.1016/S0370-2693(02)02589-3, accessed on 17 Jan 2026

[42] Wang, Yun; Kratochvil, Jan Michael; Linde, Andrei; Shmakova, Marina (2004). "Current observational constraints on cosmic doomsday". Journal of Cosmology and Astro-Particle Physics. 2004 (12): 006. arXiv:astro-ph/0409264. Bibcode:2004JCAP...12.006W. doi:10.1088/1475-7516/2004/12/006, accessed on 17 Jan 2026

[43] Frampton, P. H. (1976). "Vacuum Instability and Higgs Scalar Mass". Physical Review Letters. 37 (21): 1378–1380. Bibcode:1976PhRvL.37.1378F. doi:10.1103/PhysRevLett.37.1378, accessed on 07 Nov 2025

[44] https://science.nasa.gov/dark-matter/, accessed on 17 Jan 2026

[45] Glanz, James (1998). "Breakthrough of the year 1998. Astronomy: Cosmic Motion Revealed". Science. 282 (5397): 2156–2157, doi:10.1126/science.282.5397.2156a. S2CID 117807831, accessed on 17 Jan 2026

[46] Crane, Leah (29 June 2024). de Lange, Catherine (ed.). "How big is the universe, really?". New Scientist. p. 31,

[47] https://www.apu.apus.edu/area-of-study/math-and-science/resources/origin-of-the-universe/, accessed on 17 Jan 2026

sculpted by the debris left by its predecessor, just how stars are born from dense cosmic nurseries.

In their billions of years of existence, the brilliant stars and galaxies we see may very likely represent the last products of a previous universe. Nearing its conclusion, it still had the potential to produce new stars, suggesting that the end of one cosmic cycle and the beginning of another are inextricably linked, culminating in a final event estimated to occur in about 200 billion years. The unchangeable rules of conservation and transmutation that govern all of natural reality are followed by these occurrences that are visible in our current cosmos. These young galaxies might be seen as the last remnants or shining memories of a no longer-existing universe. The final whisper of a cosmos that once flourished in size and energy riches, they are pieces of a huge star legacy. As a result, we are living in the twilight of a magnificent cosmic history, seeing what may be called the "last dance" of matter and light from a vanished cosmos. What we see as our starry reality is just the remnant—a little but still vibrant part of an existence that is far larger than we can comprehend and that transcends both space and time. In essence, all that exists, everything we see, and everything we may learn is nothing more than the surviving remnants of time and space, the eternal mark of the dead cosmos. "Matter tells space how to curve, and space tells matter how to move." In "The Fabric of the Cosmos: Space, Time, and the Texture of Reality," Brian Greene states."[48]

The cosmos becomes less dense and complicated as this process progresses. Dense groupings of matter and energy have given way to increasingly large, empty areas interspersed with solitary islands of star activity. Thus, the James Webb Space Telescope's observations of newborn galaxies provide a window into this process of decline, illuminating the latter phases of a universe we are just starting to comprehend. In this image, the ancestral universe's demise was a protracted phenomenon rather than an instantaneous catastrophe, allowing new structures to gradually rise from its rubble. Black holes store the history of everything that previously been in their gravitational abysses, acting as the last defenders of the cosmic memory of the previous universe rather than the initiators of a new beginning. Black holes do have mass. Depending on the kind of black hole, its mass may be far larger than that of the Earth or the Sun. Supermassive black holes may have masses that are millions or billions of times that of the Sun, whereas stellar black holes typically have masses between a few and tens of times that of the Sun.

These objects are known as "black holes" because they are areas of space with such strong gravity that nothing can escape from them, not even light. This "trapping" characteristic is referred to as a "hole," even though it is not a hole in the conventional sense of an entrance or hollow. The term "black" is employed because a black hole is entirely dark and neither emits nor reflects light, making it seem "black" to any observer as light cannot escape from it. A phenomenon known as gravitational collapse may occur when certain stars, which are much more massive than the Sun, approach the end of their lifetimes. The pressure holding the star against gravity vanishes when they run out of nuclear fuel, and the star falls in on itself. A supernova may be produced by this collapse, and the surviving core may generate a stellar black hole, depending on the star's initial mass. This is an illustration of a black hole that comes from a "dead star." We become closer to the idea of a dead universe with dimensions larger than our visible universe in this manner.

The orbits of the planets in the solar system, including Earth, would initially stay intact, at least for a while, but the repercussions would be severe if the Sun abruptly ceased providing heat and light. This is due to the fact that the planets' orbit around the Sun is maintained by gravity rather than light. Light is a kind of energy that an object emits, and gravity is a result of its mass. The Sun's mass would still be there, so its gravity would still affect the planets even if it abruptly ceased generating light, which would indicate that nuclear processes are no longer occurring in its core. On the other hand, life on Earth and the planet's climate would suffer greatly in the absence of heat and light. The planets' orbits may change over time if the Sun underwent a process that drastically changed its mass, such as turning into a white dwarf. The trajectory of celestial bodies circling the Sun would be impacted by changes in the Sun's mass, which would also change its gravitational pull.

The idea of a universe that is made up of galaxies, supermassive black holes, dark matter, dark energy, and where the rules of physics are still in effect despite the absence of light emission is not out of the ordinary. Based on the presented theoretical reasoning, I can assert that such a world exists and that scientific knowledge may soon expose it. However, from a scientific perspective, the assertion that a basic fact, such a "dead universe," exists requires a considerable body of theoretical and empirical data that can be independently confirmed by testing and observations. Like many ideas and hypotheses that have come before it, this one is now in the realm of theoretical conjecture and should be treated cautiously until such proof is presented and confirmed by the scientific community's examination. Nearly all massive galaxies, including the Milky Way, have these black holes at their cores. Their masses are between millions and billions of times greater than the Sun's. Although their precise genesis is still unknown, it is thought that they expand over time by gathering materials and other black holes. Although they are an essential component of the dynamics and development of galaxies, they are not regarded as "dead galaxies."

Usually, a galaxy that has stopped producing stars is referred to as a "dead galaxy." Galaxies may "die" in terms of producing stars for a variety of reasons, including interactions with neighboring galaxies or the loss of gas, which is the fuel for star formation. These galaxies may contain supermassive black holes at their cores, but they do not turn into black holes. In contrast to the idea of multiverses proposed by numerous speculative

[48] Greene, B. (1999) The Fabric of the Cosmos: Space, Time, and the Texture of Reality. Vintage Books, accessed on 07 Nov 2025

theories, the "dead universe" hypothesis suggests that the aggregate deaths of celestial bodies converge in the construction of a single preceding world, which justifies and merits further investigation. These views often diverge from mathematical models and the scientific data that has been thoroughly examined and validated. The dead universe idea, on the other hand, provides a viewpoint that fits within the current knowledge of the world while also offering a possible foundation for further research since it is consistent with known findings and physics principles.

While the Dead Universe theory not only complies with the physical laws already in place but also offers substitute explanations that are easily verified through observation and experimentation, the consensus surrounding the Big Bang theory currently seems to be waning. Therefore, the "expansion of the universe" might be seen as a progressive separation from a previous universe, a remnant still impacting the present cosmos, driven by the rules of gravity rather than as a sign of dynamic development. One may think of this occurrence as the universe's last sigh as it progressively releases its energy. We are seeing a cooling and quiescent process in which space-time expands, matter and energy are gradually redistributed, and a condition of lasting tranquility is sought. A cosmos full of thoughtful calm and the genuine quiet that follows the bright intermission of the stars would come from this process, which tends to reduce and finally stop the development of new galaxies. The observable universe, its progeny, will expire just as its parent universe did.

2.5 Experimental Indication from the James Webb Space Telescope. The Big Bang hypothesis has long served as the foundation of cosmology, giving us a picture of a universe that was created from a singularity and expanded for around 13.5 billion years. But as more information emerges, it is becoming more and more obvious that this story has serious problems, opening the door for a different viewpoint—the "dead universe" idea that I put out. A completely new strategy is suggested by the Dead Universe idea. It suggests that the cosmos is a huge and potentially everlasting continuum where notions of origin and end are relativized, rather than being the product of an explosion. The findings of the James Webb provide hard data that casts doubt on the central idea of the Big Bang; therefore, this is more than simply a theoretical theory. The astonishing preservation of ancient galaxies that should exhibit interactions and mergers, as expected by the conventional model, points to a much more intricate and nonlinear cosmic past.

A major obstacle to modern cosmology is the observation of celestial objects that seem to be older than the universe's age as determined by the Big Bang concept. How can a universe that is now estimated to be 13.5 billion years old be reconciled with the presence of these mature structures? In an attempt to resolve this discrepancy, the Dead cosmos theory suggests that these galaxies are not only anomalies but are indicators of an ancient cosmos whose history goes beyond the temporal scale defined by the Big Bang. According to this hypothesis, traditional cosmological timelines could need to be updated in light of fresh data, potentially improving our comprehension of the universe's past and present. Furthermore, new data cast doubt on the Big Bang model's central tenet—the universe's alleged uniform expansion. The behavior of distant and old galaxies does not support fast and continuous expansion. A fundamental issue is brought up by this: what if the cosmos is not expanding evenly, or maybe not at all? According to a new idea put out by scientists, the universe may be in a more complicated, static, or inverted state than previously thought, one in which space and time are relative rather than absolute and interwoven in a manner that we are still learning about.

This is an opportunity to fundamentally reconsider our conception of the universe, not just a challenge to the prevailing story. Since the primordial nature of the Dead Universe was not light but rather the darkness of dark matter and supermassive bodies, the theory suggests a "timeless" universe or one that creates its own strange body, light. Beginning and end are human concepts rather than universal realities. From the standpoint of the dead universe, the fusing of black holes and the ensuing formation of stars can be seen as inexplicable occurrences for the creatures who inhabit this world. Imagine a society developing in the middle of unending darkness, where light is a concept that is abstract and almost legendary. The abrupt appearance of brilliant spots in the sky would be incomprehensible to them, an abnormality in an otherwise gloomy setting. It's possible that the UNO matter equation is similar to a window tint or solar control screen in that we see light while we are inside, but when we gaze from the outside in, we see no light at all and everything appears to be black and lightless. Therefore, because of the existence of a substance that I characterize as neutral, a world that is enmeshed in death inside a black fabric may show a reality of glorious brightness that we cannot perceive.

This is not just a challenge to the dominant narrative, but also a chance to radically reevaluate how we think about the cosmos. The idea proposes a "timeless" world or one that generates its own peculiar body, light, as the fundamental nature of the Dead world was not light but rather the blackness of dark matter and supermassive bodies. Rather of being universal truths, beginning and end are human notions. The merging of black holes and the subsequent creation of stars may be seen from the perspective of the dead universe as unexplainable events for the animals who live here. Imagine a culture growing up in the midst of endless darkness, where light is an almost mythical and abstract idea. They would not understand the sudden apparition of bright spots in the sky, an anomaly in a generally dreary scene. It's likely that the UNO matter equation functions similarly to a solar control screen or window tint in that, from the outside, everything seems black and lightless, but when we look in, we see light. Therefore, a world entangled in death within a black fabric may reveal a reality of glorious brightness that we are unable to perceive due to the existence of a substance that I describe as neutral.

Theories of cosmology that suggest different kinds of "barriers" or areas of transition in the cosmos. A black hole's event horizon, for instance, functions as a point of no return when gravitational pull is so powerful that not even light can escape, rendering it invisible from the outside. This is similar to looking at a dark window from the outside; you can't see through it, which gives the impression that there isn't any light or activity inside, yet there is really hidden treasure. Extending this to our concept, if there were a "UNO matter" that functioned as this type of cosmic hue, it might be a hypothetical substance or field that exists within the universe's structure and interacts with light and other forms of energy in a way that, when viewed from a particular angle, obscures the activity or underlying structure of the cosmos. Theoretically, such material may be in charge of the events we see, like as the impacts of dark matter, which affects galaxy motion but doesn't produce any observable light or radiation, making it "UNOl," or "invisible," to our existing observational techniques.

In cosmology, the term "domain wall" refers to a hypothesized structure that may serve as a partition between several vacuum state types or phases in the universe, analogous to the interface between two bubbles. Similar to our idea of "UNO matter" film, it's a theoretical idea that may help explain cosmic separation or transition regions. Though they may be helpful in explaining ideas, analogies are usually used sparingly and are always supported by sound reasoning and actual data in scientific papers. Furthermore, the basic principles of this dead cosmos may be called into question by the sheer absence of light as a primal constituent. Even though they live in a world where darkness is king, light may be seen as an encroachment or even as a metaphysical impossibility. These thoughts make us wonder whether, given our constrained viewpoint as cosmic watchers, we can indeed understand the whole of the universe. It's possible that the dead cosmos represents a spectrum of existence that is beyond our complete comprehension, and that what we take for granted are just a tiny portion of cosmic reality.

Perhaps the core of the dead world is in fact in opposition to the fundamental nature of light. Light, an object alien to its existence, was created by the mergers of black holes and supermassive entities, which constituted the universe's primordial essence. This cosmos will endure indefinitely, with light shining in contrast to its own endless darkness. This does not, however, imply that the substance of this dead world is our visible reality. Strange bodies like the galaxies we see are the result of particle unions and irregular behaviors that changed the universe's initial order. In this way, unless there is a creator entity for the dead universe, we are only encroaching on this reality by accident. Light is a peculiar aspect of the dead world's existence, if we may say so, because it will always exist with its own rules and nature. This peculiar universe contains light as a fundamental component of its essence and nature. In this way, the existence of humans and life as we know it is not debatable. According to the Abrahamic faiths, "no one can deny that the universe is more for darkness, chaos, and obscure mystery than for a reality of light."[49] This is an exciting time to investigate, ask questions, and perhaps learn more about the real nature of the universe. Since we are in the eternal time of the dead cosmos, the present will always be our time (Thorne, 1994). All of the old issues and many new ones would be raised by a single knowledge that integrates the quantum and classical worlds, which would answer some but leave the majority unsolved."[50]

The dark matter conundrum is a problem in physics. Such stuff is thought to be made up of hypothetical, indescribable particles called sterile neutrinos or compact, supermassive objects like primordial black holes. But the fundamental idea that is thought to explain dark matter resonates more in the context of the Dead Universe hypothesis than it does in the Big Bang framework. The idea that this process produced energy, like the mysterious cosmic mystery of dark energy, is supported by the presence of a previous and extinct world that was completely dark. This hypothesis holds that the rules of the previous universe are still in force and that dark energy is not the cause of cosmic expansion (Lee Smolin 2006). The Dead Universe Theory considers particle behavior, radio waves, and dark matter. However, for strictly scientific reasons, a creative agency does not disprove the Dead Universe idea. The goal of science is not to prove that the divine exists. It simply looks at natural things and uses empiricism to explain them. It also doesn't exist in order to reject the divine. Therefore, let's focus on what can be explained in the Theory of the Dead Universe and put aside what cannot be explained (Carroll, 2010). "Consider a world where any one of these figures was different. A world devoid of atoms, stars, planets, humans, and all other forms of life as we know them would exist. It would be a history-free universe. But the rules of physics as we know them would be perfectly compatible with such a reality. So why do we live in a world that is perfect for us?"[51]

2.6 Clarification for the Cold Spot in the Universe. A gigantic, under-dense area known as a super-void that CMB photons pass through and lose energy (integrated Sachs-Wolfe effect) is the best explanation for the "Cold Spot" in the cosmos, which is a sizable, abnormally chilly patch in the Cosmic Microwave Background (CMB), the afterglow of the Big Bang.[52] Although the dominant theory is a super-void, the spot's enormous size and depth defy conventional theories; some even speculate on unusual origins, such as the imprint of another universe, yet the majority of the data suggests a massive emptiness. The WMAP (Wilkinson Microwave Anisotropy Probe) satellite made the discovery in 2004, and data from the ESA's Planck mission subsequently verified it. This location defies the conventional explanation based on the Big Bang theory's prediction of the universe's homogeneity

[49] Thorne, K. (1994) Black Holes and Time Warps: Einstein's Outrageous Legacy. W. W. Norton & Company, accessed on 07 Nov 2025

[50] Smolin, L. (2006) The Life of the Cosmos. Oxford University Press, accessed on 17 Jan 2026

[51] Carroll, S. (2010) From Eternity to Here: The Quest for the Ultimate Theory of Time. Goodreads

[52] Wright, E.L. (2004). "Theoretical Overview of Cosmic Microwave Background Anisotropy". In W. L. Freedman (ed.). Measuring and Modeling the Universe. Carnegie Observatories Astrophysics Series. Cambridge University Press. p. 291, ISBN 978-0-521-75576-4, accessed on 07 Nov 2025

since it is around 70 microkelvins cooler than the average CMB.[53] According to this viewpoint, anomalies like as the Cold Spot are direct representations of the harsh circumstances and rules of the previous universe rather than just random fluctuations or the result of unidentified cosmic superstructures. The temperature fluctuations seen in the cosmic background radiation might be caused by gravitational pull or other lingering factors from this dead cosmos. Because of its state of cosmic death, temperature is a property of the dead universe rather than the visible cosmos. The idea that multiverses are colliding with this universe seems unlikely given its billion-year history; undoubtedly, other cold spots would have been encountered, but they do not exist because, for trillions of years, this cold spot served as the connection between this universe and the mother universe.

2.7 Constraint of Big Bang Theory. Anisotropies like the Cold Spot are difficult for the Big Bang theory to adequately explain, despite its effectiveness in describing the majority of the universe's known properties, such as cosmic expansion and the preponderance of light elements. The standard model predicts that cosmic inflation would cause temperature variations in the CMB to be comparatively consistent across vast scales. Because of its size and depth, the Cold Spot is difficult to incorporate into this model without the need for more intricate explanations, such as uncommon statistical fluctuations or massive, undiscovered cosmic superstructures. Thus, the Horizon Problem (uniform CMB temperature) is one of the main drawbacks of the Big Bang hypothesis, which explains a large portion of cosmology.[54], Flatness Problem (universe's geometry)[55], and Monopole Problem (lack of magnetic monopoles)[56], which are addressed by the Inflation theory, but this introduces its own issues like explaining the initial conditions and the nature of dark matter/energy.[57] Additionally, the theory has trouble explaining the matter-antimatter imbalance and the first singularity (Planck Epoch). According to the Inflation Theory, the cosmos expanded very quickly (exponentially) in its early stages. It was created in the 1980s to address a number of issues with the conventional Big Bang hypothesis, which holds that the universe expands over time somewhat slowly.[58] It is uncertain what specific particle physics process causes inflation. A number of inflation model predictions were verified by observation in 1992. For instance, temperature anisotropies seen by the COBE satellite reveal almost scale-invariant spectra, as anticipated by the inflationary paradigm, and WMAP data also provide compelling support for inflation.[59] However, some scientists dissent from this position.[60],[61]

Determining why the cosmos seems statistically homogenous and isotropic in line with the cosmological principle is known as the "horizon problem."[62] For instance, since the molecules in a gas canister are in thermal equilibrium, they are dispersed uniformly and isotopically. This is because the gas has had enough time to interact with one another to dissipate anisotropies and inhomogeneities.[63] Regions are too rapidly separated by gravitational expansion in the Big Bang scenario without inflation. Thus, there is not enough time for the early cosmos to reach equilibrium. Two widely distant parts of the visible universe cannot have equilibrated in a Big Bang with just the matter and radiation described in the Standard Model since they travel apart faster than the speed of light and have never had causal touch.[64] A cosmological fine-tuning issue with the Big Bang model of the universe is the flatness problem, often referred to as the oldness problem. The Universe is flat to within a few percent, according to observations of the cosmic microwave background.[65] Flatness rises as the universe expands. The early universe must therefore have been remarkably near to flat. The density of matter and energy in the universe influences the curvature of space-time in traditional cosmology, which is based on the Friedmann equations. A flat universe necessitates a very particular critical number.[66] It is found that the universe's present density is really near to this crucial number. Given that the overall density would rise quickly over cosmic time

[53] https://www.universetoday.com/articles/finally-an-explanation-for-the-cold-spot-in-the-cosmic-microwave-background, accessed on 07 Nov 2025
[54] Carrigan, Richard A.; Trower, W. Peter (1983). Magnetic Monopoles. doi:10.1007/978-1-4615-7370-8. ISBN 978-1-4615-7372-2, accessed on 17 Jan 2026
[55] Peacock, J. A. (1998). Cosmological Physics. Cambridge: Cambridge University Press. ISBN 978-0-521-42270-3,
[56] Hooper, Dan (October 6, 2009). Dark Cosmos: In Search of Our Universe's Missing Mass and Energy. Harper Collins. ISBN 978-0-06-197686-5, accessed on 17 Jan 2026
[57] https://ui.adsabs.harvard.edu/abs/1992BASI...20..157N/abstract, accessed on 17 Jan 2026
[58] Tyson, Neil deGrasse and Donald Goldsmith (2004), Origins: Fourteen Billion Years of Cosmic Evolution, W. W. Norton & Co., pp. 84–85, accessed on 07 Nov 2025
[59] Tsujikawa, Shinji (28 April 2003). "Introductory review of cosmic inflation". arXiv:hep-ph/0304257, accessed on 07 Nov 2025
[60] Guth, Alan H. (1997a). The Inflationary Universe: The quest for a new theory of cosmic origins. Basic Books. pp. 233–234. ISBN 978-0-201-32840-0, accessed on 17 Jan 2026
[61] Earman, John; Mosterín, Jesús (March 1999). "A Critical Look at Inflationary Cosmology". Philosophy of Science. 66 (1): 1–49. doi:10.1086/392675. JSTOR 188736. S2CID 120393154, accessed on 07 Nov 2025
[62] Misner, Charles W.; Coley, A A; Ellis, G F R; Hancock, M (1968). "The isotropy of the universe". Astrophysical Journal. 151 (2): 431. Bibcode:1998CQGra.15..331W. doi:10.1088/0264-9381/15/2/008, accessed on 07 Nov 2025
[63] Misner, Charles; Thorne, Kip S. & Wheeler, John Archibald (1973). Gravitation. San Francisco: W. H. Freeman. pp. 489–490, 525–526. ISBN 978-0-7167-0344-0, accessed on 17 Jan 2026
[64] Weinberg, Steven (1971). Gravitation and Cosmology. John Wiley. pp. 740, 815. ISBN 978-0-471-92567-5,
[65] https://map.gsfc.nasa.gov/universe/uni_matter.html, accessed on 07 Nov 2025
[66] Lightman, Alan P. (1 January 1993). Ancient Light: Our Changing View of the Universe. Harvard University Press. ISBN 978-0-674-03363-4, accessed on 17 Jan 2026

if it deviated from the crucial value,[67] The density of the early cosmos must have been even nearer the critical density, deviating from it by no more than one part in 1062. Cosmologists wonder how the original density was so precisely tailored to this "special" number.[68]

2.8 Disagreement with Cosmic Radiation Theory. The Cold Spot indicates anisotropies that could call for novel physics or modifications to existing cosmogonic theories, even if cosmic background radiation typically supports a uniform and homogeneous cosmos as anticipated by inflation. Given this, the Big Bang hypothesis is unable to directly explain this anomaly, which begs the issue of whether the model should be modified or expanded. An alternate explanation for the Cold Spot is provided by the Dead cosmos idea, which proposes that it is a "umbilical cord" from a previously collapsed cosmos. According to this idea, our visible world is only a residue of both the dead universe and a much bigger, older cosmos. Irregularities like the Cold Spot might be caused by gravity and effects from this former cosmos, which is currently only partly present. By adding the concepts of a multiverse or cosmic cycles of death and rebirth, this method not only provides an explanation for the anomaly but also advances our knowledge of the cosmos. An interesting explanation for the genesis of anomalies such as the Cold Spot in the cosmic microwave background radiation is offered by the Dead Universe idea. According to this view, the Cold Spot is a direct result of the temperature condition of a now-extinct predecessor universe rather than just a random fluctuation. Consider a massive, aged universe that gradually cools down to a large area with little thermal energy, similar to a cold chamber in space.

This comparison may be compared to opening a little door between a warmer space, like a kitchen, and an excessively cold one, like a freezer. The influence of the dead universe on the surrounding space, particularly at locations where the interaction is most strong, is comparable to the instantaneous heat exchange that takes place. In the context of the visible cosmos, this thermal exchange produces a region that is considerably colder, which we identify as the Cold Spot. Like the way cold air from a freezer mixes with warmer air in a kitchen, this equation aims to measure the direct impact of the dead universe's severe cold on the visible universe. This comparison, together with the equation that goes with it, offers a vivid and scientifically sound explanation of how the temperature of the cosmos as it exists now may be affected by an old and cold universe. Thorough observations and a thorough examination of the cosmic microwave background radiation's anisotropies, searching for particular patterns that would support this thermal interaction on a cosmic scale, are necessary for the validation of this idea.

According to the hypothesis of the previous universe's enormous gravitational magnitude, space-time may naturally distort; this phenomenon is referred to as a "gravitational well" in astrophysics and is what bends light, for instance. What astrophysics has failed to explain may be explained by the theory that the visible universe lies within the womb of a deceased mother universe that perished trillions of years ago, the same destiny as our world, which came from the womb of the previous mother. The cosmos's fabric may have been bent by the gravitational pull of the old universe, causing a "slippery" to advance across space without really moving. Despite being acknowledged as the explanation for the universe's beginning, the Big Bang hypothesis contains flaws, such as the inability to account for the universe's ongoing expansion. This alternate theory may be supported by studies linking particle accelerators that show micro-explosion-like occurrences. The presence and behavior of black holes, which provide indirect evidence of this process, could be interpreted as an expansion driven by the residual action of the gravity of a previous universe, if the observable universe originated from a "dead universe." The persistence of gravitational rules, which seem to have governed unchanged since the primordial state, might be evidence of the close relationship between the present universe and its potential antecedent in a more expansive setting.

The fact that expansions brought on by explosive events often include a degree of unpredictability in the motion of the associated particles is a relevant point of contention in the Big Bang hypothesis. But the universe's expansion points to a more regular and orderly development, perhaps driven by ideas that modern physics hasn't yet completely clarified. In reference to the description of the “Explosion” of the Big Bang itself, the phrase can be considered unsuitable if seen in the context of typical explosions. What physical processes would support such a concept if such an event did not fall within the conventional definition of an explosion? A source of energy that can support the Big Bang theory, which postulates the expansion of spacetime itself, is necessary. Furthermore, the Big Bang process refers to the expansion of spacetime itself rather than an explosion inside an existing place. The Big Bang model, which sometimes appears to waver in its explanations about the precise nature of the original event, leaves gaps that may be filled by the alternative explanation offered by the "Great Dead Universe" idea, which could provide a thorough account of cosmic expansion.

Furthermore, a traditional explosion's claimed chaotic and random beginning may appear incompatible with the universe's regularity and ordered structure. Explosive characteristics may be part of the universe's nature, according to scientific research, especially those based on quantum physics concepts. Therefore, the beginning circumstances and physical rules of this earlier universe may be the governing keys of the expansion we see today if the visible world is impacted by a previous cosmic heritage (Rees 2000). "The theory of everything is a bold attempt in theoretical physics to bring together the weak nuclear force, strong nuclear force, electromagnetism, and gravity—the four fundamental

[67] Peacock, J. A. (1998). Cosmological Physics. Cambridge: Cambridge University Press. ISBN 978-0-521-42270-3,

[68] Cox, Brian; Forshaw, J. R. (2017). Universal: a guide to the cosmos (1 ed.). Boston, MA: Da Capo Press. ISBN 978-0-306-82270-4. OCLC 973019447, accessed on 17 Jan 2026

forces of the universe." Sean Carroll said this in "From Eternity to Here: The Quest for the Ultimate Theory of Time."[69] “Each and every atom in your body originated from an exploding star. Furthermore, your left hand's atoms most likely originated from a different star than your right. You are all stardust, which is the most beautiful thing I've ever heard about physics. According to Lawrence M. Krauss, "A Universe from Nothing: Why There Is Something Rather than Nothing" (Krauss, 2012).[70] Every every atom in your body came from a star that exploded. Moreover, the atoms in your left hand most likely came from a different star than those in your right. The most exquisite thing I've ever heard about physics is that you are all stardust. As stated in "A Universe from Nothing: Why There Is Something Rather than Nothing" by Lawrence M. Krauss.

2.9 Contemporary Cosmology. Theoretical and experimental efforts interact dynamically in modern cosmology, which is always changing to overcome new obstacles. In order to reconcile theory with new empirical evidence at every stage, the field requires methodical reconstruction. The discovery of supernova fading marked a turning point in this continuing discussion,[71] a phenomenon that revealed the limitations of the Friedmann–Lemaitre–Robertson–Walker metric (here Friedmann metric). The cosmological constant was suggested to resolve this contradiction and bring the theoretical predictions into line with actual findings.[72] Galaxies are becoming further away from us, according to current surveys and astronomical studies. Understanding how structures arise and how galaxies evolve against the background of the late-time universe's accelerating expansion is a major question at the center of contemporary cosmological arguments.[73] Based on the cosmological principle, the Friedmann model has successfully explained the development of the universe in accordance with actual findings.[74],[75],[76] .[77],[78],[79] However, the mystery of dark energy and the force driving cosmic acceleration remains a tenacious challenge in contemporary physical cosmology .[80],[81] Concepts like the cosmological constant or dark energy-dominated scenarios are used in a variety of attempts to explain cosmic acceleration. Nonetheless, there are important questions raised by the cosmological constant.[82],[83],[84]Adding to these difficulties is the potential violation of the cosmological principle when homogeneity or isotropy falters in galaxy structure formation.[85],[86]

Surveys of three-dimensional redshift look further into space and uncover features without a transition to homogeneity.[87],[88] Now, questions arise regarding the

[69] Rees, M. (2000) Just Six Numbers: The Deep Forces That Shape the Universe. Hachette Book Group, accessed on 07 Nov 2025

[70] Krauss, L. M. (2012) A Universe from Nothing: Why There Is Something Rather than Nothing. Atria Books

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steadfastness of the cosmological principle.[89] On the highest statistical scale accessible, the distribution of galaxies in recent observations (or light) and simulations of the distribution of dark matter (or matter) show notable inhomogeneity.[90] The search for the cosmological principle in the present visible light or matter distribution in the cosmos is complicated by the much more inhomogeneous matter distribution.[91] Recent model-independent examinations of a brilliant red galaxy sample utilizing the Sloan Digital Sky Survey's Sixteenth Data Release (SDSS-IV DR16) revealed an angular scale of cosmic homogeneity of 60–80 h−1 Mpc.[92] A homogeneity test for the matter distribution based on the Baryon Oscillation Spectroscopic Survey Data Release 12 CMASS galaxy sample has contested this conclusion.[93] Up to a radius of 300 h−1 Mpc, which is about the maximum statistically possible scale, it was discovered that the observed distribution of matter is statistically improbable to be a random arrangement.

The discovery of massive quasar groups (LQGs) intensifies the controversy by implying an underlying inhomogeneity that is incompatible with accepted cosmological theories.[94],[95] These discoveries highlight the need of a thorough cosmological reexamination.[96] To prevent misinterpretations of the sources under analysis, accurate testing of the standard model's prediction on the spatial distributions of luminous astronomical sources must be based on high-resolution cosmological simulations involving a sizable sample of isolated galaxies using reliable data-driven detectors.[97] Three-dimensional catalogs provide a complicated picture of inhomogeneous galaxy distributions, but two-dimensional predictions seem consistent with isotropy and homogeneity.[98] Attempts to adopt a single viewpoint are complicated by these conflicting results on the shift to homogeneity.[99],[100] These discoveries' disparate character calls into question the widely accepted notion of cosmic homogeneity and isotropy.[101] Understanding cosmic acceleration and the need for an extra dark energy component may be affected by the consequences.[102],[103]

Given the observable abnormalities of the standard model and its lack of physical reason, researchers think it essential to investigate alternate theories of dark energy or its modified forms to account for the universe's cosmic acceleration.[104],[105],[106],[107] The suggested model incorporates dark energy and modified gravity theories in which the scalar field takes the place of the

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cosmological constant.[108,109] The Friedmann model and the concordance model of cosmology in general are challenged by recent data such as the unexplained Hubble parameter tensions, large-scale anisotropies, and enormous disk galaxies at higher redshifts. For instance, the Hubble parameter derived from Type Ia supernovae and the redshift of their host galaxies is different from that derived from the cosmic microwave background (CMB) radiation.[110,111] Other hypotheses suggest that the classic redshift model, as a distance–scale factor connection, may be imperfect, whereas the concordance model's incompleteness is one potential reason.[112,113] Resolving these facts encourages changes to some of the fundamental principles that form the basis of cosmology.[114] Investigating current Hubble tensions may be made more credible by altering the conventional redshift relation.[115]

According to several other hypotheses, cosmic acceleration is an emergent phenomenon.[116] Cosmological redshift is the primary impact of cosmic evolution on photon propagation. Cosmological redshift is a theoretical function of the scale factor obtained from the Friedmann metric in the standard model. Instead of depending on its theoretical form, researchers are increasingly using data to rebuild this scale factor–redshift association.[117,118] The unknown function of the measured redshift, which raises the equation's degree of freedom, is a disadvantage of remapping cosmological models. Before using a parametric method, this problem has been resolved by adding function parameterization using Taylor expansion. A cosmological model that modifies the conventional redshift relation to explain the universe's accelerating expansion is one example of related study.[119] Under the premise that the Friedmann model is insufficient, it has been shown that combining Friedmann equations with a version of redshift remapping may result in a self-consistent framework.[120,121] The parametric,[122] non-parametric,[123] and modified standard redshift models,[124] are expected to address the cosmological constant problem.

All of these lofty goals, meanwhile, are dependent on a necessary prerequisite and a wealth of precise and comprehensive cosmological data. Notwithstanding the increasing amount of observable evidence, enduring constraints need a cautious evaluation of the correctness and completeness of the present cosmological models.[125,126,127] Equipped with a 3.6 gigapixel camera, the future Vera Rubin Observatory might conduct a groundbreaking ten-year expedition,[128] prepared to examine the whole night sky and explore the complexities

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of the cosmos.[129] Again, in 2015 the parametric model proposed by Bassett et al.[130] introduces modifications to the traditional redshift paradigm, seeking to refine our understanding of cosmic dynamics. By adding parameters that account for changes in the redshift space, this model enables a more sophisticated interpretation of observational data. By adding certain characteristics, the model takes into account intricate features of cosmic processes and offers a more thorough and precise depiction of findings connected to redshift. However, the non-parametric model, developed by Wojtak and Prada in 2017, adopts a different strategy by eschewing predetermined parameters, enabling more freedom in simulating cosmic occurrences.[131] The non-parametric model allows for a more flexible and data-driven examination of redshift-related phenomena since it does not impose preset parameters as parametric models do. When the underlying dynamics are complicated and difficult to capture by preset parameters, this approach is invaluable.

It offers a more flexible instrument for analyzing data from observations.
The local cosmos has a diverse range of developed star systems (Norris et al. 2014),[132] from globular clusters (Brodie & Strader 2006; Kruijssen 2014; Renzini et al. 2015)[133],[134],[135] to compact elliptical galaxies (Faber 1973)[136], ultrafaint dwarfs (e.g., Simon & Geha 2007)[137], and ultra-diffuse spheroids (van Dokkum et al. 2017)[138], each of which presumably has its own characteristic formation pathway. In addition to their ancient antiquity, several of these systems have tremendous star concentrations (Forbes and Bridges 2010)[139] suggest that at $z \gtrsim 1.5$, when the universe's gas concentrations were generally much greater, the bulk of their star formation took place. Getting a sensitive, high-resolution image of the distant cosmos is one potentially viable avenue to explore the development of these local systems. Fortunately, such discoveries may be made by combining the magnifying effect of gravitational lensing with the capability of long exposures with the Hubble Space Telescope, as recently done in the ambitious Hubble Frontier Fields (HFF) mission (Coe et al. 2015; Lotz et al. 2017)[140],[141]. Since many of the progenitors of local systems are probably required, these sensitive observations enable us to probe to extremely low luminosities. Numerous galaxies may be analyzed at extremely high spatial resolution because of the strong lensing magnifications from huge galaxy clusters, which stretch them by significant factors. As it has discussed in Bouwens et al. (2021b) [142], this stretching can reliably be estimated up to linear magnifications of $\sim 30\times$ (or total magnification factors of $\sim 50\times$). It is also available in Bouwens et al. 2017a, c[143],[144], where similar though smaller limits were presented with the then-current models, and Meneghetti et al. 2017)[145]. Given the small inferred sizes of the fainter lensed sources identified by Kawamata et al. (2018)[146] and Bouwens et al. (2021b).[147] It is intriguing to consider these sources in relation to other tiny star-forming systems, such as star clusters or cluster complexes, as well as other stellar systems that they may develop into today. An initial look at such comparisons was already executed in an earlier unpublished study by our group (Bouwens et al. 2017b)[148] and also by Kikuchihara et al. (2020)[149]. One significant early conclusion from these investigations was that, in size/mass space, lensed z = 6–8 galaxies seem to fall between ultracompact dwarfs/globular clusters and compact elliptical galaxies, with masses and diameters that fall between 107 and 108 M⨀ and around 50–500 pc. Over the last ten years, significant advancements have been made in the discovery of galaxies that formed within a billion years of the Big Bang, at $z > 6$. It is fantastic, mostly because

Precision with Gaia EDR3 Parallaxes and Hubble Space Telescope Photometry of 75 Milky Way Cepheids Confirm Tension with ΛCDM. Astrophys. J. Lett. 2021, 908, L6, accessed on 13 Nov 2025

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148 Bouwens R. J., Illingworth G. D., Oesch P. A. et al. 2017b arXiv:1711.02090, accessed on 30 Jan 2026

149 Kikuchihara S., Ouchi M., Ono Y. et al. 2020 ApJ 893 60, accessed on 30 Jan 2026

to confirmation spectra from huge ground-based observatories and photos from the Hubble Space Telescope. The James Webb Space Telescope (JWST) and ground-based Extremely Large Telescopes (ELTs) will push the "high redshift frontier" even further during the next years.[150] The Nancy Grace Roman Space Telescope, also known as the Roman Space Telescope, Roman, or RST, is an infrared space telescope being developed by NASA that is expected to launch into a Sun-Earth L2 orbit by May 2027.[151] The narrow field of view of these facilities, particularly JWST, and the Roman Space Telescope's (previously WFIRST) sensitivity confined to the near-infrared (near-IR, $\lambda < 2\mu m$)[152] and EUCLID wide-field imaging space missions, and which mean that a crucial piece of the jigsaw remains missing. That is a wide-field imaging survey,[153] Finding the rarest most massive and bright galaxies at the greatest redshifts—whose progenitors are probably the earliest galactic structures to form—requires research at near and mid-IR wavelengths (necessarily from space). For galaxies at $z > 10$, NIR spectroscopy at $\lambda > 2\mu m$ (corresponding to the rest-frame optical frame) is also required to get comprehensive information (metallicity, star mass).[154]

With the completion of the JWST mission, which is projected to uncover a multitude of faint galaxies at high redshift and address the function of these early galaxies in the reionization of the inter-galactic medium, the astrophysics landscape is anticipated to be very rich between 2035 and 2050. The most powerful radio telescope on the planet right now is the Millimeter/submillimeter Array (ALMA). An international intergovernmental radio telescope project called the Square Kilometre Array (SKA) is being constructed in South Africa (mid-frequency) and Australia (low-frequency). By then, SKA will have investigated the molecular emission and dust re-emission from several of these objects, and ALMA will be a well-developed facility.[155] It was low luminosity sources that caused the Universe to reionize.[156],[157],[158] Only in groups or proto clusters will these low brightness sources be detectable. Given that the early galaxies were quite faint, this is probably the case. Finding proto clusters between z~6 and z~15 would thus reveal the re-ionization history of the Universe.[159] At wavelengths less than 2 microns, the Rubin Observatory (formerly LSST) on Earth and EUCLID and the Roman Space Telescope in space will investigate rare and brilliant sources at high redshift as well as transients like distant supernovae.[160] After many decades, new facilities like Athena will enable AGN to reach previously unheard-of distances in the X-ray. However, a wide-field IR survey mission with spectroscopy and imaging operating beyond 2 microns has to be addressed in the future, since there is a significant gap in the parameter space that is yet unexplored.[161] This incomplete voyage into the enigmatic cosmos will continue. However, in order to inform the formation and origin of the universe based on the current development of the notion of physics, this analytical study effort will assess and explain the chronological evolution of concepts and theories of physics. The author will also make an attempt to research, describe, and evaluate the universe's genesis and future.

3. Progress of Modern Theory of Science

The foundation of all natural sciences is physics. Our knowledge of chemistry, biology, astronomy, and geology is based on its principles. Using universal rules to describe a wide range of events is one of physics' greatest achievements. From commonplace items like lightbulbs, cell phones, and can openers to biological systems like muscles, lungs, and brains; from artistic endeavors like paints, piccolos, and pirouettes to technological innovations like cameras, cars, and cathedrals; from natural disasters like hurricanes, tsunamis, and earthquakes to subatomic particles like quarks, DNA, and black holes, it aids in our understanding of how the world functions. By showing relationships between apparently unconnected occurrences, physics helps us make sense of the cosmos. It offers strong resources to stimulate innovation, broaden our horizons, and cultivate creativity. Physics serves as the basis for the majority of contemporary technology, including the equipment and techniques utilized in scientific, technical, and medical research and development. Technology based on physics is crucial to manufacturing.[162] Energy solutions (nuclear, solar power), medical imaging (MRI, X-ray, ultrasonogram, etc.), and quantum computing are all products of applied physics and are entwined with the future of human existence. Modelling the Earth's climate system requires physics because it

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enables scientists to forecast changes in atmospheric conditions, sea levels, and weather patterns—all of which are vital for the survival and adaption of life on Earth in the future.

The Copernican mathematician, astronomer, and physicist Galileo Galilei (1564–1642) was an Italian who made several contributions. He modified the telescope, carried out empirical research, and found new celestial phenomena. At the period, the primary disciplines of law, medicine, and theology—all of which were intimately related to philosophy—overshadowed his function as a mathematician at the university. Galileo discovered that bodies do not fall with weight-proportional velocities. Even though the legend of him throwing weights from the Leaning Tower of Pisa is probably untrue, he did prove that a projectile's trajectory is a parabola and discovered inertia, which foreshadowed Newton's laws of motion.[163] Among them is what is now called Galilean relativity, which was the first precise explanation of space and time's characteristics outside of three-dimensional geometry. Galileo is sometimes considered to be the "father of modern observational" approaches in astronomy,[164] the "father of modern physics", the "father of science",[165]and "the father of modern science". "Galileo, perhaps more than any other single person, was responsible for the birth of modern science," according to Stephen Hawking.[166] Galileo's support for heliocentrism caused controversy since religious orthodoxy maintained a geocentric or Tychonic understanding of the Solar system, which resulted in his prosecution by the Inquisition. His discovery of the Jovian moons, which he published in 1610, helped him get a position at the Medici court as a mathematician and philosopher.[167] In addition to drawing a sizable readership for his own writings, such as the Discourses and Mathematical Demonstrations Concerning Two New Sciences, he was expected to engage in discussions with Aristotelian thinkers. Following his detention, his writings, including the Dialogue Concerning the Two Chief World Systems, were published all over the world.[168,169] Galileo's emphasis on conducting experiments and creating mathematical explanations of motion made experimentation a cornerstone of natural science philosophy.[170]

The British mathematician and physicist Sir Isaac Newton (1642–1727), a member of the Royal Society of England, developed a single framework for explaining how the cosmos functions. In 1672, he was made a Fellow of the Royal Society of England. Later, from 1703 until his death in 1727, he served as President of the Society.[171] The link between objects and their motion is described by Newton's three laws of motion. Additionally, he developed the law of universal gravitation, which explains how planets and other heavenly objects move as well as how things fall on Earth.[172] In order to accomplish his goals, Newton created calculus, a new area of mathematics that Gottfried Leibniz also independently created. This branch turned into a crucial instrument for later developments in several branches of physics. In the *Philosophiae Naturalis Principia Mathematica*, also known as the *Mathematical Principles of Natural Philosophy*, Newton described his findings in full. Its publication in 1687 signaled the beginning of the modern age in astronomy and mechanics.[173] The Cartesian mechanical theory, which holds that all movements are caused by instantaneous forces from corpuscles, was contested by Newton. He replaced the notion that things follow preset natural courses with the knowledge that all future movements can be mathematically predicted using present motion, mass, and the forces at work by using his three laws of motion and the rule of universal gravitation.[174] Nevertheless, the observed celestial movements did not quite fit a Newtonian viewpoint, and Newton—who was also deeply interested in theology—thought that God's involvement was required to preserve the stability of the solar system.[175]

Continental thinkers disagreed with Newton's ideas, with the exception of his mathematical techniques, and deemed his lack of philosophical justifications for motion and gravity intolerable.[176] The Continental and British intellectual traditions began to

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166 https://www.inventionandtech.com/content/galileo-and-birth-modern-science, accessed on 26 Nov 2025

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168 Drake, Stillman (1978), Galileo at Work: His Scientific Biography, Chicago, Illinois: University of Chicago Press, ISBN 0-226-16226-5, accessed on 30 Jan 2026

169 Biagioli, Mario (1993), Galileo, Courtier: The Practice of Science in the Culture of Absolutism, Chicago, Illinois: University of Chicago Press, ISBN 0-226-04559-5, accessed on 26 Nov 2025

170 Brading, Katherine (August 2019). "A note on rods and clocks in Newton's Principia". Studies in History and Philosophy of Science Part B: Studies in History and Philosophy of Modern Physics. 67: 160–166, doi:10.1016/j.shpsb.2017.07.004, accessed on 30 Jan 2026

171 Matthews, Michael R. (2000). Time for Science Education: How Teaching the History and Philosophy of Pendulum Motion Can Contribute to Science Literacy. New York: Springer Science+Business Media, LLC. p. 181. ISBN 978-0-306-45880-4, accessed on 30 Jan 2026

172 Cheng, K. C.; Fujii, T. (1998). "Isaac Newton and Heat Transfer". Heat Transfer Engineering. 19 (4): 9–21. doi:10.1080/01457639808939932. ISSN 0145-7632, accessed on 30 Jan 2026

173 Whiteside, D.T., ed. (1970). "The Mathematical principles underlying Newton's Principia Mathematica". Journal for the History of Astronomy. 1. Cambridge University Press. pp. 116–138, accessed on 30 Jan 2026

174 Rynasiewicz, Robert A. (22 August 2011). "Newton's Views on Space, Time, and Motion". Stanford Encyclopedia of Philosophy. Stanford University, accessed on 30 Jan 2026

175 Bloye, Nicole; Huggett, Stephen (2011). "Newton, the geometer" (PDF). Newsletter of the European Mathematical Society (82): 19–27. MR 2896438, accessed on 30 Jan 2026

176 Goldstine, Herman H. (1980). A History of the Calculus of Variations from the 17th Through the 19th Century.

sharply diverge about 1700. Intense, continuous, and often personal disagreements between Newtonian and Leibnizist adherents about who should have precedence in the development of calculus's analytical methods—which each had separately invented—were the main source of this division.[177] Leibnizian calculus notation was widely used everywhere except Britain at first because the Cartesian and Leibnizian traditions predominated on the European continent. Although he made it clear in his works that a philosophical explanation of gravity was not necessary to deduce its effects in reality, Newton himself was uncomfortable with the lack of one.[178] Throughout the 18th century, continental natural philosophers increasingly adopted the Newtonians' strategy of eschewing ontological metaphysical explanations in favor of mathematically specified movements.[179],[180]

Newton developed a theory of color, which he described in *Opticks*, and constructed the first functional reflecting telescope. The fact that a prism divides white light into the several colors that are visible to the human eye spectrum served as the foundation for his hypothesis.[181] In 1690, Christiaan Huygens put up a rival wave theory to explain the behavior of light, in contrast to Newton's description of light as consisting of microscopic particles. However, the wave hypothesis did not acquire much momentum until the 19th century because of the great reputation of Newton and the general trust in mechanical philosophy. In addition, Newton proved the generalized binomial theorem, investigated power series, created an empirical rule of cooling, and developed a technique for calculating the roots of an equation function.[182] Simon Stevin's work on decimals served as inspiration for his studies on infinite series.[183] Most significantly, Newton showed that the same natural laws—which are neither hazardous nor unpredictable—control the movements of things on Earth and in space. Newton removed any residual skepticism about heliocentrism by demonstrating how his theory of gravity and Kepler's rules of planetary motion aligned.[184] Newton successfully established the foundation for contemporary mathematics and science by combining the concepts put forward throughout the Scientific Revolution.[185]

Springer New York. pp. 7–21. ISBN 978-1-4613-8106-8, accessed on 30 Jan 2026

177 Newton, I. (1999). The Principia, The Mathematical Principles of Natural Philosophy. Translated by Cohen, I.B.; Whitman, A. Los Angeles: University of California Press, accessed on 29 Nov 2025

178 Guicciardini, Niccolò (1999), Reading the Principia: The Debate on Newton's Methods for Natural Philosophy from 1687 to 1736, New York: Cambridge University Press, accessed on 03 Feb 2026

179 Hall, A. Rupert (1980), Philosophers at War: The Quarrel between Newton and Leibniz, New York: Cambridge University Press. accessed on 03 Feb 2026

180 Bertolini Meli, Domenico (1993), Equivalence and Priority: Newton versus Leibniz, New York: Oxford University Press, accessed on 29 Nov 2025

181 Wilson, Raymond N. (2013). "1.1 Period 1608–1672". Reflecting Telescope Optics I: Basic Design Theory and its Historical Development. Springer. pp. 1–10. ISBN 978-3-662-03227-5, accessed on 03 Feb 2026

182 Barth, Nils R. (2004). "Computing Cavalieri's Quadrature Formula by a Symmetry of the n-Cube". The American Mathematical Monthly. 111 (9): 811–813. doi:10.2307/4145193, accessed on 29 Nov 2025

183 Błaszczyk, Piotr; Katz, Mikhail; Sherry, David (2012), "Ten misconceptions from the history of analysis and their debunking", Foundations of Science, 18: 43–74, doi:10.1007/s10699-012-9285-8, accessed on 03 Feb 2026

184 "Orbits and Kepler's Laws". NASA Solar System Exploration. 26 June 2008. Archived from the original on 2022-12-13, accessed on 03 Feb 2026

185 Palomo, Miguel (2 January 2021). "New insight into the origins of the calculus war". Annals of Science. 78 (1): 22–40. doi:10.1080/00033790.2020.1794038, accessed on 03 Feb 2026

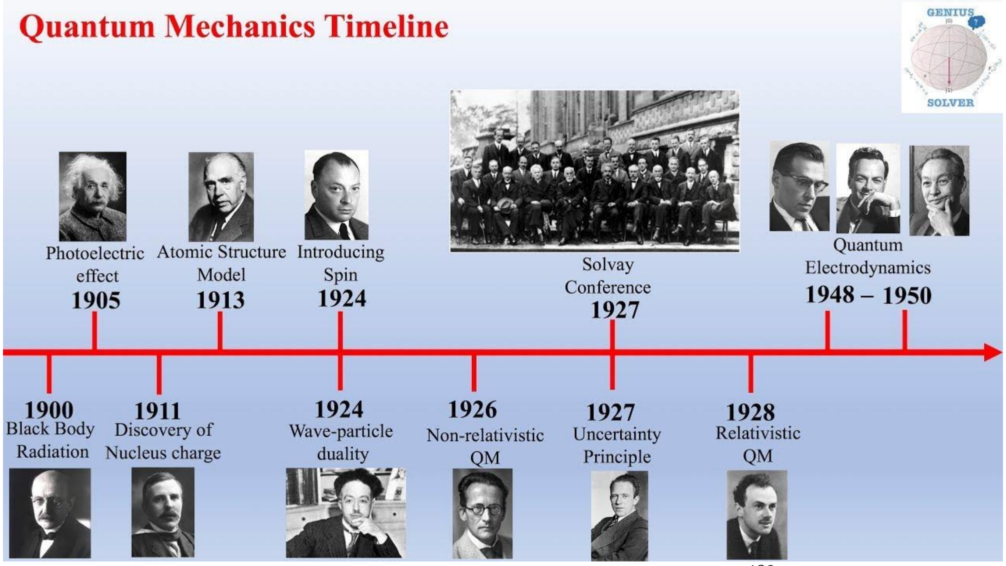

Figure 1: *A brief history of quantum mechanics*[186]

After relocating to Bern, Switzerland, in 1905, a 26-year-old German physicist named Albert Einstein proved how motion between the observer and the object of observation impacts time and space measurements.[187] Significant developments in quantum theory were also made by Einstein. E=mc2, his mass-energy equivalency formula derived from special relativity, has been named "the world's most famous equation."[188] His contributions to theoretical physics are among the best intellectual works ever created. Even though he did not develop the theory of relativity, Einstein recognized that there is an absolute limit to speed and that the speed of light in a vacuum is constant, or the same for all observers. This has less impact on a person's day-to-day activities since most objects travel at far slower speeds than light. However, the theory of relativity states that an object's length will decrease as measured by an observer on Earth as it approaches the speed of light because its connected clocks will operate more slowly. Einstein also developed the equation E=mc2, which asserts the equality of mass and energy.[189] Einstein argued that electromagnetic principles should be universally applicable, independent of reference frame, and that the speed of light is constant across all inertial reference frames. In 1921, he was awarded the Nobel Prize in Physics for his research on the photoelectric effect. Science was drastically altered by Einstein's groundbreaking theory of relativity. His theory of relativity is still his most significant contribution, despite the fact that he made several other significant contributions.

[186] https://www.youtube.com/watch?v=EXq7P2OzgbE, accessed on 02 Jan 2026

[187] Whittaker, E. (1 November 1955). "Albert Einstein. 1879–1955". Biographical Memoirs of Fellows of the Royal Society. 1: 37–67. doi:10.1098/rsbm.1955.0005, accessed on 03 Feb 2026

[188] Yang, Fujia; Hamilton, Joseph H. (2010). Modern Atomic and Nuclear Physics. World Scientific. p. 274. ISBN 978-981-4277-16-7, accessed on 03 Feb 2026

[189] Miller, Arthur I. (1981), Albert Einstein's special theory of relativity. Emergence (1905) and early interpretation (1905–1911), Reading: Addison–Wesley, ISBN 978-0-201-04679-3, accessed on 03 Feb 2026

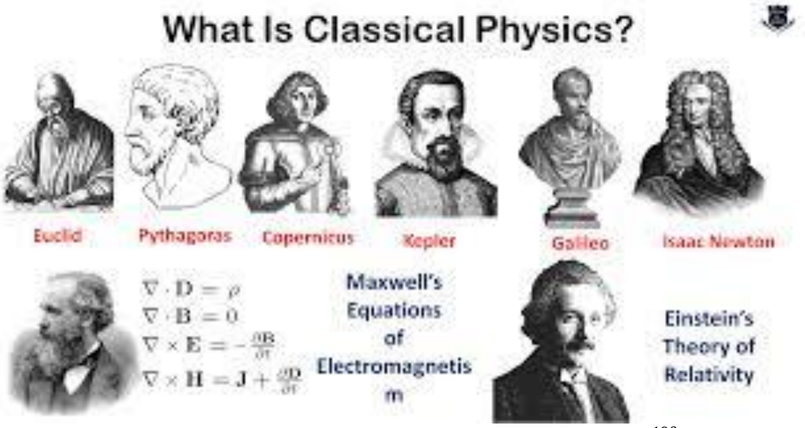

Figure 2: *Journey of classical to modern physics* [190]

Albert Einstein in 1905 develop "special theory of relativity" and that made the ether "superfluous" to physical theory and maintained that measurements of length and time changed according on the observer's motion with regard to the object being observed.[191] Furthermore, the equation suggested that energy and mass were equal quantities. In order to provide an accurate explanation for the dispersion of blackbody radiation, theoretical physicist Max Planck suggested a constant in 1900.[192] In another publication the same year, Einstein asserted that electromagnetic radiation was transmitted in definite amounts, or quanta. The peculiarities of the photoelectric effect were explained by this premise. [193] The special theory of relativity explains the connection between the concepts of space and time and physical phenomena. The idea, which had a big impact on both domains, was born out of the contradictions between electromagnetic and Newtonian physics. The first historical concern was whether it was pertinent to discuss motion in terms of the "ether" that carries electromagnetic waves and if it was feasible to detect such motion, as the Michelson–Morley experiment unsuccessfully sought to do. Both of these questions and the concept of ether were refuted by Einstein in his special theory of relativity. However, his basic formulation does not incorporate entire electromagnetic theory. "What is time?" is the first question it poses. "Absolute, true, and mathematical time, by itself and from its own nature, runs equably without connection to anything external," was Newton's straightforward and mathematical explanation in the Principia (1686).[194] This definition is basic to all classical physics.

When the bright Einstein challenged it, he found it to be deficient. Instead, two observers travelling in relation to each other will have separate time scales, and each "observer" must use their own time scale. This has a comparable effect on position measurements. Space and time become concepts that are fundamentally dependent on the observer. Each observer controls their own space-time framework or coordinate system. Since there is no absolute frame of reference, each witness of a given event provides a unique measurement that is yet equally legitimate (and reconcilable). According to Einstein's relativity postulate, "the basic rules of physics are same for two observers who have a constant relative velocity with regard to each other," which establishes what is absolute. The discovery of "Poincaré symmetry," a new symmetry law of nature that replaced "Galilean symmetry," by special relativity had a profound effect on physics. It started off as a revision of the electromagnetic theory.'[195] Another long-lasting impact on dynamics was special relativity.[196] It quickly became evident that relativistic dynamics distinguishes between rest mass, an invariant (observer-independent) feature of a particle or system of particles, and the energy and momentum of a system, despite its original credit for combining mass and energy. [197] The latter two are not invariant between observers, although they are preserved independently in every situation. The definition of "mass" in particle physics has changed over time; since the late 20th century, it almost always refers to rest mass. Therefore, the part of an object's or system's total mass that is unaffected by the system's overall motion is known as invariant mass, rest mass, intrinsic mass, proper mass, or simply mass in the context of bound systems. In particular, it is a characteristic of the

[190] https://www.instagram.com/p/DUGN-M0ifcd/, accessed on 03 Feb 2026
[191] Mermin, N. David (2009). It's about time: understanding Einstein's relativity (Sixth printing, and first paperback printing ed.). Princeton, NJ and Oxford: Princeton University Press. ISBN 978-0-691-14127-5, accessed on 03 Dec 2025
[192] Peres, Asher; Terno, Daniel R. (6 January 2004). "Quantum information and relativity theory". Reviews of Modern Physics. 76 (1): 93–123, doi:10.1103/RevModPhys.76.93, accessed on 03 Feb 2026
[193] Goody, R. M.; Yung, Y. L. (1989). Atmospheric Radiation: Theoretical Basis (2nd ed.). Oxford University Press. ISBN 978-0-19-510291-8, accessed on 03 Dec 2025
[194] https://www.britannica.com/topic/Principica, accessed on 03 Feb 2026
[195] https://www.feynmanlectures.caltech.edu/I_52.html, accessed on 03 Dec 2025
[196] Greenwood, D.T. (1997). Classical Dynamics. Dover books on mathematics. Dover Publications. ISBN 978-0-486-69690-4, accessed on 03 Dec 2025
[197] Flego, Silvana; Plastino, Angelo; Plastino, Angel Ricardo (2011-12-20). "Information Theory Consequences of the Scale-Invariance of Schröedinger's Equation". Entropy. 13 (12). MDPI AG: 2049–2058, doi:10.3390/e13122049, accessed on 03 Feb 2026

system's total momentum and energy that holds true for all frames of reference connected by Lorentz transformations.[198] The invariant mass is equal to the entire mass in the "rest frame" if the system has a center-of-momentum frame. In the end, the system's total or relativistic mass is more than the invariant mass, but the invariant mass doesn't change.[199]

After expanding this to include all states of motion, including non-uniform acceleration, Einstein created the general theory of relativity in 1916. The gravitational force at every point in space was explained by the curvature of space-time, a new concept that Einstein presented in this theory. The curvature of space-time replaced Newton's universal rule of gravity. Einstein claimed that the manifestation of gravitational force in the traditional sense is caused by the geometry of space. The curvature of space-time caused by the existence of a mass determines the space-time path that all freely moving objects take.[200] Additionally, experiments supported this theory's prediction that gravity would have an impact on light. This aspect of relativity explained the characteristics of the cosmic microwave background radiation, predicted black holes, and explained the phenomena of light bending around the sun. This discovery led to serious problems with the conventional Steady-State paradigm.[201] For his contributions to blackbody radiation, relativity, and the photoelectric effect, Einstein received the Nobel Prize in 1921. The ultimate acceptance of Niels Bohr's model of the atom, Einstein's theories of relativity, and the quantized nature of light transmission led to a thorough endeavor to rebuild physics on new fundamental principles, which created as many problems as they addressed.[202] Extending relativity to accelerating reference frames in the 1910s gave rise to the "general theory of relativity."[203] In order to conclude that space is curved and limited in size, Einstein proposed an equivalence between the inertial force of acceleration and the force of gravity. This led to the prediction of phenomena like gravitational lensing and the distortion of time in gravitational fields.[204] Therefore, anything that bends light from a distant source as it moves towards an observer—such as a point particle or a cluster of galaxies—is known as a gravitational lens. Albert Einstein's general theory of relativity describes the magnitude of gravitational lensing.[205]

A second theoretical issue was how to explain the distribution of electromagnetic radiation emitted by a black body, even though relativity resolved the conflict between electromagnetic phenomena as shown by Michelson and Morley. Experiments revealed that at shorter wavelengths, towards the ultraviolet end of the spectrum, the energy approached zero, but classical theory predicted it should become infinite. The new theory of quantum mechanics resolved this stark disparity, sometimes referred to as the ultraviolet disaster.[206] The theory of atoms and subatomic systems is known as quantum mechanics. The idea was conceived and developed over the first thirty years of the twentieth century. By arguing that energy is released in discrete packets known as "quanta" rather than continually, Max Planck (1858–1947) presented the fundamental concepts of quantum theory in 1900.[207] This groundbreaking research on black-body radiation established the groundwork for contemporary quantum mechanics and resolved a significant physics issue. For his discovery, he received the 1918 Nobel Prize in Physics. Planck's constant h, a basic constant that connects a quantum's energy to its frequency ($E=h\nu$), was first presented by his work.[208] When Louis de Broglie claimed that matter may be seen as acting like a wave in a manner similar to that of electromagnetic waves (wave–particle duality) and the Compton Effect demonstrated that light has velocity and can scatter off particles, the quantum theory gained acceptance.[209]

The photoelectric phenomenon was explained by Einstein in 1905 using the quantum theory, while the stability of Rutherford's atom and the light frequencies

[198] https://books.google.com.bd/books?id=Nv5GAyAdijoC&pg=PA1073&redir_esc=y#v=onepage&q&f=false,

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[208] https://www.nist.gov/physics/explainers/planck-constant, accessed on 03 Dec 2025

[209] Wittke, J.P; Dicke, R.H (June 1, 1961) [1960]. "11". In Holladay, W.G. (ed.). Introduction to Quantum Mechanics (eBook). Vol. 16. Nashville, Tennessee: ADDISON WESLEY LONGMAN INC (published January 1, accessed on 03 Dec 20251978). p. 10. doi:10.1063/1.3057610. ISBN 978-0-201-01510-2, accessed on 03 Feb 2026

emitted by hydrogen gas were explained by Danish scientist Niels Bohr in 1913 using the same constant.[210] In the 1920s, full-scale quantum mechanics replaced the quantized theory of the atom. In 1925, Werner Heisenberg, Max Born, and Pascual Jordan developed new principles of "quantum" rather than "classical" mechanics in matrix form. These principles rejected the idea of causality and were based on the probabilistic link between discrete "states".[211] Heisenberg, Wolfgang Pauli, Paul Dirac, and Erwin Schrödinger developed quantum mechanics in great detail. In 1926, Schrödinger proposed an analogous theory based on waves.[212],[213] Once again, the "Copenhagen interpretation" and Heisenberg's 1927 "uncertainty principle," which states that it is impossible to measure position and momentum exactly and simultaneously [214] of quantum mechanics (named after Bohr's hometown) persisted in rejecting the idea of basic causality, despite the fact that detractors like Einstein would figuratively claim that "God does not play dice with the universe."[215] In order to study and explain atomic-level occurrences, the new quantum mechanics became an essential instrument. The research on photons conducted by Indian physicist Satyendra Nath Bose in the 1920 [216] Bose-Einstein statistics and the theory of the Bose-Einstein condensate are based on quantum mechanics.[217] Any particle in quantum mechanics may be either a boson (statistically Bose–Einstein) or a fermion (statistically Fermi–Dirac), according to the spin–statistics theorem.[218] All basic bosons, including the photon, which transmits electromagnetism, were eventually discovered to transfer forces. Particles "like electrons and nucleons" are called fermions, and they are often found in matter. Later, Fermi-Dirac statistics were used in many other fields, including as semiconductor design and astronomy.

Classical physics refers to the earlier sciences, while "modern physics" refers to the work based on quantum and relativity theories. This is because of the conceptual differences between the physics theories that were discussed in the 19th century and those that were most historically prominent in the first decades of the 20th century. The split, which was first used to describe "classical mechanics" in mechanics, ultimately came to describe quantum and relativistic phenomena.[219] Physicists like Max Planck and Hendrik Lorentz, well-known scientists who identified problems that conventional theories could not explain, were the first to push this characterization. This division was first proposed as a notion as a result of their participation in and contributions at the 1911 Solvay Conference.[220] The names of several physics textbooks reflect this split. For instance, Goldstein's Classical mechanics prelude shows why physics students might still benefit from studying the subject.[221] Arthur Beiser begins Concepts of contemporary Physics by defining contemporary physics as follows: Max Planck's discovery of the energy quantization component of blackbody radiation in 1900 marked the beginning of modern physics. Albert Einstein's equally groundbreaking theories of relativity and quantum theory of light came shortly after.[222] A few chapters on the shortcomings of classical physics open Kenneth Krane's Modern Physics, a book on quantum and relativity ideas.[223] The Classical Theories in book one and The Modern Theories in volume two of E.T. Whittaker's two-volume History of the Theories of Aether and Electricity (1900–1926) are subtitled.[224]

Paul Dirac's 1928 formulation of a relativistic quantum theory was the first of many quantum theories developed as the philosophically minded continued to dispute the underlying nature of the cosmos.[225] However, theoretical formulations that produced limitless

[210] Bohr, N. (1928). "The Quantum Postulate and the Recent Development of Atomic Theory". Nature. 121 (3050): 580–590. Bibcode:1928Natur. 121..580B. doi:10.1038/121580a0, accessed on 03 Dec 2025

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[216] Wali, Kameshwar C (2009), Satyendra Nath Bose: his life and times (selected works with commentary), Singapore: World Scientific, ISBN 978-981-279-070-5, accessed on 03 Feb 2026

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[222] Beiser, Arthur (2003). Concepts of modern physics (International ed., 6. ed.). Boston: McGraw-Hill. ISBN 978-0-07-244848-1, accessed on 03 Feb 2026

[223] Krane, Kenneth S. (2020). Modern physics (4 ed.). Hoboken, New Jersey: John Wiley & Sons, Inc. ISBN 978-1-119-49548-2, accessed on 03 Dec 2025

[224] Whittaker, Edmund T. (1989). A history of the theories of aether & electricity. 2: The modern theories, 1900 - 1926 (Repr ed.). New York: Dover Publ. ISBN 978-0-486-26126-3, accessed on 03 Feb 2026

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energies hampered efforts to fully quantize electromagnetic theory into the 1930s. Only after World War II, when Julian Schwinger, Richard Feynman, and Sin-Itiro Tomonaga independently proposed the renormalization approach, which made it possible to build a robust quantum electrodynamics (QED), was this issue deemed sufficiently overcome.[226] As the concept of the quantization of fields through "exchange forces" governed by an exchange of transient "virtual" particles—which were permitted to exist in accordance with the laws governing the uncertainties inherent in the quantum world—grew in popularity, new theories of fundamental particles proliferated.[227] The uncertainty principle limits the existence of virtual particles, which are theoretical transitory particles that have some of the properties of conventional particles but may spontaneously originate from vacuum at short time and space ranges.[228] Notably, Hideki Yukawa postulated that a particle with a mass between that of the electron and the proton mediated a strong but short-range force that held the nucleus' positive charges together.[229] This particle, known as the "pion," was discovered in 1947 as one of several particles that were found after World War II. These particles were first discovered to be ionising radiation left by cosmic rays, but they are now increasingly being created in more advanced and potent particle accelerators.[230]

The development of the laser, which won the 1964 Nobel Prize in Physics, was one of the major breakthroughs of the era outside of particle physics.[231] Additionally, the study of superconductivity both theoretically and experimentally, particularly the development of a quantum theory of superconductivity by Vitaly Ginzburg and Lev Landau, which won the 1962 Nobel Prize in Physics, and its subsequent explanation via Cooper pairs (1972 Nobel Prize in Physics).[232] One of the first instances of quasiparticles was the Cooper pair. According to Einstein, a single theory can account for all of the basic interactions in nature.[233] Several efforts to "merge" multiple interactions resulted in unified field theories. A gauge theory, which is a generalization of the concept of symmetry, is one of many formulations of such theories.[234] At last, the unification of strong, weak, and electromagnetic interactions was achieved by the Standard Model.[235] Every effort to combine gravity with another force was unsuccessful. In her experiment, "Chien-Shiung Wu" shattered parity in weak interactions,[236] a series of discoveries were created thereafter.[237] New basic quantum theories were made possible by the interaction of these particles via decay and scattering. These new particles were given some order by Murray Gell-Mann and Yuval Ne'eman, who categorized them based on a number of characteristics, starting with what Gell-Mann called the "Eightfold Way."[238],[239] While its further development, the quark model,[240] at first seemed inadequate to describe strong nuclear forces,[241] The development of quantum chromodynamics in the 1970s finalised a set of basic and exchange particles, permitting the brief emergence of rival theories such the S-Matrix,[242] It made it possible to create a "standard model" based on

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gauge invariance mathematics that effectively explained all forces save gravitation and is still widely used in its field.[243],[244]

The Standard Model, based on the ‘Yang–Mills theory’[245] groups the ‘electroweak interaction theory’[246] and quantum chromodynamics into the "gauge group" structure.[247] Abdus Salam, Steven Weinberg, and Sheldon Glashow are credited for formulating the standard model's unification of the electromagnetic and weak interactions.[248] Neutral weak currents were subsequently seen in experiments to validate the electroweak hypothesis,[249],[250] and distinguished by the 1979 Nobel Prize in Physics. Fundamental particle physics, especially the Big Bang idea put out as a result of Einstein's general theory of relativity, has shed light on the early universe's cosmology since the 1970s.[251],[252] But since the 1990s, astronomical discoveries have also presented new problems, such the need for fresh theories on galaxy stability, or "dark matter," and the apparent acceleration of the universe's expansion, or "dark energy."[253],[254] Though many theorists thought that supersymmetry and string theory would be a promising path forward, no theory that reconciles general relativity with the Standard Model has yet been discovered, despite the fact that accelerators have confirmed most aspects of the Standard Model by detecting expected particle interactions at various collision energies. The way these threads move across space and communicate with one another is explained by string theory.[255] A string behaves as a particle on distance scales greater than the string scale; its vibrating state determines its mass, charge, and other characteristics. According to string theory, the graviton, a quantum mechanical particle that conveys the gravitational pull, is one of the string's many vibrational states.[256] As a result, string theory is a quantum gravity theory.[257] However, since it started running in 2008, the Large Hadron Collider has not discovered any evidence in favour of supersymmetry or string theory.[258]

After Einstein's General Theory of Relativity was published in 1915, cosmology could be considered a serious study subject, but it wasn't until the "Golden age of general relativity" that it became widely accepted in science.[259] Edwin Hubble and Vesto Slipher discovered the expansion of the universe in the 1920s by measuring the redshifts of Doppler spectra from galactic nebulae, around ten years later, during what was known as the "Great Debate."[260],[261] The Big Bang hypothesis was developed by Georges Lemaître and George Gamow using Einstein's general relativity.[262] Fred Hoyle, Thomas Gold, Jayant Narlikar, and Hermann Bondi developed a competing hypothesis known as the steady

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[262] Ryden, Barbara (17 November 2016). Introduction to Cosmology (2 ed.). Cambridge University Press. doi:10.1017/9781316651087. ISBN 978-1-107-15483-4, accessed on 02 Dec 2025

state theory.[263] In the 1960s, Robert Woodrow Wilson and Arno Allan Penzias confirmed the existence of cosmic microwave background radiation, which supported the big bang theory over the steady state theory.[264] Among others, George Smoot et al. (1989) used data from the Cosmic Background Explorer (CoBE) in their later work,[265] and these findings were improved by the Wilkinson Microwave Anisotropy Probe (WMAP) satellites.[266] Alan Guth proposed inflation theory in the 1980s, the same decade as the COBE data. Dark energy and dark matter issues have recently taken center stage on the cosmological agenda.[267]

On July 4, 2012, scientists at the Large Hadron Collider at CERN [268] declared the discovery of a new subatomic particle that closely resembles the Higgs boson. This particle might be crucial to explaining the existence of variety and life in the cosmos as well as the reason why elementary particles have mass.[269] It is now referred to by some physicists as a "Higgslike" particle. "It's something that may, in the end, be one of the biggest observations of any new phenomena in our field in the last 30 or 40 years, going way back to the discovery of quarks, for example," said Joe Incandela of the University of California, Santa Barbara.[270] "This is a big moment for particle physics and a crossroads – will this be the high water mark or will it be the first of many discoveries that point us towards solving the really big questions that we have posed," stated Michael Turner, a cosmologist at the University of Chicago and chairman of the physics center board.'[271] The concept of the Higgs field (also known as "cosmic molasses") was created in 1964 by six scientists, including Peter Higgs, who worked in three separate groups. Higgslike fields are crucial to string theory and universe theories, despite the fact that they have never been seen.[272] They may get infused with energy that exerts an antigravitational force under certain circumstances, according to the peculiar accounting of Einsteinian physics. These fields have been suggested as the origin of the universe's early inflation, a massive expansion, and as the source of the dark energy that seems to be speeding up the universe's expansion today.[273]

The basic physical theory that explains how matter and light behave is called quantum mechanics; its peculiar properties usually arise at and below the size of atoms.[274] A key component of the history of contemporary physics is the development of quantum mechanics. The creation of quantum concepts to describe specific phenomena, such as solar emission spectra, blackbody radiation, and the photoelectric effect, marks the beginning of the main chapters of this history. This period is known as the "old" or "older" quantum theories.[275] A number of experimental discoveries of atoms that didn't make intuitive sense within the framework of classical physics gave rise to the discipline of quantum physics in the late 1800s and early 1900s. The understanding that matter and energy may be seen as discrete packets, or quanta, having a minimum value attached to them was one of the fundamental discoveries.[276] For instance, energy is delivered by light with a defined frequency in quanta known as "photons." At this frequency, the energy of each photon will be the same and cannot be divided into smaller units.[277] Actually, the Latin origin of the term "quantum" means "how much." Understanding quantum principles changed how we

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275 Whittaker, Edmund T. (1989). A history of the theories of aether & electricity. 2: The modern theories, 1900 - 1926 (Repr ed.). New York: Dover Publ. ISBN 978-0-486-26126-3, accessed on 02 Dec 2025

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thought about the atom, which is made up of an electron-surrounded nucleus.[278] According to early theories, electrons were particles that orbited the nucleus in a manner similar to that of satellites orbiting the Earth. Instead, electrons are understood by modern quantum physics to be dispersed inside orbitals, which are mathematical representations of the likelihood that electrons will reside in several locations within a particular range at any given moment.[279] When an electron gains or loses energy, it may move from one orbital to another, but it cannot be located in between orbitals. A few key ideas contributed to the development of quantum physics' foundations:

➢ Wave-particle duality: Matter and energy, like electrons and light, may have both particle-like and wave-like characteristics. In processes like interference and diffraction, light acts like a wave; but, in other situations, like the photoelectric effect, which includes discrete energy packets, light behaves like a particle.[280] According to Louis de Broglie, the concept also applies to matter, which has a wave character.[281],[282] This idea has existed since the beginning of quantum research. It explains the results of studies that demonstrated that matter and light had either particle or wave characteristics, depending on how they were measured. We now know that these many types of energy are neither particles nor waves. They are unique quantum entities that are difficult for us to imagine.

➢ Superposition: Imagine touching a pond's surface simultaneously at two distinct locations. From each point, waves would radiate outward and eventually overlap to create a more intricate design. This is a wave superposition. Similar to this, in quantum physics, particles with wavelike characteristics, like electrons and photons, may combine to form what is known as superposition. This phrase refers to an item that is simultaneously a composite of many different states. A ripple on a pond's surface, which is the result of two waves overlapping, is comparable to a superposed item. In mathematics, an equation with several solutions or outcomes may be used to describe an object in superposition.[283]

➢ Uncertainty principle: A key idea in quantum physics is the uncertainty principle, which asserts that there is a limit to how accurately certain pairs of physical attributes, such as location and momentum, may be known at the same time.[284] This implies that you can determine a particle's momentum less accurately the more exactly you know its location, and vice versa. This idea is not the product of faulty measuring instruments, but rather an inherent characteristic of nature.[285] It is a mathematical idea that shows a trade-off between opposing viewpoints. This indicates that two characteristics of an item, such its location and velocity, cannot be accurately determined simultaneously in physics.[286] For instance, we can only determine an electron's speed to a certain extent if we measure its location correctly.[287]

Entanglement: refers to a quantum phenomenon in which, independent of their distance from one another, two or more particles become connected and have entangled features.[288] Faster-than-light communication is not possible, yet measuring one entangled particle's property instantly affects the other's corresponding property. In a broader context, "entanglement" may also mean being fully immersed in a challenging or complicated circumstance.[289] This phenomenon happens when two or more items, even if they are extremely far away, are linked in a manner that allows them to be considered as a unified system. It is impossible to properly explain the state of one item in that system without knowing the state of the other.[290] Similarly, discovering details about one item often reveals something about another, and vice versa.[291]

It is somewhat honest for a guy on Earth to determine the location and speed of a moving object. We can instantly determine the location of items by measuring an automobile moving at 100 km/h or a person strolling

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278 Heisenberg, W. (1930), Physikalische Prinzipien der Quantentheorie (in German), Leipzig: Hirzel English translation The Physical Principles of Quantum Theory. Chicago: University of Chicago Press, 1930, accessed on 03 Feb 2026

279 https://www.cantorsparadise.com/mathematical-uncertainty-principles-d45134b10e4d, accessed on 02 Dec 2025

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284 https://www.britannica.com/science/uncertainty-principle, accessed on 02 Dec 2025

285 Sen, D. (2014). "The Uncertainty relations in quantum mechanics" (PDF). Current Science. 107 (2): 203–218. Archived (PDF) from the original on 2019-09-24, accessed on 02 Dec 2025

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287 https://www.youtube.com/watch?v=MBnnXbOM5S4, accessed on 03 Feb 2026

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289 Horodecki, Ryszard; Horodecki, Pawel; Horodecki, Michal; Horodecki, Karol (2009). "Quantum entanglement". Reviews of Modern Physics. 81 (2): 865–942. arXiv:quant-ph/0702225. Bibcode:2009RvMP...81..865H. doi:10.1103/RevModPhys.81.865, accessed on 02 Dec 2025

290 https://scienceexchange.caltech.edu/topics/quantum-science-explained/entanglement, accessed on 03 Feb 2026

291 Holland, Connor M.; Lu, Yukai; Cheuk, Lawrence W. (8 December 2023). "On-demand entanglement of molecules in a reconfigurable optical tweezer array". Science. 382 (6675): 1143–1147, doi:10.1126/science.adf4272, accessed on 03 Feb 2026

at 9 km/h. However, a basic mathematical property known as the uncertainty principle makes these computations impossible in the quantum world of particles. According to the widely accepted Copenhagen interpretation, quantum systems live in a superposition of possibilities until they are measured. Since just one result is chosen at random at the time of measurement, the precise future is unclear.[292] Interestingly, German physicist and Nobel laureate Werner Heisenberg showed in 1927 that the inability to precisely know some combinations of properties simultaneously, such a particle's position and momentum, further limits overall prediction.[293] To put it another way, if a person were reduced to the size of an electron, we could only accurately ascertain its position or speed, not both at once. Although the Heisenberg uncertainty principle is well recognized in quantum physics, issues in pure mathematics and conventional physics also follow a similar concept. This idea basically applies to any object that has wave-like properties. Because of the nature of quantum mechanics theory, quantum objects are special because they naturally exhibit wave-like characteristics.[294] The area of study that studies matter and energy at the most fundamental level is called quantum physics. Its objective is to comprehend the characteristics and actions of the basic components of the natural world.[295]

Figure 4: What will future navigation and reality look like296

Consider a ripple in a pond to understand the fundamental idea of the uncertainty principle. You would follow a number of passing peaks and troughs to gauge its pace. Your understanding of the wave's speed will improve with the number of peaks and troughs you track, but your ability to pinpoint its precise location will diminish as it is scattered across those peaks and troughs. On the other hand, you would only need to watch a tiny portion of the wave in order to identify the location of a single peak, giving up information about its speed. The uncertainty principle essentially emphasizes a trade-off between two related qualities, such as location and speed. Another comparison is a roller-coaster: when the automobile reaches the top of a hill, a picture can reveal its location but not its speed; as it descends the hill, speed can be measured but its precise location is less definite. The idea shows how to balance two complementing factors, such location and speed.[297] Because subatomic particles may behave like waves, the basic law is applicable in the quantum domain. The uncertainty principle in quantum physics is often misunderstood to imply that our measurements are imprecise or uncertain.[298] In actuality, every event exhibiting wave-like behavior is fundamentally characterized by uncertainty.[299]

4. Investigation of Different Concept of Modern Science and Uncertainty

4.1 Einstein's Special Theory of Relativity and the Block Universe. Two events that seem simultaneously to one observer may not occur simultaneously to another observer travelling at a different speed, according to a fundamental tenet of special relativity. This is due to the fact that, regardless of an observer's motion, the speed of light remains constant. The theory

[292] Sen, D. (2014). "The Uncertainty relations in quantum mechanics" (PDF). Current Science. 107 (2): 203–218. Archived (PDF) from the original on 2019-09-24, accessed on 13 Oct 2025

[293] Werner Heisenberg (1989), Encounters with Einstein and Other Essays on People, Places and Particles, Princeton University Press, p. 53, accessed on 03 Feb 2026

[294] http://www.physics.udel.edu/~bnikolic/teaching/phys624/lectures/what_is_solid_state_physics.pdf, accessed on 13 Oct 2025

[295] https://scienceexchange.caltech.edu/topics/quantum-science-explained/quantum-physics, accessed on 03 Feb 2026

[296] https://www.facebook.com/groups/virtualrealitys/posts/1777999482292708/, accessed on 02 Feb 2026

[297] https://www.zmescience.com/feature-post/pieces/heisenberg-uncertainty-principle-095235/, accessed on 03 Feb 2026

[298] https://www.livescience.com/50776-thermodynamics.html, accessed on 03 Feb 2026

[299] https://scienceexchange.caltech.edu/topics/quantum-science-explained/uncertainty-principle, accessed on 13 Oct 2025

unifies space and time into a single, four-dimensional continuum known as spacetime in order to reconcile the perspectives of many observers. By fusing space and time into a single, four-dimensional entity known as space-time, Einstein's special theory of relativity completely changed our understanding of both concepts. The idea of the "block universe" resulted from this. Because of this, all earthly events—past, present, and future—exist concurrently and forever as components of a fixed continuum. According to this perspective, time exists all at once, just like space, rather than flowing.[300] The relativity of simultaneity, which means that various observers may disagree about what is occurring right now based on their relative velocities, is a crucial consequence. The philosophical concept of eternalization, which holds that every instant in time is equally real, is therefore supported by the collapse of the idea of a globally shared "present."[301] Determinism is implied by the block universe as the future seems to be regulated by the same unchangeable laws of physics as the past.[302] Determinism is implied by the block universe as the future seems to be regulated by the same unchangeable laws of physics as the past.[303] This idea, which implies a deterministic cosmos in which every occurrence is already "there" in spacetime, has significant philosophical ramifications.

4.2 Determinism Versus Indeterminism in Relativity. If a theory can only have one conceivable future conclusion given all beginning circumstances and the rules of physics, it is said to be deterministic.[304] Special relativity theory is completely deterministic as it deals with spacetime in an inertial (non-accelerating) context. By guaranteeing that all witnesses agree on the order of cause-and-effect occurrences, it supports the notion of causality. In addition to being locally deterministic—that is, given enough knowledge in a region of spacetime, its immediate future is uniquely determined—General Relativity (GR) defines gravity as the curvature of spacetime.[305] The fundamental equations of the theory are deterministic Einstein Field Equations. Accordingly, relativity proposes a deterministic cosmos in which the whole timeline—including the future—is fixed and preset. But this raises a question: can the future be really open if relativity reflects the large-scale cosmos accurately? We must go to quantum mechanics, which adds true indeterminacy to physical law, to overcome this conflict between determinism and an open future.[306] The theory predicts singularities, when the equations break down and predictability is lost, such those at the core of black holes or the Big Bang. It is generally accepted that a theory of quantum gravity must ultimately replace classical general relativity as it is inaccurate in these extreme circumstances. A boundary known as a Cauchy horizon may emerge in certain particular, but potentially unphysical, solutions to the equations (such as some charged black holes). A failure of determinism is shown by the possibility of various potential futures arising from the same basic circumstances beyond this horizon.[307] The spacetime must be "globally hyperbolic" in order to provide global determinism, in which a whole "now" slice of spacetime determines the entire future of the universe. However, this attribute is absent from many intriguing GR solutions, suggesting that determinism could not be a universal feature in all potential relativistic worlds.

4.3 Quantum Mechanics and the Indeterminacy of Reality. In contrast to classical determinism, quantum mechanics describes systems in terms of wave functions, which store probability for every potential event rather than specific values. Quantum systems exist in superposition—a composite of all conceivable states—prior to measurement.[308] Measurement yields a single result, but it is only possible to anticipate the outcome probabilistically rather than deterministically. Numerous experiments have confirmed this fundamental aspect of quantum physics.[309] Wave function collapse, the process by which the probabilistic wave function simplifies to a single conclusion, remains one of the most enigmatic aspects of quantum theory. Determining whether the future is fixed or open requires an understanding of whether this collapse is genuine and what causes it. By claiming that a system's attributes are not definite until measured and that results are dictated by probability distributions rather than strict causality, quantum mechanics introduces the indeterminacy of reality.[310] This idea, also referred to as the uncertainty principle or quantum indeterminacy, states that even with full knowledge of a quantum state (its wavefunction), one can only forecast the probability of various possibilities. This basic uncertainty casts doubt on classical determinism and suggests that nature is fundamentally probabilistic and subject to observation at the subatomic level.

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[300] https://iai.tv/articles/einstein-and-the-block-universe-auid-2065, accessed on 03 Feb 2026

[301] Einstein, Albert; Podolsky, Boris; Rosen, Nathan (1935). "Can Quantum-Mechanical Description of Physical Reality Be Considered Complete?". Phys. Rev. 47 (10): 777–780, doi:10.1103/PhysRev.47.777, accessed on 03 Feb 2026

[302] https://www.informationphilosopher.com/freedom/special_relativity.html, accessed on 02 Dec 2025

[303] https://goldennumberratio.medium.com/the-block-universe-interpretation-of-einsteins-relativity-spacetime-is-wrong-224cd9a038a5, accessed on 03 Feb 2026

[304] https://inters.org/determinism-indeterminism, accessed on 03 Feb 2026

[305] https://www.quora.com/What-is-the-difference-between-indeterminism-and-determinism-Which-do-physicists-believe-is-true-of-our-world, accessed on 02 Dec 2025

[306] https://medium.com/neo-cybernetics/determinism-and-indeterminism-b1e3a58b548f, accessed on 02 Dec 2025

[307] James, William. "The Dilemma of Determinism." In The Will to Believe and Other Essays in Popular Philosophy and Human Immortality. New York: Dover Publications, 1956, accessed on 03 Feb 2026

[308] Jaeger, Gregg (September 2014). "What in the (quantum) world is macroscopic?". American Journal of Physics. 82 (9): 896–905. Bibcode:2014AmJPh. 82..896J. doi:10.1119/1.4878358, accessed on 03 Feb 2026

[309] Bialynicka-Birula, Zofia (2009), "Why photons cannot be sharply localized", Physical Review A, 79 (3): 7–8, doi:10.1103/PhysRevA.79.032112, accessed on 03 Feb 2026

[310] https://thequran.love/2025/03/11/quantum-indeterminacy-how-quantum-mechanics-introduces-true-indeterminism-and-creates-free-will/#:~:text=, accessed on 03 Feb 2026

Probabilities take the role of classical certainty in quantum mechanics. For instance, the wavefunction simply gives a chance for when a radioactive atom could decay; the precise time is not known.[311] The measuring process is essential because it affects a particle's state by "collapsing" its wavefunction from a superposition of possibilities into a single, certain result. Intrinsic uncertainty is a characteristic of quantum systems and is not caused by measurement mistake or external influence. For example, the Kochen-Specker theorem shows that all measurable attributes of a quantum state cannot have sharp, definite values at the same time. Classical determinism, which maintains that all occurrences are foreseeable given sufficient knowledge about the system's starting state, is essentially challenged by challenge to determinism theory. According to quantum indeterminacy, reality is regulated by chance within the confines of those probabilities rather than being preset at its most basic level.[312] Although quantum indeterminacy is a fundamental idea, other interpretations try to explain its meaning. One such interpretation is that every quantum event splits the cosmos into several branches, each of which exists in a distinct reality.[313] Additionally, it implies that a kind of objective, spontaneous collapse takes place without the need for observation. So, the exact nature of quantum indeterminacy and its metaphysical implications (whether it represents a true indeterminacy in reality or is merely a limitation of our knowledge) remains a topic of ongoing discussion among physicists and philosophers.[314]

[311] https://fiveable.me/key-terms/principles-of-physics-iv/quantum-indeterminacy,

[312] https://pmc.ncbi.nlm.nih.gov/articles/PMC7517274/, accessed on 02 Dec 2025

[313] https://arxiv.org/abs/quant-ph/0012007, accessed on 03 Feb 2026

[314] https://www.researchgate.net/publication/232968685_Quantum_Mechanics_and_Metaphysical_Indeterminacy,

Figure 5: Quantum physics and prove parallel is it fact or fiction315

4.4 The Copenhagen Interpretation and Non-Determinism. Quantum mechanics (QM), not relativity, is the primary cause of indeterminism in contemporary physics. The traditional Copenhagen interpretation of QM holds that the results of quantum measurements are essentially random and independent of past occurrences. In order to give a more comprehensive understanding of determinism in the cosmos, theoretical physics is now working to unify these two pillars of contemporary research into a single theory of quantum gravity.[316] The philosophical ramifications of this scientific determinism on ideas like free will may be investigated.[317] One of the earliest and most extensively taught interpretations of quantum physics is the Copenhagen interpretation. According to this theory, a quantum system stays in superposition until a measurement is conducted, at which time the wave function collapses to a single, definitive result. This adds a basic element of randomness to the cosmos, which means that even with perfect knowledge of the present, it is impossible to forecast the future with confidence. But when mixed with relativity, this creates problems. Observers may disagree on whether the wave function of a certain event has already collapsed because they may perceive simultaneity differently. This disparity shows how difficult it is to reconcile quantum collapse with relativistic space-time and casts doubt on the notion of a universally accepted reality.[318]

[315] https://vocal.media/01/fact-or-fiction-could-quantum-physics-prove-parallel-universes, accessed on 02 Dec 2025

[316] Bishop, Robert. C. and Kronz, Frederick M. "Is Chaos Indeterministic?" In Language, Quantum, Music: Selected Contributed Papers of the Tenth International Congress of Logic, Methodology & Philosophy of Science, Florence, August 1995. Edited by Maria Luisa Dalla Chiara, Roberto Giuntini and Federico Laudisa. Boston: Kluwer Academic Publishers, 1999, accessed on 03 Feb 2026

[317] Smith, Leonard A. "Disentangling Uncertainty and Error: On the Predictability of Nonlinear Systems." In Nonlinear Dynamics and Statistics. Edited by A. I. Mees. Boston: Birkäuser, 2001, accessed on 03 Feb 2026

[318] Hossain K A, (2026), Quantum Foundations and Technological Futures: A Critical Analysis of Interpretative Frameworks and Socio-Economic Projections, Transactions on Engineering and Computing Sciences; Vol. 14 No. 01; 2026, pp 59-118; https://doi.org/10.14738/tmlai.1401.19883, ISSN: 2756-2638, accessed on 02 Feb 2026

Figure 6: Copenhagen vs Many Worlds Interpretation of Quantum Mechanics319

4.5 The Many-Worlds Interpretation and Determinism Restored. By suggesting that every potential result of a quantum event really takes place in distinct, parallel worlds, the Many-Worlds Interpretation (MWI) restores determinism. The global wavefunction, which develops deterministically in accordance with the Austrian physicist Schrödinger equation, instead of a single world collapsing into a single result,[320] just divides into many separate, non-interacting branches (worlds). The development of the multiverse as a whole is completely predictable and deterministic, yet from the viewpoint of an observer inside any one universe, the result seems random. A probabilistic "collapse" of the wave function, which is essential to the Copenhagen interpretation of quantum mechanics, is avoided by the MWI.[321] Once again, the wave function keeps evolving rather than collapsing. The wave function branches as a result of the observer being entangled with the system during a measurement or interaction. Each branch, however, stands for a distinct potential measurement result. In Schrödinger's cat, for instance, the world divides into two parts: one where the cat is alive and the other where it is dead. The Schrödinger equation governs the singular, deterministic process of the multiverse's whole development.[322] However, the result seems random from the viewpoint of a single observer inside one branch.[323] Because their own wave function is entangled with the measurement result, an observer can only ever perceive one of the possible outcomes.[324] Consequently, the MWI presents a bold but sophisticated alternative: it completely rejects the wave function's collapse. Instead, it suggests that all possible outcomes of a quantum event occur, each in its own parallel branch of the universe. The Schrödinger equation describes the deterministic evolution of the wave function, and every potential outcome is realised in some branch.[325] While all other versions of themselves experience different results, observers get entangled with these branches and encounter just one result. The cosmos is completely deterministic from a global standpoint, with all branches coexisting. Since the branching respects causal bounds like the speed of light, this interpretation is consistent with Einstein's relativity. However, since they only live in one branch, spectators see randomness from a subjective perspective.[326] Here, we have discovered that randomness is a result of our constrained viewpoint inside a particular branch rather than a basic aspect of reality.[327] Last but not least, this deterministic perspective results from acknowledging the universal wave function as physically

[319] https://www.youtube.com/watch?v=OjrEudqgZ1M, accessed on 02 Dec 2025

[320] Schrödinger, E. (1926). "An Undulatory Theory of the Mechanics of Atoms and Molecules" (PDF). Physical Review. 28 (6): 1049–70, doi:10.1103/PhysRev.28.1049. Archived from the original, accessed on 03 Feb 2026

[321] Everett, Hugh; Wheeler, J. A.; DeWitt, B. S.; Cooper, L. N.; Van Vechten, D.; Graham, N. (1973). DeWitt, Bryce; Graham, R. Neill (eds.). The Many-Worlds Interpretation of Quantum Mechanics. Princeton Series in Physics. Princeton, New Jersey: Princeton University Press. p. v. ISBN 0-691-08131-X, accessed on 03 Feb 2026

[322] Tegmark, Max (1998). "The Interpretation of Quantum Mechanics: Many Worlds or Many Words?". Fortschritte der Physik. 46 (6–8): 855–862. arXiv:quant-ph/9709032. Bibcode:1998ForPh. 46..855T. doi:10.1002/(SICI)1521-3978(199811)46:6/8<855::AID-PROP855>3.0.CO;2-Q, accessed on 03 Feb 2026

[323] Brown, Harvey R.; Christopher G. Timpson (2016). "Bell on Bell's Theorem: The Changing Face of Nonlocality". In Mary Bell; Shan Gao (eds.). Quantum Nonlocality and Reality: 50 years of Bell's theorem. Cambridge University Press. pp. 91–123. arXiv:1501.03521. doi:10.1017/CBO9781316219393.008, accessed on 02 Dec 2025

[324] Everett, Hugh (1957). "Relative State Formulation of Quantum Mechanics". Reviews of Modern Physics. 29 (3): 454–462, doi:10.1103/RevModPhys.29.454, accessed on 03 Feb 2026

[325] Schlosshauer, Maximilian; Kofler, Johannes; Zeilinger, Anton (August 2013). "A snapshot of foundational attitudes toward quantum mechanics". Studies in History and Philosophy of Science Part B: Studies in History and Philosophy of Modern Physics, (2013), 44 (3): 222–230, doi:10.1016/j.shpsb.2013.04.004, accessed on 02 Dec 2025

[326] Skyrms, Brian (1976). "Possible Worlds, Physics and Metaphysics". Philosophical Studies. 30 (5): 323–332. doi:10.1007/BF00357930. S2CID 170852547, accessed on 02 Dec 2025

[327] DeWitt, Bryce S. (1970). "Quantum mechanics and reality". Physics Today. 23 (9): 30–35. Bibcode:1970PhT....23i..30D. doi:10.1063/1.3022331. See also Ballentine, Leslie E.; Pearle, Philip; Walker, Evan Harris; Sachs, Mendel; Koga, Toyoki; Gerver, Joseph; DeWitt, Bryce (1971). "Quantum-mechanics debate". Physics Today. 24 (4): 36–44. Bibcode:1971PhT....24d..36.. doi:10.1063/1.3022676, accessed on 02 Dec 2025

real and letting it change in accordance with the basic quantum mechanical equations without the need for further, ad hoc restrictions like wave function collapse.[328]

4.6 Relativity, Decoherence, and the Propagation of Branching. Our comprehension of physical reality was completely transformed by the simultaneous discovery of quantum theory and Einstein's general theory of relativity. The concepts of spacetime and quantum superposition are perhaps the most unique aspects of each of these theories. Finding a coherent way to unify quantum theory with general relativity is the biggest difficulty facing current physicists.[329] Any theory that combines quantum mechanics and relativistic gravitation must unquestionably be able to characterize spacetime as having quantum-mechanical degrees of freedom, whose states exist in a complex Hilbert space and can be arranged in quantum superpositions of various configurations.[330], [331] Branching is not instantaneous across the universe under the Many-Worlds paradigm. Rather, it propagates at or below the speed of light in accordance with relativistic causality. Different realities are defined by entangled webs, which are made up of interrelated quantum events. Here, decoherence is essential because it explains how quantum branches effectively become separated from one another.[332] Each branch exhibits classical behavior as quantum interference between branches diminishes over time. A physical explanation for the change from quantum probability to classical experiences is provided by decoherence.[333] This results in an objective interpretation of the present as the particular entanglement network of which the observer is a member. However, because of the relativity of simultaneity, how each observer perceives "now" varies according on how they move through space-time.[334] This research enhances MWI's reputation as a solid framework for relativistic quantum theory by elucidating the interaction between branching, entanglement, and relativity.[335] It also draws attention to unsolved ontological issues: a thorough explanation of nonlocal branching requires a more thorough comprehension of the existence of entangled states in space and time. Future research will fill this gap.[336],[337]

[328] Byrne, Peter (2010). The Many Worlds of Hugh Everett III: Multiple Universes, Mutual Assured Destruction, and the Meltdown of a Nuclear Family. Oxford University Press. ISBN 978-0-19-955227-6, accessed on 02 Dec 2025

[329] C. Marletto and V. Vedral, gravitationally induced entangle-ment between two massive particles is sufficient evidence ofquantum effects in gravity, Phys. Rev. Lett. 119, 240402, (2017), accessed on 02 Dec 2025
(PDF) Relativity and decoherence of spacetime superpositions. Available from: https://www.researchgate.net/publication/368332890_Relativity_and_decoherence_of_spacetime_superpositions [accessed Nov 28 2025], accessed on 03 Feb 2026

[330] S. Bose, A. Mazumdar, G. W. Morley, H. Ulbricht, M. Toroˇs, M. Paternostro, A. A. Geraci, P. F. Barker, M. S. Kim, andG. Milburn, Spin entanglement witness for quantum gravity, Phys. Rev. Lett. 119, 240401 (2017), accessed on 02 Dec 2025

[331] D. L. Danielson, G. Satishchandran, and R. M. Wald, Black holes decohere quantum superpositions, arXiv preprintarXiv:2205.06279 (2022), accessed on 03 Feb 2026

[332] https://arxiv.org/html/2302.03259v2, accessed on 03 Feb 2026

[333] R. Gambini, J. Olmedo, and J. Pullin, Quantum black holes in loop quantum gravity, Classical and Quantum Gravity 31, 095009 (2014), accessed on 02 Dec 2025

[334] C. Kiefer, Conceptual problems in quantum gravity and quantum cosmology, ISRN Mathematical Physics 2013, 1–17 (2013), accessed on 02 Dec 2025

[335] Vaidman, L. (2021). Many-Worlds Interpretation of Quantum Mechanics. The Stanford Encyclopedia of Philosophy (Fall 2021 Edition), Edward N. Zalta (ed.). https://plato.stanford.edu/archives/fall2021/ entries/qm-manyworlds/, accessed on 03 Feb 2026

[336] Wallace, D. and C. G. Timpson (2010). Quantum Mechanics on Spacetime I: Spacetime State Realism. The British Journal for the Philosophy of Science 61, pp. 697-727, accessed on 02 Dec 2025

[337] Wallace, D. (2012). The Emergent Multiverse: Quantum Theory according to the Everett Interpretation. Oxford: Oxford University Press, accessed on 03 Feb 2026

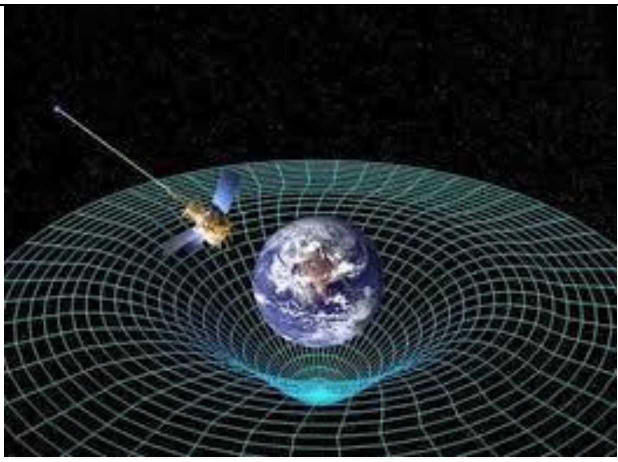

Figure 7: Relativity considered a theory rather than a law338

4.7 Pilot-Wave Theory and Its Challenges. Another interpretation of quantum physics that reinstates determinism without mentioning parallel universes is the de Broglie–Bohm pilot-wave theory.[339] As the first alternative formulation of quantum mechanics, de Broglie and Bohm's pilot-wave theory has a unique position in the history of modern physics.[340] It asserts that a guiding wave function that changes in accordance with quantum laws influences the particular paths that particles take. This gives particle behavior a precise, non-random explanation.[341] One of the difficulties with pilot-wave theory is that it is incompatible with special relativity, which necessitates a non-local, deterministic, and non-relativistic framework.[342] Its increased mathematical complexity, the ambiguous physical meaning of the "pilot wave," and the absence of reciprocal interaction between the particle and wave are further difficulties. Despite providing a deterministic substitute for the Copenhagen interpretation's unpredictability, these problems make it less well-liked than conventional interpretations. Nonetheless, there are substantial challenges in harmonizing the pilot-wave theory with special relativity.[343] The theory's non-local, instantaneous links between particles seem to go against the idea that nothing can move faster than the speed of light, which presents a significant obstacle.[344] A fundamental tenet of special relativity, Lorentz invariance, is violated by pilot-wave theory as it necessitates a preferred frame of reference.[345] According to the hypothesis, there is a true guiding wave, but it doesn't exist in the three-dimensional world we see; instead, it resides in an abstract, multi-dimensional realm. This makes it challenging to comprehend its physical nature, particularly because it cannot be identified as a separate item. It does not readily fit into the relativistic framework, which holds that no influence can move faster than light, since it contains non-local effects, where changes in one location may instantly impact distant particles. Its status as a comprehensive, contemporary physics theory is weakened by this incompatibility with relativity.[346] The hypothesis explains a one-way interaction in which the particle is guided by the pilot wave but has no effect on the wave. This goes against the basic idea of action-reaction in classical physics, which states that forces are always reciprocal. There are no new testable predictions made by pilot-wave theory that would set it apart from conventional quantum mechanics. The effectiveness of the theory is predicated on the idea of "quantum equilibrium," which postulates that the probabilistic character of quantum mechanics results from our incomplete understanding rather than from underlying randomness.

4.8 Consciousness and the Nature of the Present. The ability to analyses and compare mental experiences in a single instant, or "present time," is made possible by consciousness, a state of awareness that connects our perspective of the past, present, and future. Philosophically speaking, awareness is closely linked to the present; according to certain traditions,

[338] https://www.facebook.com/groups/physicsisfun109/posts/354094670602717/, accessed on 02 Dec 2025
[339] https://journals.aps.org/prd/abstract/10.1103/PhysRevD.54.2564, accessed on 02 Dec 2025
[340]https://www.researchgate.net/publication/391956708_The_trouble_with_pilot-wave_theory_a_critical_evaluation, accessed on 03 Feb 2026
[341]https://medium.com/swlh/on-pilot-wave-theories-and-general-issues-in-quantum-mechanics-2d2414320b15, accessed on 03 Feb 2026
[342]https://theconversation.com/why-did-louis-de-broglie-nobel-laureate-in-physics-abandon-his-own-pilot-wave-theory-244594, accessed on 03 Feb 2026
[343] https://www.aps.org/policy/reports/popa-reports/energy/climate.cfm, accessed on 03 Feb 2026
[344] https://link.springer.com/chapter/10.1007/978-3-319-55420-4_6, accessed on 03 Feb 2026
[345] uis Gonzalez-Mestres (1997-05-26). "Absence of Greisen-Zatsepin-Kuzmin Cutoff and Stability of Unstable Particles at Very High Energy, as a Consequence of Lorentz Symmetry Violation". Proceedings of the 25th International Cosmic Ray Conference (Held 30 July - 6 August). 6: 113, accessed on 03 Feb 2026
[346] A. C. de la Hamette, V. Kabel, E. Castro-Ruiz, and C. Brukner, falling through masses in superposition: quantum reference-frames for indefinite metrics (2021), accessed on 05 Dec 2025
(PDF) Relativity and decoherence of spacetime superpositions. Available from: https://www.researchgate.net/publication/368332890_Relativity_and_decoherence_of_spacetime_superpositions [accessed Nov 28 2025], accessed on 03 Feb 2026

consciousness is the capacity to see and value the "now" as the sole reality in which existence takes place. Others, such as philosopher Henri Bergson, see consciousness as an ongoing flow of "duration," a conflict between the present's immediacy and memory's expansive reach.[347] According to one idea, consciousness is thought to be the brain's greatest ability to connect space and time into global mental representations, presumably via quantum mechanical processes inside the brain. Many stress the significance of "conscious living," which is defined as being in the now and embracing the situation as it is rather than being preoccupied with regrets from the past or worries about the future. According to Eckhart Tolle, awareness is one with the present, and the self is essentially a sensation of presence or being that is the same as the present.[348] Consciousness is a constant "duration" that connects the accumulated potential of the past with the immediate present, according to Henri Bergson.[349] According to Matthew David Segall, awareness is a process that allows for freedom and choice by contrasting the present with what may be.[350] According to certain beliefs, physical reality comes after awareness, which is essential. According to a new theoretical concept, time, space, and matter originate from consciousness rather than substance.[351] Some theories make a distinction between the subjective, knower, or self that experiences the ideas and sensations that the brain processes and the processing itself.[352] Some believe that consciousness arises from matter or the brain, while others contend that awareness may really create matter.[353]

The subject of how quantum fields and quantum particles behave in a superposition of spacetimes seems to be outside the scope of theoretical and experimental studies in the absence of a comprehensive theory of quantum gravity.[354] The concept of a block universe raises an important philosophical and experiential query: what does it mean to perceive the present if all events have already occurred? The "now" we perceive is not an instantaneous moment but rather a prolonged period, according to consciousness, which results from neuronal processes developing over time.[355] These prolonged present runs counter to naïve notions of a clear temporal border between the past and the future, as well as presentism and the idea that only the present instant is genuine. Rather, a more nuanced, dispersed understanding of the present that is consistent with relativity's relative simultaneity is supported by our conscious awareness of time.[356] These cast doubt on oversimplified conceptions of time and pose more profound queries about the subjective perception of temporal flow.[357] A non-Turing test for machine consciousness based on a computer's capacity to generate philosophical conclusions was proposed by Victor Argonov in 2014.[358] In 2023, Nick Bostrom made the case that having a strong belief that large language models (LLMs) are not sentient would be unjustified. He also discussed whether aspects of consciousness theory are true and how they relate to machines.[359] According to him, awareness is a degree,[360] He maintained that, in principle, computers may be much more intelligent than people.[361]

Does the future already exist? That is the central question. It is still unsolved and mostly relies on one's preferred interpretation of quantum physics. According to the Copenhagen perspective, the future is essentially unpredictable and can only be influenced by observation. In a large multiverse, the future is decided for those who favor Many-Worlds, but each observer follows a branching, unpredictable route.[362] Physics is still struggling to reconcile the direction and flow of time, which explains why humans can recall the past but not the future.[363] In order to comprehend time, determinism, and the structure of reality, the movie concludes by emphasizing the significance of combining physical theory with philosophical understandings and the subjective realities of consciousness. Let's talk about the universe's transience, highlighting the fact that all matter—from stars and planets to galaxies—emerged from primordial cosmic beginnings and will eventually return to a fundamental, formless state. In a huge and mostly hostile universe, Earth is said to be a unique, life-supporting oasis. Earth, a planet in the solar system

[347] Robert C. Grogin, The Bergsonian Controversy in France, 1900–1914, Univ of Calgary Press (May 1988), ISBN 0919813305, accessed on 05 Dec 2025

[348] Rottgardt, Beate (27 May 2008). "Amerikas Guru stammt aus Lünen" [America's guru comes from Lünen]. Ruhr Nachrichten. Archived from the original on 15 January 2011, accessed on 05 Dec 2025

[349] Merquior, J. G. (1987). Foucault (Fontana Modern Masters series), University of California Press, p.11. ISBN 0-520-06062-8, accessed on 03 Feb 2026

[350] https://footnotes2plato.com/mds/, accessed on 03 Feb 2026

[351] https://footnotes2plato.substack.com/p/the-nature-of-consciousness-and-what, accessed on 05 Dec 2025

[352] https://www.organism.earth/library/document/out-of-your-mind-1, accessed on 03 Feb 2026

[353] P.A. Guertin (2019). "A novel concept introducing the idea of continuously changing levels of consciousness". Journal of Consciousness Exploration & Research. 10 (6): 406–412. Archived from the original on 2021-12-15, accessed on 03 Feb 2026

[354] Jaynes J (2000) [1976]. The Origin of Consciousness in the Breakdown of the Bicameral Mind. Houghton Mifflin. ISBN 0-618-05707-2, accessed on 05 Dec 2025

[355] https://www.frontiersin.org/articles/10.3389/fphy.2013.00006/full, accessed on 03 Feb 2026

[356] https://iopscience.iop.org/article/10.3847/0004-637X/830/2/83, accessed on 05 Dec 2025

[357] V. Kabel, A.-C. de la Hamette, E. Castro-Ruiz, and C. Brukner, Quantum conformal symmetries for spacetimes in superposi-tion (2022), accessed on 03 Feb 2026

[358] Victor Argonov (2014). "Experimental Methods for Unraveling the Mind-body Problem: The Phenomenal Judgment Approach". Journal of Mind and Behavior. 35: 51–70. Archived from the original on 2016-10-20, accessed on 03 Feb 2026

[359] Leith S (2022-07-07). "Nick Bostrom: How can we be certain a machine isn't conscious?". The Spectator,

[360] https://www.nytimes.com/2023/04/12/world/artificial-intelligence-nick-bostrom.html, accessed on 05 Dec 2025

[361] Shulman C, Bostrom N (August 2021). "Sharing the World with Digital Minds". Rethinking Moral Status: 306–326. doi:10.1093/oso/9780192894076.003.0018. ISBN 978-0-19-289407-6, accessed on 03 Feb 2026

[362] https://philsci-archive.pitt.edu/24763/7/branching%202025.pdf, accessed on 05 Dec 2025

[363] https://www.thp.uni-koeln.de/gravitation/zeh/Spacetime-Branching.pdf, accessed on 03 Feb 2026

and a member of the Milky Way galaxy, is a part of a cosmos that is always changing due to cycles of creation and destruction. This dynamic universe spans unfathomably vast periods, laying the groundwork for a future-focused story that examines how celestial planets, including Earth, will change and ultimately meet their demise.

4.9 The String-theory. A theoretical framework known as "string theory" substitutes one-dimensional objects known as "strings" for point-like particles. These strings vibrate in many ways, and each vibrational mode represents a distinct particle type, such an electron or a quark. Although the theory has not yet been scientifically confirmed, it seeks to unite the basic forces of nature, including gravity, and all forms of matter into a unified framework. String theory has the ability to include all matter and the four basic forces—gravity, electromagnetism, strong force, and weak force—into a single, coherent quantum mechanical framework, making it a contender for a "theory of everything." The theory's need for more dimensions than the three spatial and one temporal dimension of our universe—specifically, 10 or 11 dimensions in most formulations—is a crucial component. It is hypothesized that the additional dimensions are "compactified," or rolled up, and hence invisible at our size. String theory is still a theoretical idea despite its mathematical elegance.[364] As of yet, it has not produced testable predictions that have been confirmed by experimentation. The fact that the complete theory lacks a proper definition in every situation is one of the difficulties with string theory. Another problem is that the theory is believed to explain a vast array of potential universes, which has made attempts to create particle physics theories based on string theory more difficult.[365] Because of these problems, some members of the community have questioned the worth of further string theory unification research and criticized these methods of approaching physics.[366]


Figure 8: The frictional concept of string theory367

Stephen Wolfram, a mathematician, computer scientist, and physicist, recently shocked the scientific world by declaring that he had essentially worked out how the universe works. In the scientific world, Wolfram is well-known. He is the creator of Wolfram Alpha, the search engine that AskJeeves dreamed it were, Wolfram Language, a math-based programming language that powers the well-known Mathematica system, and the Wolfram Physics Project.[368] His contributions date back to his early years, when he wrote three books on physics before the age of 14.[369] His contributions date back to his early years, when he wrote three books on physics before the age of 14.[370] In order to do this, physicists and other scientists have developed ideas ranging from "we're all living in a computer simulation" (which raises the issue of what the universe the computer is in is comprised of) to numerous worlds (as in, more than one universe). Therefore, referring to a physics theory as "wacky" suggests a whole different degree of strangeness. "The fact that our universe is expanding was discovered almost a century ago, but scientists only realized how exactly this happens in the 90s of last century, when powerful telescopes (including orbital ones) appeared and the era of exact cosmology began," said Artyom Astashenok. Three to four billion years after the universe's creation, measurements and data analysis revealed that the universe is not only expanding, but expanding at an accelerated rate.[371] Additionally, he said, "And so the concept was created that the Universe is filled with some "dark energy," which has extraordinary qualities, rather than regular matter. It is called "Dark Energy" because no one understands

[364] Becker, Katrin; Becker, Melanie; Schwarz, John (2007). String theory and M-theory: A modern introduction. Cambridge University Press. ISBN 978-0-521-86069-7, accessed on 05 Dec 2025

[365] Zwiebach, Barton (2009). A First Course in String Theory. Cambridge University Press. ISBN 978-0-521-88032-9, accessed on 03 Feb 2026

[366] Merali, Zeeya (2011). "Collaborative physics: string theory finds a bench mate". Nature. 478 (7369): 302–304 [303]. Bibcode:2011Natur. 478..302M. doi:10.1038/478302a, accessed on 03 Feb 2026

[367] https://www.space.com/17594-string-theory.html, accessed on 05 Dec 2025

[368] Johnson, Bobbie (March 9, 2009). "British search engine 'could rival Google'". The Guardian. UK: Guardian News and Media, accessed on 03 Feb 2026

[369] https://writings.stephenwolfram.com/2020/04/finally-we-may-have-a-path-to-the-fundamental-theory-of-physics-and-its-beautiful/, accessed on 03 Feb 2026

[370] https://www.reddit.com/r/Physics/comments/16socnp/is_wolfram_physics_considered_a_legitimate/, accessed on 05 Dec 2025

[371] https://www.spacedaily.com/reports/Evidence_suggests_key_assumption_in_discovery_of_dark_energy_is_in_error_999.html, accessed on 05 Dec 2025

what it is or how it operates. And this energy makes up 70% of the universe.

The experts at the Immanuel Kant Baltic Federal University (IKBFU) offered their own notion about the "Dark Energy," which is the subject of several hypotheses. They clarified: "It has long been known that two metal plates put in a vacuum are attracted to one another. This phenomenon is known as the Casimir effect, after the Dutch scientist Hendrik Casimir. Since there is nothing in the hoover, it would seem that this cannot be. However, in accordance with quantum theory, particles are always appearing and disappearing there, and a very little attraction results from their contact with plates, which mark certain limits of space (which is crucial). Additionally, there is a theory that roughly the same thing occurs in space. On the contrary, only this causes more repulsion, which speeds up the universe's expansion. In other words, there is a manifestation of the universe's limits but ultimately no "Dark Energy." Naturally, this does not imply that it comes to an end, although complicated topology may occur. You may use the Earth as an example. Ultimately, it is finite yet also without bounds. The Earth and the Universe vary in that we deal with two-dimensional space in the former and three-dimensional space in the latter. According to Artem Astashenok, the published article expands on the concepts in Alexander Teplyakov's thesis and offers a mathematically sound model of the universe where additional repulsion takes place and the law of universal gravitation and the acceleration of the universe's expansion do not conflict.[372]

Recently, two physicists from IKBFU in Russia put forward a completely new theory of the universe. In essence, our whole universe is a component of an immensely huge quantum system spanning a "uncountable" multiverse, according to their study, which combines the absurd notion that we live in a computer simulation with the astounding "many worlds" hypothesis. When we think about quantum systems, such as Google's and IBM's quantum computers, we often picture a machine that uses qubits, which are subatomic particles, to carry out quantum computations. For now, these computers are helpful as a means of investigating the difference between classical and quantum reality, but they may eventually be able to do sophisticated computations that are now beyond the capabilities of classical computers.[373] The IKBFU academics who conducted the aforementioned study, Artyam and Valerian Yurov, argue that everything in the world—including the universe itself—should be thought of as a quantum object. This implies that we are already in "quantum reality" and do not need to examine qubits or subatomic particles. It's all quantum! In the opening of their work, Yurov and Yurov claim to have reversed the prevailing theories of theoretical physics. The article continues by providing a mathematical explanation of how the whole universe is a quantum item. In other words, it has quantum features that should include superposition, much like a small subatomic particle.[374] There must be something out there for our universe to interact with, even if it means using incredibly counterintuitive quantum mechanics to interact with itself in multiple states at once. This is because, theoretically, our universe should be able to exist in multiple places or states at once.

Expanding quantum mechanics to massive things, such as a single cell, has the drawback of making other theoretical quantum properties less logical. In this instance, "decoherence," or the process by which quantum objects "collapse" from many states into the physical state seen in our classical observations, doesn't seem to hold up at the cosmic scale.[375] The "many worlds" idea is then expanded to include numerous universes, or multiverses, by the researchers' calculations based on their assumptions. If the universe is a quantum item, it must interact with something, and that something is most likely other universes. This is the main notion here. The findings do not, however, explain why our world and everything in it would exist as something like to a single qubit in a massive quantum computer that concurrently spans numerous realities. If humans aren't the magical observers that measure the quantum realm and force it to "collapse" into classical reality, then we could just be gears in a machine; perhaps the cosmos is a qubit, and we are the qubits. Maybe humans are merely background noise that the universes overlook as they do their computations. Perhaps we are really living in a computer simulation. But rather than being the preferred NPCs of some sophisticated species, we are only mathematical components that support the operation of the operating system. Ultimately, one must question the viability of a unified theory of the universe that draws inspiration from both Nick Bostrom's simulation hypothesis and the arcade gaming age in comparison to M-theory, relativity, or other established solutions.[376] However, a rising tide lifts all ships, and Wolfram's present enthusiasm will undoubtedly produce some intriguing mathematical outcomes.

5. Ultimate Finding from Scientific Theories and Difficulties

5.1 Limitation of Theory of Science or Physics.

To yet, no physical hypothesis is thought to be exactly correct. Rather, physics has advanced via a sequence of "successive approximations" that enable more precise forecasts over an ever-expanding array of phenomena. Therefore, some physicists maintain that the sequence of approximations will never end in the "truth" and that it is incorrect to mix theoretical models with the actual nature of reality.[377] Einstein himself

[372] https://doi.org/10.1142/S0218271819501761, accessed on 03 Feb 2026

[373] https://thenextweb.com/news/ibm-algorithms-key-quantum-utility-first-european-data-centre, accessed on 05 Dec 2025

[374] https://thenextweb.com/news/spacex-inspires-iqm-quantum-computing, accessed on 05 Dec 2025

[375] https://thenextweb.com/news/study-our-universe-may-be-part-of-a-giant-quantum-computer,

[376] https://philosophybreak.com/articles/simulation-with-bostrom/, accessed on 05 Dec 2025

[377] Results, search (17 December 2006). The New Cosmic Onion: Quarks and the Nature of the Universe. CRC Press. ISBN 978-1-58488-798-0, accessed on 05 Dec 2025

sometimes voiced this opinion.[378] Whether a theory of everything is worthy of being referred to as the basic law of the universe is a topic of philosophical discussion within the physics community.[379] The hard reductionist viewpoint holds that the theory of everything is the basic law and that all other theories that apply to the cosmos follow from it. According to a different perspective, emergent laws—which control how complex systems behave—should be seen as equally basic.[380] The theory of natural selection and the second law of thermodynamics are two instances of emergent laws.[381] Emergence proponents contend that emergent laws are distinct from low-level, microscopic rules, particularly those that describe complex or living systems. According to this perspective, emergent rules are just as essential as a universal theory.

Weinberg notes that it is difficult to determine the exact trajectory of a real projectile in Earth's atmosphere.[382] Therefore, how can we be certain that our theory of projectile motion is sufficient? Newton's equations of motion and gravity, according to Weinberg, are "well enough" for basic situations, such as how planets move in empty space. We can be quite certain that these concepts will apply to more complicated situations since they have worked so effectively on simpler ones. For instance, general relativity is commonly regarded as a legitimate theory even if it contains equations without precise solutions since all of its equations with exact solutions have been confirmed via experimentation.[383] In a similar vein, a theory of everything must function for a variety of straightforward cases such that we can be very certain it will function for any scenario in physics. Combining quantum physics with general relativity often leads to challenges in developing a theory of everything since the equations of quantum mechanics start to break when the force of gravity is applied to them. The fundamental premise is that a quantum system loses its ability to exist as an autonomous entity when it interacts with a measurement device because their respective wave functions become entangled.[384] The uncertainty principle is one effect of the fundamental quantum formalism. In its most well-known version, this asserts that no quantum particle preparation may imply simultaneous, accurate predictions for a measurement of the particle's location and momentum.[385]

Once again, the zero-energy universe hypothesis postulates that there is precisely zero energy in the cosmos overall, with the negative energy of gravity precisely cancelling out the positive energy of matter.[386] Although the zero-energy universe hypothesis necessitates the existence of both a matter field with positive energy and a gravitational field with negative energy, some physicists, including Lawrence Krauss, Stephen Hawking, and Alexander Vilenkin, refer to this condition as "a universe from nothingness."[387] Popular sources address the theory in general. The strong CP problem, the absolute mass of neutrinos, matter–antimatter asymmetry, and the nature of dark matter and dark energy are only a few of the significant issues that still need to be resolved in the field of physics outside of the Standard Model.[388],[389] The Standard Model's mathematical foundation, which is still incompatible with general relativity, is another major issue. Under extreme circumstances, such as within known spacetime gravitational singularities like those at the Big Bang and at the centers of black holes beyond their event horizons, both theories collapse due to this contradiction.[390] On the other hand, Big Bang cosmology's chronology explains the universe's past and future. According to research released in 2015, the earliest phases of the universe's existence occurred 13.8 billion years ago, with a 68% confidence level uncertainty of around 21 million years.[391]

On a timescale of millions of trillions of years, it is hypothesized that black holes would appear to evap-

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[378] The Theory of Everything: Are we getting closer, or is a final theory of matter and the universe impossible? Debate between John Ellis (physicist), Frank Close and Nicholas Maxwell, accessed on 05 Dec 2025

[379] https://www.bbc.co.uk/programmes/p004y24b, accessed on 03 Feb 2026

[380] O'Connor, Timothy; Wong, Hong Yu (February 28, 2012). "Emergent Properties". In Edward N. Zalta (ed.). The Stanford Encyclopedia of Philosophy (Spring 2012 Edition), accessed on 03 Feb 2026

[381] Darwin, Charles (1872). The Origin of Species by Means of Natural Selection, or the Preservation of Favoured Races in the Struggle for Life (6th ed.). London: John Murray. OCLC 1185571, accessed on 05 Dec 2025

[382] Einstein, letter to Felix Klein, 1917. (On determinism and approximations.) Quoted in Pais (1982, Ch. 17),

[383] Landau, L. D.; Lifshitz, E. M. (1975), The Classical Theory of Fields, v. 2, Elsevier Science, Ltd., ISBN 978-0-08-018176-9, accessed on 05 Dec 2025

[384] Greenstein, George; Zajonc, Arthur (2006). "8 Measurement". The Quantum Challenge: Modern Research on the Foundations of Quantum Mechanics (2nd ed.). Jones and Bartlett. p. 215. ISBN 978-0-7637-2470-2. Archived from the original on 2023-01-02, accessed on 03 Feb 2026

[385] Landau, Lev D.; Lifschitz, Evgeny M. (1977). Quantum Mechanics: Non-Relativistic Theory. Vol. 3 (3rd ed.). Pergamon Press. ISBN 978-0-08-020940-1. OCLC 2284121, accessed on 05 Dec 2025

[386] "A Universe From Nothing lecture by Lawrence Krauss at AAI". YouTube. 2009. Archived from the original on 2021-12-15, accessed on 03 Feb 2026

[387] Isham, Christopher (14 July 1994). Quantum Cosmology and the Origin of the Universe (Speech). Lecture presented at the conference Cosmos and Creation. Cambridge University, accessed on 05 Dec 2025

[388] Hammond, Richard (1 May 2008). "The Unknown Universe: The Origin of the Universe, Quantum Gravity, Wormholes, and Other Things Science Still Can't Explain". Proceedings of the Royal Society of London, Series A. 456 (1999): 1685, accessed on 05 Dec 2025

[389] Womersley, J. (February 2005). "Beyond the Standard Model" (PDF). Symmetry Magazine. Archived from the original (PDF) on 17 October 2007, accessed on 03 Feb 2026

[390] Overbye, Dennis (11 September 2023). "Don't Expect a 'Theory of Everything' to Explain It All". The New York Times. Archived from the original on 11 September 2023, accessed on 03 Feb 2026

[391] Planck Collaboration (October 2016). "Planck 2015 results. XIII. Cosmological parameters". Astronomy & Astrophysics. 594: Article A13. arXiv:1502.01589. Bibcode:2016A&A...594A..13P. doi:10.1051/0004-6361/201525830, accessed on 03 Feb 2026

orate almost instantly, rare quantum tunnelling phenomena would appear to occur frequently, and quantum or other phenomena so improbable that they might occur only once in a trillion years might occur numerous times.[392] Once again, the hypothetical collection of all worlds is known as the multiverse.[393] All of space, time, matter, energy, information, and the physical laws and constants that characterize them are assumed to be included in these universes. The terms "parallel universes," "flat universes," "other universes," "alternate universes," "multiple universes," "plane universes," "parent and child universes," "many universes," or "many worlds" refer to the several realities that make up the multiverse. The multiverse is often thought of as a "patchwork quilt of separate universes all bound by the same laws of physics."[394] What will happen to the cosmos in the end is the question now. In the end, the cosmos will descend into near-absolute stillness and extreme darkness. Entropy will rule all processes, and all stars, galaxies, and structures will have either vanished or disintegrated. The universe's dark age, which might last forever, would be characterized by motionlessness, quiet, and eternity, broken only by brief, inconsequential quantum occurrences. But the last word is still elusive. There might be fresh beginnings at the nexus of general relativity and quantum physics, or the cosmos could stay inactive forever. In either scenario, the story concludes with humility and awe in the face of a huge, enigmatic, and incompletely understood universe.[395]

5.2 Possibility of the Alcubierre Warp Drive Ship. One potential faster-than-light propulsion method, the Alcubierszre warp drive, has long been limited by its need on unusual negative-energy materials.[396] It begs the question: would superluminal travel be technically possible in the near future? It could be theoretically feasible. One of the most fascinating possibilities in contemporary theoretical physics is the concept of faster-than-light (FTL) travel. The Alcubierre warp drive, which Miguel Alcubierre initially presented in 1994, is one of the suggested models[397] proposes a way for a spaceship to surpass the speed of light without going against special relativity. In order to accomplish this, spacetime is expanded behind the spaceship and contracted in front of it, enabling the ship to "surf" on a wave of spacetime. Despite its theoretical allure, the Alcubierre drive has a number of basic issues that have been thoroughly studied over the previous thirty years. These difficulties include the need for negative energy, the viability of dynamically modifying spacetime curvature, the possible consequences for time travel and closed time like curves (CTCs), and the massive energy requirements of maintaining a warp bubble. The need for a negative energy density to maintain the warp bubble is one of the main challenges in implementing an Alcubierre drive.[398] But it's thought that the quantity needed for a macroscopic warp drive is orders of magnitude more than what can be made in a lab right now. Lentz's recent work[399] and Bobrick & Martire[400] implies that, although these models are still theoretical, certain spacetime geometries could provide modified warp bubble solutions that reduce or eliminate the demand for exotic matter. Furthermore, new developments in semiclassical gravity and quantum field theory suggest that energy condition violations could not be as severe as originally believed, providing a potential avenue for further study.[401]

Another major challenge is the engineering of spacetime itself to achieve the anticipated contraction and expansion. Theoretical studies by Natáriopresent alternate warp drive metric formulations that do not need an explicit expansion area, implying that various geometries might result in more useful designs. Furthermore, new research on metric engineering in higher-dimensional theories and modified gravity models (such string theory and f(R) gravity) suggests potential ways to deform spacetime without the need for impractical energy densities.[402] Additionally, while experimental proof is still difficult, White et al.'s numerical simulations at NASA's Eagleworks laboratory have investigated possible methods of manipulating spacetime via local energy fluctuations.[403] The possible connection between warp drive physics and time travel is an important and often discussed topic. An operational Alcubierre drive might potentially allow backward time travel, which would result in causality

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[392] Razavy, Mohsen (2003). Quantum Theory of Tunneling. World Scientific. pp. 4, 462. ISBN 978-981-256-488-7,

[393] https://www.newscientist.com/article/mg26234971-300-we-are-closer-than-ever-to-finally-proving-the-multiverse-exists/, accessed on 03 Feb 2026

[394] Swain, Frank (2017). The Universe Next Door: A Journey Through 55 Alternative Realities, Parallel Worlds and Possible Futures. London: New Scientist. p. 12. ISBN 978-1-4736-5867-7, accessed on 05 Dec 2025

[395] Hossain K A, (2025), Appraisal of Chronological Development of Physics with Creation of Universe and Uncertainty of Future, Transactions on Engineering and Computing Sciences - Vol. 13, No. 06 Publication Date: December 19, 2025 DOI:10.14738/tmlai.1306.19717, accessed on 05 Feb 2026

[396] Auci, M. (2021) Multi-Bubble Universe Model: A Quantum-Relativistic Gravitational Theory of Space-Time. Journal of Modern Physics, 12, 179-21, accessed on 05 Feb 2026

[397] Alcubierre, M. (1994) The Warp Drive: Hyper-Fast Travel within General Relativity. Classical and Quantum Gravity, 11, L73-L77, accessed on 03 Feb 2026

[398] Casimir, H.B.G. (1948) On the Attraction between Two Perfectly Conducting Plates. Proceedings of the Koninklijke Nederlandse Akademie van Wetenschappen, 51, 793-795, accessed on 05 Dec 2025

[399] Lentz, E.W. (2021) Breaking the Warp Barrier: Hyper-Fast Solitons in Einstein-Maxwell-Plasma Theory. Classical and Quantum Gravity, 38, Article ID: 075015, accessed on 05 Dec 2025

[400] Bobrick, A. and Martire, G. (2021) Introducing Physical Warp Drives. Classical and Quantum Gravity, 38, Article ID: 105009, accessed on 03 Feb 2026

[401] Visser, M. (1996) Lorentzian Wormholes: From Einstein to Hawking. AIP Press, accessed on 05 Dec 2025

[402] Capozziello, S. and Faraoni, V. (2011) Beyond Einstein Gravity: A Survey of Gravitational Theories for Cosmology and Astrophysics. Springer, accessed on 03 Feb 2026

[403] White, H.G., March, P., Lawrence, J., Vera, J., Sylvester, A., Brady, D. and Bailey, P. (2013) Measurement of the Warp Field Dynamics of a Lorentzian Wormhole. Journal of the British Interplanetary Society, 66, 242-247, accessed on 06 Dec 2025

paradoxes since any superluminal travel in general relativity entails the existence of closed time-like curves (CTCs).[404] After studying the stability of CTCs in warp drive spacetimes, Everett and Roman came to the conclusion that quantum backreaction effects could be able to avoid these paradoxes.[405] Furthermore, Barceló *et al*.[406] have investigated whether Hawking's chronology preservation methods and quantum inequalities may stop CTCs from forming in physically plausible situations. However, there is still disagreement regarding whether causality violations are an inevitable aspect of FTL travel or if there is a mechanism that may fix the problem. The Alcubierre drive's energy requirements continue to be a significant obstacle; preliminary calculations indicate that they would surpass the entire mass-energy of the visible universe.[407] The goal of recent studies has been to improve these computations so they are more physically sound. Pfenning and Ford[408] established limitations on warp bubble energy distributions, showing that energy needs may be greatly decreased by thinning the warp bubble wall. Furthermore, soliton-based warp bubble designs may enable subluminal preparation prior to superluminal speeds, thereby lowering energy requirements, according to recent research by Lentz.[409] In the meanwhile, studies on manipulating quantum vacuum energy, including those carried out by Davis and Puthoff,[410] suggests that the extraction of useful negative energy from the vacuum itself might be made possible by future developments in quantum field control.

In a recent study, Bi Qiao from the University of Wuhan Technology's Physics Department presents a unique method based on extended gauge transformations. He also creates a new formula that allows the electromagnetic tensor to be directly converted to the Weyl tensor. This method offers a workable alternative for the Alcubierre warp drive, in which precise electromagnetic field manipulation causes spacetime expansion (negative curvature) at the spacecraft's back and compression (positive curvature) at its front.[411] By doing this, it gets around Einstein's field equations' strict requirements for negative energy and exotic matter, providing a strong theoretical basis for the development of warp-drive propulsion.[412] He has shown and said that "a more practical path to realizing warp drive physics may be an electromagnetic field-induced Weyl curvature mechanism." He demonstrates that "a dramatic reduction in energy demands suggests that future technological advancements may be able to achieve faster-than-light travel." Additionally, his study offers crucial information on the controllability and safety of upcoming warp-driven spacecraft.[413] The suggested electromagnetic tensor to Weyl tensor modulation provides a potential path towards the practical implementation of warp-drive spacecraft, building upon the unification of the four basic interactions and generalized gauge transformations in primary fiber bundles. This method turns superluminal travel from a theoretical speculation into a possibly feasible engineering reality by removing the need on negative energy exotic matter and drastically lowering energy limitations. This discovery might enable mankind to transcend the boundaries of our solar system in the not-too-distant future, bringing about the interstellar period. [414]

6. Contemporary Concept of Universe Creation and it's Future

6.1 Preparation of Cosmic Calendar. An illustration of the universe's 13.8-billion-year history condensed into a single calendar year is the Cosmic Calendar. Carl Sagan popularized it in order to help people comprehend the length of cosmic history.[415] The Geologic Calendar is a comparable metaphor used to illustrate the geologic time scale and the evolution of life on Earth.[416] According to the Cosmic Calendar, human history represents a very small portion of cosmic time. In comparison to our species, the cosmos is unfathomably ancient. The majority of significant cosmic occurrences took place long before humanity arrived.[417] The

[404] Thorne, K.S. (1994) Black Holes & Time Warps: Einstein's Outrageous Legacy. W. W. Norton & Company,

[405] Everett, A.E. and Roman, T.A. (1997) Superluminal Travel and the Violation of the Weak Energy Condition. Physical Review D, 56, 2100-2108, accessed on 06 Dec 2025

[406] Barceló, C., Liberati, S. and Visser, M. (2002) Chronology Protection in Lorentzian Traversable Wormholes. Journal of High Energy Physics, 11, 42, accessed on 03 Feb 2026

[407] Klinkhamer, F.R. and Volovik, G.E. (2008) The Alcubierre Drive and the Energy Conditions. Physics Letters B, 673, 214-217, accessed on 06 Dec 2025

[408] Pfenning, M.J. and Ford, L.H. (1997) The Unphysical Nature of 'Warp Drive'. Classical and Quantum Gravity, 14, 1743-1751, accessed on 03 Feb 2026

[409] Davis, E. and Puthoff, H.E. (2000) Quantum Vacuum Energy Extraction and Applications to Space Propulsion. AIAA Journal of Propulsion and Power, 16, 763-768, accessed on 03 Feb 2026

[410] Davis, E. and Puthoff, H.E. (2000) Quantum Vacuum Energy Extraction and Applications to Space Propulsion. AIAA Journal of Propulsion and Power, 16, 763-768, accessed on 06 Dec 2025

[411] Bi, Q. (2023) Large Scale Fundamental Interactions in the Universe. Journal of Modern Physics, 14, 1703-1720,

[412] Auci, M. (2023) Quantum-Relativistic Properties of the Space-Time Bubbles and Their Evolution in a Multi-Bubble Universe. Journal of Modern Physics, 14, 1045-1066, accessed on 03 Feb 2026

[413] Qiao, B. (2024) Further Exploration of the Gauge Transformation across Fundamental Interactions. Journal of Modern Physics, 15, 2317-2334, accessed on 06 Dec 2025

[414] https://www.scirp.org/journal/paperinformation?paperid=141629, accessed on 03 Feb 2026

[415] Bell, Elizabeth A.; Boehnike, Patrick; Harrison, T. Mark; et al. (19 October 2015). "Potentially biogenic carbon preserved in a 4.1-billion-year-old zircon" (PDF). Proc. Natl. Acad. Sci. U.S.A. 112 (47): 14518–21. Bibcode:2015PNAS.11214518B. doi:10.1073/pnas.1517557112. ISSN 1091-6490, accessed on 03 Feb 2026

[416] Witt, Steven (December 2024). "Libraries at the intersection of history and the present". IFLA Journal. 50 (4): 691–695. doi:10.1177/03400352241299307. ISSN 0340-0352, accessed on 03 Feb 2026

[417] Borenstein, Seth (19 October 2015). "Hints of life on what was thought to be desolate early Earth". Excite. Yonkers, New York: Mindspark Interactive Network. Associated Press, accessed on 03 Feb 2026

Big Bang occurred at midnight on January 1st, according to this representation, and the present instant corresponds to the conclusion of December 31st, just before midnight.[418] There are 37.8 million years per cosmic day, 1.58 million years per cosmic hour, and 438 years every cosmic second at this size. If today is December 31 at 23:59:59 and the Big Bang occurred on January 1 at 00:00, then the remaining events are shown on a graph below in order.

COSMIC CALENDAR

January to March: Early Universe

Jan 1: Big Bang

Jan 10: First star form

Jan 13: First galaxies appear

April to August: Galaxy Growth

May: Milky Way begins to form

August: Our Milky Way stabilizes

September: Birth of the Solar System

Sep 1: Formation of the Sun

Sep 2: Formation of Earth

Sep 21: Earliest life (simple cells)

October — November: Evolution

Oct 9: Photosynthesis begins

Nov 12: First complex cells (eukaryotes)

Nov 15: First multicellular life

Nov 24: First animals (simple forms)

December: Life Explodes

Dec 5: Fish evolve

Dec 14: First land plants

Dec 17: Amphibians

Dec 18: Reptiles

Dec 26: Dinosaurs appear

Dec 30 (early morning): Dinosaurs go extinct

Dec 30 (afternoon): Mammals diversify

December 31 — Humans Arrive

Dec 31, 22:24: First humans (Homo sapiens)

Dec 31, 23:59:35: Agriculture starts

Dec 31, 23:59:50: Ancient civilizations (Egypt, Mesopotamia)

Dec 31, 23:59:59: All of recorded human history. → 1 second on the cosmic calendar.

Figure 9: Cosmic Calendar in short[419]

6.2 Earth and the Solar System's that Cloose to Near Future (2100–3000 AD). Significant astronomical and environmental changes are highlighted in projections into the 22nd and 23rd centuries. Sea level rise and ice cap melting are accelerated by global warming, which is brought on by increasing greenhouse gas levels. This forces coastal communities to relocate, mirroring the migrations of ancient humans. The Earth's magnetic field is progressively disrupted by solar phenomena including sunspot cycles, rising solar flares, and coronal mass ejections, which also pose a danger to contemporary technological systems like power grids, satellites, and communication infrastructure. By 2200 AD, increased volcanic activity releases aerosols that momentarily cool the planet, yet solar wind interactions with the Earth's magnetosphere still result in bright auroral displays. Around 2300 AD, polar melting inhibits ocean currents like the Gulf Stream, causing tropical regions to warm and portions of Europe to cool. This amplifies climatic disruption. Long-term orbital cycles known as Milankovitch cycles start to have a greater impact on climate as Earth approaches 2500 AD. These include variations in Earth's axial tilt, eccentricity (or orbital shape), and precession (wobble), which may cause both small ice ages and significant ecological disruptions. Human civilization faces significant problems as a result of these changes. Concurrently, cosmic ray levels are impacted by the solar system's motion across the galaxy, which may have an impact on Earth's temperature and atmospheric chemistry.

By 3000 AD, there may be protracted glacial periods, and gradual gravitational changes between planets would start to slightly change their orbits over far longer times.[420] In his book "The Future of Humanity: Terraforming Mars, Interstellar Travel, Immortality, and Our Destiny Beyond Earth," renowned theoretical physicist, futurist, and popular science author Michio Kaku explores how humanity can become a multiplanetary species to ensure survival. It covers everything from string theory and artificial intelligence to interstellar travel and colonization, offering an optimistic vision of space exploration.[421] Our existing civilization is classified as mid-level Type 0 by Michio Kaku. What does it signify? In 1964, Russian astronomer Nikolai Kardashev identified several civilization types and assigned them numbers ranging from 1 to 5. He made no mention of a Type 0. Another renowned astronomer, Carl Sagan, emphasized that by measuring our present condition inside a Type 0 parameter. From Amazonian tribal civilizations to our energy-hungry modern cities and nations, Sagan characterized human life as existing somewhere between Type 0.5 and 0.6. We were proficient in flying at 0.5. We arrived at the Moon at 0.6. As we are ready to establish a lasting presence on our closest celestial neighbor, we are now at 0.7. We will advance to 0.8, which should occur before 2100, after fusion energy is mastered and quantum computing becomes widely used. Kardashev's scale corresponded with the energy consumption of civilizations.[422] We are now at 17.5 Terawatt-hours, which is still a long way from Kardashev's first prediction of Type 1, which would increase our energy consumption until it is 100,000 times more than it is now. In the next 100 to 200 years, Kaku thinks that milestone will be reached and exceeded. This implies that humans will capture all of the solar energy that reaches Earth—roughly 100

[418] Blanchard, Therese Puyau (1995). "The Universe At Your Fingertips Activity: Cosmic Calendar". Astronomical Society of the Pacific. Archived from the original on 2007-12-16, accessed on 03 Feb 2026

[419] https://visav.phys.uvic.ca/~babul/AstroCourses/P303/BB-slide.htm, accessed on 03 Feb 2026

[420] https://jaxroam.medium.com/will-humanity-make-it-to-year-3000-on-earth-and-what-will-it-be-like-9940a308c948, accessed on 03 Feb 2026

[421] https://www.kirkusreviews.com/book-reviews/michio-kaku/the-future-of-humanity/, accessed on 06 Dec 2025

[422] https://www.nytimes.com/2018/05/25/books/review/the-future-of-humanity-michio-kaku.html, accessed on 06 Dec 2025

quadrillion Watt-hours. Our Type 1 society will be able to regulate volcanoes, earthquakes, and the weather.

Could we do this in a century or two? I don't believe it. But it seems plausible by the year 2500 CE. What more can we accomplish between that year and the next 500? Is it possible for humans to reach each Kardashev's Type 2 and use all of the Sun's energy, not only the sunlight that reaches our planet? Can we move Earth and the other planets in the Solar System using our Type 2 technologies? Can the extinction-level event link to the extinction of the dinosaurs no longer be considered a danger to human civilization if we reach Type 2? By 3000 CE, all of this appears improbable. When you consider how far we have come from 2500 BCE, the time when the Great Pyramids were built, to where we are today, however, then leaps of futuristic insight like this seem possible.[423] The Great Pyramid of Giza, built for Pharaoh Khufu around 2560 BCE (part of the 4th Dynasty Old Kingdom), was a staggering engineering feat using massive stone blocks, a feat achieved with copper tools and immense human labor, with no wheels or advanced machines It demonstrates extraordinary organizational and engineering expertise for that time period, given that building took around 20 to 30 years and involved transporting blocks weighing tons.[424] Consider our previous advancements. We used fire, water, and wind energy to power our preindustrial societies as early as 2500 BCE. Electricity and atomic energy have been introduced in the present.[425]

Human knowledge quadrupled every 1,500 years prior to the year 0 CE. It quadrupled every century by 1900 CE. Every 25 years by 1945. It now occurs once every twelve months, but it will soon occur once every twelve hours. By the year 3000 CE, which is 977 years from now, our society and the planet will hardly resemble what we know now. Both our world and ourselves will be re-engineered. We shall then go to Type 3, 4, 5, and beyond, mastering the Solar System and beyond. As we go through each of these phases, try to picture how human society will look at that point. What will limit us? Based on the speed of light, Einstein proposed a speed limit for the universe. Scientists are investigating the idea of Star Trek's warp drive, which bends spacetime to enable faster-than-light (FTL) travel without breaking relativity locally. NASA and others are looking into theoretical frameworks like the Alcubierre Drive, but there are still many obstacles to overcome, such as the requirement for a huge amount of negative energy, which makes it purely theoretical and far from being implemented in practice.[426] Scientists at NASA are working to make it happen now. Can we create the transporter from Star Trek and transmit ourselves around the galaxy if we can grasp quantum entanglement?[427] Furthermore, the fictitious wormholes that show up in science fiction films like Contact may serve as the equivalent of metropolitan subways, enabling humans to travel between star systems and come across other species that are going through similar phases of civilization to our own.[428]

6.3 Ecological and Solar Evolution Over Millennia (4000 AD–10,000 AD). While solar history is predicted to stay steady and continue its normal cycles within the existing knowledge of stellar physics, geological evolution will be dominated throughout the millennia between 4000 AD and 10,000 AD by continuous sea-level rise caused by the gradual melting of ice sheets.[429] Earth's topography is still being shaped by tectonic processes as millennia go by. While growing volcanic activity, particularly from super-volcanoes like Yellowstone, raises the possibility of extended climate cooling or "nuclear winter" conditions, mountain ranges like the Himalayas are rising.[430] The Earth gradually warms due to the Sun's increasing brightness, which also pushes the globe toward a wet greenhouse state and a critical tipping point when water starts to evaporate into the atmosphere, endangering biodiversity and ocean stability.[431] Reversals of the geomagnetic field finish their cycles, which might decrease Earth's magnetic shield and change how charged particles are distributed in the atmosphere. These modifications might have a domino impact on technology and the environment.[432] The subduction and spreading of the ocean bottom, as well as the assembly and disintegration of continents, are examples of plate tectonic processes that take place over millions of years. Significant large-scale tectonic movements are not expected between 4000 and 10,000 AD, but there will be continuous, slow alterations and sporadic volcanic eruptions (including potentially unanticipated super-volcano occurrences).[433] The Earth's climate system will continue to adapt to human influences. Over the millennia, it is anticipated that changes in rainfall patterns, a rise in the frequency of severe weather events, and changes in

[423] https://www.reddit.com/r/AskEngineers/comments/17rn2bd/how_could_the_great_pyramid_have_been_built_in_20/, accessed on 03 Feb 2026

[424] https://www.respectegypttours.com/blog/when-were-ancient-pyramids-built, accessed on 06 Dec 2025

[425] https://www.21stcentech.com/world-3000-beyond/, accessed on 06 Dec 2025

[426] Choi, M., Okyay, M.S., Dieguez, A.P., Ben, M.D., Ibrahim, K.Z. and Wong, B.M. (2024) QRCODE: Massively Parallelized Real-Time Time-Dependent Density Functional Theory for Periodic Systems. Computer Physics Communications, 305, Article ID: 109349, accessed on 06 Dec 2025

[427] https://gamerant.com/star-trek-warp-drive-technology-explained/, accessed on 06 Dec 2025

[428] https://www.youtube.com/watch?v=Z8axMaBL4uo, accessed on 06 Dec 2025

[429] Abreu, J.A., Beer, J., Steinhilber, F., Tobias, S.M. and Weiss, N.O., 2008, "For how long will the current grand maximum of solar activity persist?", Geophys. Res. Lett., 35, L20109, accessed on 03 Feb 2026

[430] https://cc.oulu.fi/~usoskin/personal/lrsp-2008-3Color.pdf, accessed on 03 Feb 2026

[431] Abreu, J.A., Beer, J., Ferriz-Mas, A., McCracken, K.G. and Steinhilber, F., 2012, "Is there a planetary influence on solar activity?", Astron. Astrophys., 548, A88, accessed on 03 Feb 2026

[432] Argento, D.C., Reedy, R.C. and Stone, J.O., 2013, "Modeling the earth's cosmic radiation", Nucl. Instrum. Methods B, 294, 464–469, accessed on 03 Feb 2026

[433] Donadini, F., Korte, M. and Constable, C., 2010, "Millennial Variations of the Geomagnetic Field: from Data Recovery to Field Reconstruction", Space Sci. Rev., 155, 219–246, accessed on 03 Feb 2026

ecosystem boundaries (such as desertification) would continue to alter landscapes.[434] The heliosphere, the Sun's protective bubble, contracts when the solar system passes through thicker interstellar gas clouds, letting more cosmic rays into the atmosphere.[435] On geological scales, this might change climate patterns and promote cloud formation via atmospheric ionization. These elevated radiation levels may accelerate biological evolution by raising the rates of mutations, some of which may be detrimental and others of which may be beneficial.[436]

6.4 Long-Term Geological and Cosmic Changes (10,000 AD–1 million AD). Although it is a relatively little era in Earth's whole geological history, the time between 10,000 and 1 million AD was sufficient for significant changes to the planet's ecology and surface. Earth's tectonic plates will continue to shift throughout the course of the next hundreds of thousands to millions of years, progressively forming a new supercontinent.[437] Ocean circulation, temperature zones, and ecosystems will undergo significant changes as a result of this event, which happens around every 300–500 million years. Continued tectonic plate movement will result in slow continental drift. Even if it moves slowly, this movement over a million years may change coastlines, create new mountain ranges, and cause changes in the sites of earthquakes and volcanoes.[438] Natural cycles of warming and cooling will occur in the Earth's climate system. It is expected that there will be many ice ages over this time, which will result in widespread glaciation, increasing and declining sea levels, and major changes in the patterns of erosion and sedimentation. Global ice volume fluctuations will significantly alter coasts around the globe. Areas that are now close to sea level may become dry ground during glacial maximums or submerged during warm seasons.[439] Large meteor strikes, enormous volcanic eruptions, significant earthquakes, and large-scale landslides are examples of uncommon occurrences whose likelihood grows over a million-year timeline, but their precise timing is uncertain. The Sun's activity and the planets' orbits will mostly not change from what they are now. For billions of years, the Sun will remain in its main sequence phase. The Milky Way galaxy's stars are always moving. As stars move out of our line of sight, the constellations that are visible from Earth will gradually change form over a million years, becoming somewhat different from the patterns we see now.[440] The solar and terrestrial magnetic fields will continue to control variations in the flow of cosmic rays that reach Earth, which over extended periods of time may have slight effects on the atmosphere's chemistry and temperature. While volcanic activity continues across tectonic boundaries, erosion continues to sculpt the surface. Continental drift may ultimately cause the Atlantic Ocean to shut, resulting in significant collisions between landmasses and the creation of tall mountain ranges. At the same time, the Sun will keep becoming brighter.[441]

Its enhanced radiation will gradually evaporate ocean water, transforming most of Earth into a desert environment over time, even while it is still in its main-sequence phase. In the larger scheme of things, the Milky Way galaxy is headed toward merging with the Andromeda galaxy; this process is already in progress

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[434] Barnard, L., Lockwood, M., Hapgood, M.A., Owens, M.J., Davis, C.J. and Steinhilber, F., 2011, “Predicting space climate change”, Geophys. Res. Lett., 38, L16103, accessed on 03 Feb 2026

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[436] Haigh, J.D., Winning, A.R., Toumi, R. and Harder, J.W., 2010, “An influence of solar spectral variations on radiative forcing of climate”, Nature, 467, 696–699, accessed on 03 Feb 2026

[437] Rescher, Nicholas (1998). Predicting the future: An introduction to the theory of forecasting. State University of New York Press. ISBN 978-0-7914-3553-3, accessed on 03 Feb 2026

[438] Stars in the Milky Way galaxy are in constant motion. Over a million years, the constellations visible from Earth will subtly change shape as stars drift from our perspective, making them slightly different from the patterns we see today, accessed on 03 Feb 2026

[439] Adams, Fred C.; Laughlin, Gregory (1 April 1997). "A dying universe: the long-term fate and evolution of astrophysical objects" (PDF). Reviews of Modern Physics. 69 (2): 337–372, doi:10.1103/RevModPhys.69.337. ISSN 0034-6861, accessed on 03 Feb 2026

[440] Blackman, J. W.; Beaulieu, J. P.; Bennett, D. P.; Danielski, C.; et al. (13 October 2021). "A Jovian analogue orbiting a white dwarf star". Nature. 598 (7880): 272–275, doi:10.1038/s41586-021-03869-6, accessed on 03 Feb 2026

[441] Ferreira, Becky (13 October 2021). "Astronomers Found a Planet That Survived Its Star's Death – The Jupiter-size planet orbits a type of star called a white dwarf, and hints at what our solar system could be like when the Sun burns out". The New York Times. Archived from the original on 28 December 2021, accessed on 03 Feb 2026

and should be completed in billions of years.[442] The center supermassive black holes will combine into a single, bigger entity as a result of this merger, which will also drastically restructure star systems and start fresh waves of star formation. Planetary systems will be rearranged due to gravitational perturbations brought on by these galactic movements.[443]

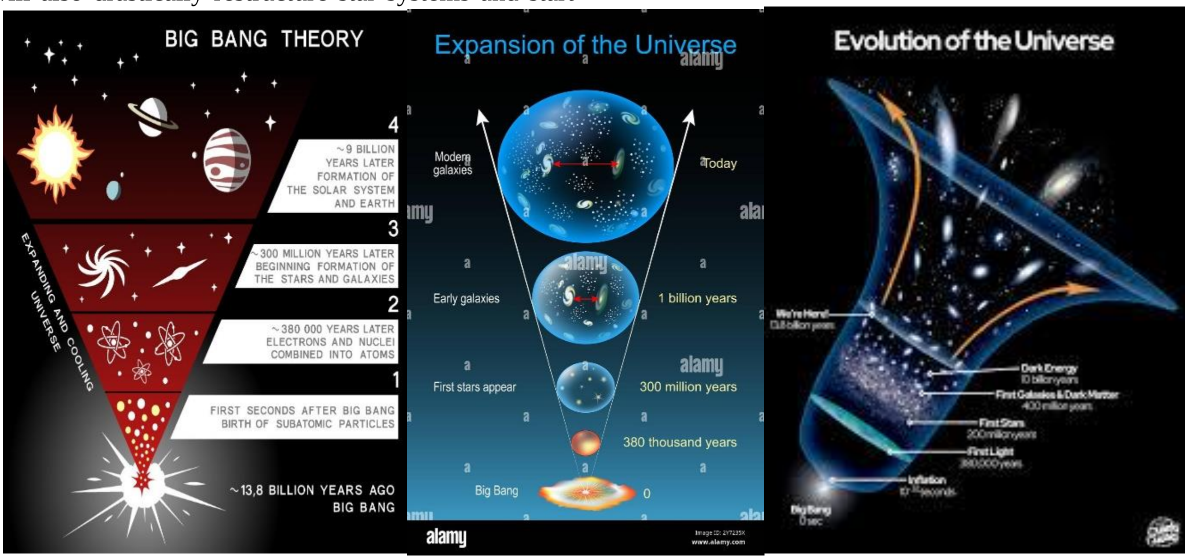

Figure 10: The Big Bang and evaluation of universe444,445,446

6.5 The Far Future of Earth and the Solar System (1 million–10 billion Years).

Mass extinctions might result from hits from asteroids the size of the Chicxulub impactor over this enormous duration.[447] But the Sun will undergo the biggest change. The Sun will run out of hydrogen fuel in around 5 billion years and turn into a red giant, swallowing all the inner planets, including Earth, in the process.[448] Earth will be burned and devoid of its atmosphere if it is not eaten, making it uninhabitable. A white dwarf—a dense, cooling star remnant—will be left behind when the Sun sheds its outer layers, creating a stunning but transient planetary nebula.[449] This white dwarf will continue to fade and lose heat over billions of years. As the solar system progressively turns into a cold, inert region, the gas giants and Kuiper Belt objects will freeze and their orbits may change.[450] The solar system will essentially be dead—silent, frozen, and drifting across the dark expanse of the galaxy—when the white dwarf cools into a black dwarf in around 10 billion years.[451]

6.6 The Degenerate Era and the Dark Universe (10 trillion–10^150 Years).

When all stars have run out of fuel, this period—known as the degenerate era—will start. The absence of hydrogen gas will prevent the formation of new stars.[452] Red dwarf stars are now the longest-lived, and all surviving white dwarfs will cool into black dwarfs. Eventually, it will burn out. Galaxies will spread over billions of years as gravitational forces propel stars and

[442] Komatsu, E.; Smith, K. M.; Dunkley, J.; Bennett, C. L.; et al. (2011). "Seven-Year Wilkinson Microwave Anisotropy Probe (WMAP) Observations: Cosmological Interpretation". The Astrophysical Journal Supplement Series. 192 (2): 18. arXiv:1001.4731. Bibcode:2011ApJS.192...19W. doi:10.1088/0067-0049/192/2/18, accessed on 03 Feb 2026

[443] Landstreet, John D. (2003). Physical Processes in the Solar System: An introduction to the physics of asteroids, comets, moons and planets. Keenan & Darlington. p. 121. ISBN 978-0-9732051-0-7, accessed on 03 Feb 2026

[444] https://www.lode.de/blog/the-big-bang, accessed on 03 Feb 2026

[445] https://www.alamy.com/evolution-of-the-universe-universe-expansion-cosmic-timeline-and-evolution-of-stars-galaxy-and-universe-after-big-bang-general-relativity-illust-image623922262.html, accessed on 03 Feb 2026

[446] https://www.facebook.com/groups/physicsisfun109/posts/529983169680532/, accessed on 07 Nov 2025

[447] Haddok, Eitan (29 September 2008). "Birth of an Ocean: The Evolution of Ethiopia's Afar Depression". Scientific American. Archived from the original on 24 December 2013, accessed on 03 Feb 2026

[448] Berski, Filip; Dybczyński, Piotr A. (November 2016). "Gliese 710 will pass the Sun even closer: Close approach parameters recalculated based on the first Gaia data release". Astronomy & Astrophysics. 595: L10, doi:10.1051/0004-6361/201629835. ISSN 0004-6361, accessed on 03 Feb 2026

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[450] Finkleman, David; Allen, Steve; Seago, John; Seaman, Rob; et al. (June 2011). "The Future of Time: UTC and the Leap Second". American Scientist. 99 (4): 312. arXiv:1106.3141. Bibcode:2011arXiv1106.3141F. doi:10.1511/2011.91.312, accessed on 07 Nov 2025

[451] Bilham, Roger (November 2000). "NOVA Online | Everest | Birth of the Himalaya". pbs.org. Archived from the original on 19 June 2021, accessed on 07 Nov 2025

[452] Loeb, Abraham; Batista, Rafael; Sloan, W. (2016). "Relative Likelihood for Life as a Function of Cosmic Time". Journal of Cosmology and Astroparticle Physics. 2016 (8): 040. arXiv:1606.08448. Bibcode:2016JCAP...08.040L. doi:10.1088/1475-7516/2016/08/040, accessed on 07 Nov 2025

debris into intergalactic space.[453] As they merge and devour surrounding matter, black holes emerge as the dominating cosmic formations. Even they eventually start to evaporate due to Hawking radiation, a gradual process that may take up to 1010010^ {100}10100 years or more. Cosmic microwave background radiation will eventually become undetectable and the cosmos will be a sparse, dark environment full of low-energy particles. Time will become irrelevant in any meaningful sense when particle interactions become so uncommon.[454] The universe will achieve total thermodynamic equilibrium, or maximum entropy.

6.7 Speculative Scenarios Beyond the Heat Death (Post-10^150 Years). According to speculative physics ideas, quantum fluctuations may sometimes result in transient occurrences at this last stage, such as the creation of new particles or even black holes.[455] Such events are very uncommon, however. Whole universes could be recreated by quantum tunneling or vacuum decay, according to certain ideas like everlasting inflation and Poincare recurrence. This might potentially begin cosmic development with a new Big Bang.[456] Boltzmann brains and self-aware creatures that momentarily exist as a result of random fluctuations are further possibilities.[457] The problems of time, entropy, and awareness in endless worlds are highlighted by these strange beings.[458] At the smallest scales, quantum foam might persist as a dynamic, flickering background and possibly the final trace of physical activity in an otherwise static universe.[459]

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453 Adams, F. C.; Bodenheimer, P.; Laughlin, G. (2005). "M dwarfs: planet formation and long-term evolution". Astronomische Nachrichten. 326 (10): 913–919. Bibcode:2005AN....326.913A. doi:10.1002/asna.200510440, accessed on 07 Nov 2025

454 Tayler, Roger John (1993). Galaxies, Structure and Evolution (2nd ed.). Cambridge University Press. p. 92. ISBN 978-0-521-36710-3, accessed on 03 Feb 2026

455 Douglas, M. (21 March 2003). "The statistics of string / M theory vacua". JHEP. 0305 (46): 046. arXiv:hep-th/0303194. Bibcode:2003JHEP...05.046D. doi:10.1088/1126-6708/2003/05/046, accessed on 07 Nov 2025

456 https://ludus-vitalis.org/html/textos/30/30-03_kwiatkowska_szatzschneider.pdf, accessed on 06 Dec 2025

457 https://ui.adsabs.harvard.edu/abs/2002nap.book10248F/, accessed on 03 Feb 2026

458 Linde, Andrei (2007). "Sinks in the landscape, Boltzmann brains and the cosmological constant problem". Journal of Cosmology and Astro-particle Physics. 2007 (1): 022, doi:10.1088/1475-7516/2007/01/022. ISSN 1475-7516, accessed on 03 Feb 2026

459 Andreassen, Anders; Frost, William; Schwartz, Matthew D. (12 March 2018). "Scale-invariant instantons and the complete lifetime of the standard model". Physical Review D. 97 (5) 056006, doi:10.1103/PhysRevD.97.056006, accessed on 07 Nov 2025

Figure 11: We know very less about dark matter and dark energy460

7. Scientific Theories about the Future of Universe and Contradiction

7.1 The Big Bang nucleosynthesis. The idea that explains how the elements formed in the early cosmos is called Big Bang nucleosynthesis. When the cosmos was about three minutes old and its temperature fell below the point at which nuclear fusion could take place, it came to an end. Only the lightest elements were created since Big Bang nucleosynthesis could only function for a short time. It mostly created deuterium, helium-4, and lithium from hydrogen ions or protons. Only tiny amounts of other elements were generated. In 1948, Robert Herman, Ralph Asher Alpher, and George Gamow devised the fundamental theory of nucleosynthesis.[461] Because the Big Bang nucleosynthesis hypothesis links the abundances of primordial light elements with the characteristics of the early universe, it was used for many years as a physics probe during the Big Bang.[462] It may be used to test the equivalency principle in particular,[463] to test neutrino physics and investigate dark matter.[464] According to certain cosmologists, Big Bang nucleosynthesis indicates the existence of a fourth "sterile" neutrino type.[465]

One of the biggest endeavors in cosmology is to comprehend the creation and development of the biggest and oldest structures, including as quasars, galaxies, clusters, and superclusters. Cosmologists investigate a concept of hierarchical structure creation in which the biggest items, such superclusters, are still assembling while smaller objects form first.[466] Surveying the visible galaxies is one approach to quantify the matter power spectrum and create a three-dimensional image of the universe's galaxies. The Sloan Digital Sky Survey and the 2dF Galaxy Redshift Survey take this tack.[467] Cosmologists employ simulations to examine the gravitational aggregation of matter in the cosmos as it clusters into filaments, superclusters, and voids. This

[460] https://www.discovery.com/science/we-have-liftoff--congratulations-to-nasa-and-spacex, accessed on 06 Dec 2025

[461] Peebles, Phillip James Edwin (April 2014). "Discovery of the hot Big Bang: What happened in 1948". The European Physical Journal H. 39 (2): 205–223, doi:10.1140/epjh/e2014-50002-y, accessed on 06 Dec 2025

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[467] Cole, Shaun; Percival, Will J.; Peacock, John A.; Norberg, Peder; Baugh, Carlton M.; Frenk, Carlos S.; et al. (2005). "The 2dF Galaxy Redshift Survey: power-spectrum analysis of the final data set and cosmological implications". Monthly Notices of the Royal Astronomical Society. 362 (2): 505–534, doi:10.1111/j.1365-2966.2005. 09318.x, accessed on 03 Feb 2026

is another way to comprehend structure development.[468] Since there is a lot more-dark matter in the universe than visible, baryonic matter, the majority of simulations only include non-baryonic cold dark matter, which should be enough to comprehend the world on the biggest scales. More sophisticated models are beginning to investigate the origin of individual galaxies and include baryons. Cosmologists examine these simulations to see if they match the galaxy surveys and to interpret any differences.[469]

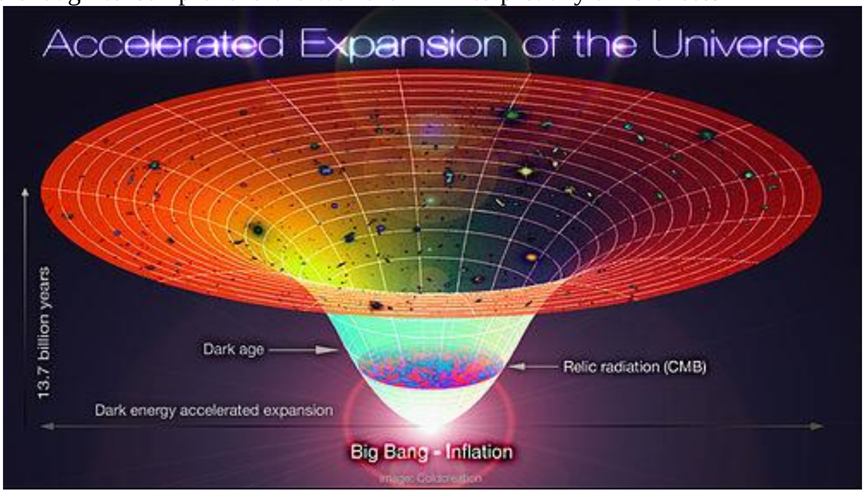

Figure 12: Lambda-CDM, accelerated expansion of the universe470

The cosmic microwave background, structure creation, Big Bang nucleosynthesis, and galaxy rotation curves all provide evidence that non-baryonic dark matter makes up around 23% of the universe's mass, whereas visible, baryonic matter makes up just 4%.[471] Because dark matter acts like a cool, non-radiative fluid that forms haloes surrounding galaxies, its gravitational effects are well known. Dark matter's particle physics nature is still entirely unknown, and it has never been found in a lab. A stable supersymmetric particle, a huge particle that interacts weakly, a big particle that interacts gravitationally, an axion, and a massive compact halo object are some of the possible options in the absence of observational constraints. An effect from brane cosmology or a change of gravity at tiny accelerations (MOND) are alternatives to the dark matter theory. Gravitational lensing may be explained by TeVeS, a kind of MOND. On the other hand, a hypothesis called Modified Newtonian Dynamics (MOND) suggests altering Newton's equations to take into consideration the observable characteristics of galaxies.[472] Modified gravity is the outcome of changing Newton's law of gravity, while modified inertia is the effect of changing Newton's second law.[473] Compared to the adjusted gravity version, the latter has not gotten as much attention. One of the most well-known ideas in this class, its main goal is to explain galaxy rotation curves without the need for dark matter. MOND was created by Israeli scientist Mordehai Milgrom in 1982 and debuted in 1983.[474]

In addition to the 23% dark matter and 4% baryons that make up the universe's energy density, there must be another component that accounts for 73% of the universe's energy density if it is flat. We refer to this as dark energy. It must not cluster in haloes like dark matter and baryons to avoid interfering with Big Bang nucleosynthesis and the cosmic microwave background. Strong observational evidence for dark energy exists since the universe's entire energy density is known because to limitations on its flatness, yet the quantity of clumping matter is precisely measured and far lower than this. In 1999, observations showed that the universe's expansion had started to progressively accelerate, supporting the theory for dark energy.[475] Dark energy is unknown except for its density and clustering characteristics. The cosmological constant (CC), which

[468] Percival, Will J.; et al. (2007). "The Shape of the Sloan Digital Sky Survey Data Release 5 Galaxy Power Spectrum". The Astrophysical Journal. 657 (2): 645–663. arXiv:astro-ph/0608636. Bibcode:2007ApJ...657.645P. doi:10.1086/510615, accessed on 03 Feb 2026

[469] Kuhlen, Michael; Vogelsberger, Mark; Angulo, Raul (November 2012). "Numerical simulations of the dark universe: State of the art and the next decade". Physics of the Dark Universe. 1 (1–2): 50–93, doi:10.1016/j.dark.2012.10.002, accessed on 06 Dec 2025

[470] Weinberg, Steven (2008). Cosmology. Oxford University Press. ISBN 978-0-19-852682-7, accessed on 06 Dec 2025

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[472] Andrei, Cosmin; Ijjas, Anna; Steinhardt, Paul J. (12 April 2022). "Rapidly descending dark energy and the end of cosmic expansion". Proceedings of the National Academy of Sciences. 119 (15) e2200539119, doi:10.1073/pnas.2200539119. ISSN 0027-8424, accessed on 03 Feb 2026

[473] Jacob Bekenstein & M. Milgrom (1984). "Does the missing mass problem signal the breakdown of Newtonian gravity?". Astrophys. J. 286: 7–14, doi:10.1086/162570, accessed on 06 Dec 2025

[474] Milgrom, M. (1983). "A modification of the Newtonian dynamics as an alternative to the hidden mass hypothesis". Astrophysical Journal. 270: 365–370, doi:10.1086/161130, accessed on 06 Dec 2025

[475] Perlmutter, Saul; Turner, Michael S.; White, Martin (1999). "Constraining Dark Energy with Type Ia Supernovae and Large-Scale Structure". Physical Review Letters. 83 (4): 670–673, doi:10.1103/PhysRevLett.83.670, accessed on 06 Dec 2025

is 120 orders of magnitude greater than the measured value, is predicted by quantum field theory to be similar to dark energy.[476] Several string theorists, including Steven Weinberg, have cited the "weak anthropic principle."[477] In this case, physicists see a world with a tiny cosmological constant since a universe with a bigger cosmological constant would not allow for the existence of physicists or any life.[478] The weak anthropic principle is self-evident (there must be at least one universe with a cosmological constant (CC) that permits life to exist given the existence of living observers), but it does not attempt to explain the context of that universe, which is why many cosmologists find this explanation unsatisfactory.[479] The question of the universe's ultimate destiny is probably going to be resolved with a deeper comprehension of dark energy. The fast expansion caused by dark energy is inhibiting the formation of formations bigger than superclusters in the present cosmic epoch. It is uncertain whether the acceleration will ultimately reverse, result in a Big Freeze, or follow some other scenario, or if it will continue continuously, perhaps even rising till a Big Rip.[480]

[476] Adler, Ronald J.; Casey, Brendan; Jacob, Ovid C. (July 1995). "Vacuum catastrophe: An elementary exposition of the cosmological constant problem". American Journal of Physics. 63 (7): 620–626. Bibcode:1995AmJPh.63..620A. doi:10.1119/1.17850, accessed on 03 Feb 2026

[477] Schombert, James. "Anthropic principle". Department of Physics at University of Oregon. Archived from the original on 2012-04-28, accessed on 03 Feb 2026

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[479] Siegfried, Tom (11 August 2006). "A 'Landscape' Too Far?". Science. 313 (5788): 750–753. doi:10.1126/science.313.5788.750, accessed on 30 Nov 2025

[480] Fernández-Jambrina, L. (September 2014). "Grand rip and grand bang/crunch cosmological singularities". Physical Review D. 90 (6) 064014. arXiv:1408.6997. Bibcode:2014PhRvD.90f4014F. doi:10.1103/PhysRevD.90.064014, accessed on 03 Feb 2026

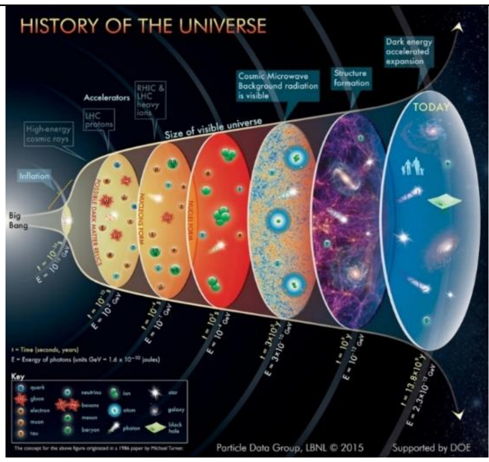

Figure 13: History of universe481

Physics is still unsure about the existence and fate of primordial black holes in our universe.[482] Cosmologists must find cosmic rays with energies higher than the GZK cutoff and determine if this indicates a high-energy breakdown of special relativity.[483] The Greisen–Zatsepin–Kuzmin limit, also known as the GZK cutoff or GZK limit, is a theoretical upper limit on the energy of cosmic ray protons that travel to our galaxy from other galaxies via the intergalactic medium. They must ascertain the concept of equivalency,[484] if Einstein's general theory of relativity is the best way to explain gravity,[485] and if the fundamental laws of physics governing the cosmos are universal.[486] Cosmologists must explain biophysical cosmology, a branch of physical cosmology that examines and comprehends life as both an intrinsic and a component of physical cosmology. It emphasizes that since life is a natural part of the cosmos, it occurs often.[487],[488] Different scientific theories have projected a number of conceivable futures, such as the possibility that the cosmos existed for a limited or infinite amount of time or to explain how and under what conditions it began.[489] The density of the cosmos may influence its destiny. The "Big Freeze" scenario below results from the majority of data to date, which is based on measurements of the mass density and the rate of expansion, favoring a universe that will continue to expand endlessly.[490] Alternative hypotheses are still conceivable, however, and findings are not definitive. By "weighing" the universe—for instance, by calculating the respective contributions of matter, radiation, dark matter, and dark energy to the critical density—one might choose between these difficult possibilities (discussed below). More specifically, opposing hypotheses are assessed in light of information on distant supernovas, galaxy clustering, and cosmic microwave background anisotropies.[491]

7.2 The Big Freeze or Heat Death. The conflict between the pull or push of gravity and the velocity of expansion determines how the cosmos evolves. The Hubble Constant measures the present rate of expansion, while the density and pressure of the universe's matter determine how strong gravity is.[492] The density

[481] https://encrypted-tbn0.gstatic.com/images?q=tbn:ANd9GcQugbskfiB8KnCrD8M85sPWiRpJ0S79eCcH9O-nJ0DpRQ&s, accessed on 03 Feb 2026

[482] Kovetz, Ely D. (2017). "Probing Primordial Black Hole Dark Matter with Gravitational Waves". Physical Review Letters. 119 (13)131301, doi:10.1103/PhysRevLett.119.131301, accessed on 30 Nov 2025

[483] Takeda, M.; et al. (10 August 1998). "Extension of the Cosmic-Ray Energy Spectrum beyond the Predicted Greisen-Zatsepin-Kuz'min Cutoff". Physical Review Letters. 81 (6): 1163–1166, doi:10.1103/PhysRevLett.81.1163, accessed on 30 Nov 2025

[484] Boucher, V.; Gérard, J.-M.; Vandergheynst, P.; Wiaux, Y. (November 2004). "Cosmic microwave background constraints on the strong equivalence principle". Physical Review D. 70 (10) 103528, doi:10.1103/PhysRevD.70.103528, accessed on 30 Nov 2025

[485] Turyshev, Slava G. (2008). "Experimental Tests of General Relativity". Annual Review of Nuclear and Particle Science. 58 (1): 207–248. arXiv:0806.1731. Bibcode:2008ARNPS. 58..207T. doi:10.1146/annurev.nucl.58.020807.111839, accessed on 04 Feb 2026

[486] Uzan, Jean-Philippe (March 2011). "Varying Constants, Gravitation and Cosmology". Living Reviews in Relativity. 14 (1) 2. arXiv:1009.5514. Bibcode:2011LRR....14....2U. doi:10.12942/lrr-2011-2, accessed on 04 Feb 2026

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[490] https://map.gsfc.nasa.gov/universe/uni_fate.html, accessed on 04 Feb 2026

[491] Hu, Wayne; Dodelson, Scott (September 2002). "Cosmic Microwave Background Anisotropies". Annual Review of Astronomy and Astrophysics. 40 (1): 171–216, doi:10.1146/annurev.astro.40.060401.093926,

[492] https://map.gsfc.nasa.gov/universe/uni_expansion.html, accessed on 04 Feb 2026

determines the destiny of the cosmos if the matter's pressure is low, as it is for the majority of matter types that we are aware of. The cosmos will expand indefinitely if its density is lower than the critical density, as shown by the green or blue arcs in the graph above.[493] Gravity may eventually limit the rate of expansion, but at densities below the critical density, the material's gravitational force is insufficient to halt or reverse the outward expansion. The cosmos will gradually chill as it expands until it can no longer support any life, which is why it is sometimes referred to as the Big Chill or Big Freeze.

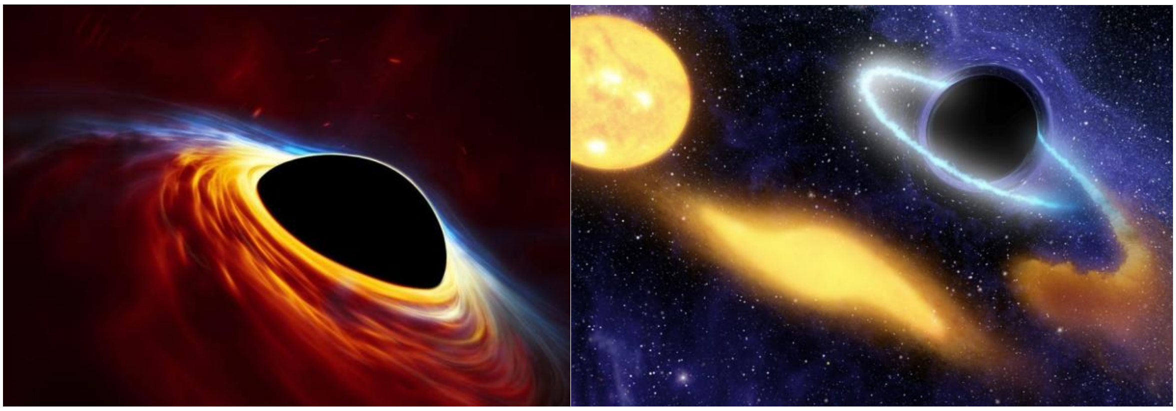

Figure 14: Black holes don't emit light and they might make dark matter shine494,495

The Big Freeze (or Big Chill), also referred to as the "heat death of the universe," is a scenario in which the universe's temperature asymptotically approaches absolute zero due to ongoing expansion.[496] According to this theory, the world ultimately achieves a state of maximum entropy, where everything is distributed equally and there are no energy gradients—all of which are necessary to support information processing, including life. This situation is now more likely to occur.[497] The gas supply required for star formation will ultimately run out, although stars are predicted to develop properly for 1012–1014 (1–100 trillion) years.[498] The cosmos will gradually and unavoidably get darker when current stars run out of fuel and stop shining. Black holes will eventually rule the cosmos, but since they release Hawking radiation, they will eventually vanish.[499] According to the Poincaré recurrence theorem, thermal fluctuations may cause a spontaneous entropy drop over an unlimited amount of time,[500],[501] and the fluctuation theorem.[502],[503] Any of the three spatial models can accommodate the heat death scenario, but it necessitates that the universe eventually reach a minimum temperature.[504] It could only take place in a flat or hyperbolic geometry in the absence of dark energy. It may also happen in a closed universe with a positive cosmological constant.

493 https://map.gsfc.nasa.gov/universe/bb_concepts.html, accessed on 04 Feb 2026

494 https://www.forbes.com/sites/startswithabang/2020/07/07/could-black-holes-be-the-dark-matter-our-universe-needs/, accessed on 10 Feb 2026

495 https://www.space.com/29382-black-holes-make-dark-matter-shine.html, accessed on 10 Feb 2026

496 Glanz, James (1998). "Breakthrough of the year 1998. Astronomy: Cosmic Motion Revealed". Science. 282 (5397): 2156–2157. Bibcode:1998Sci...282.2156G. doi:10.1126/science.282.5397.2156a, accessed on 30 Nov 2025

497 Wang, Yun; Kratochvil, Jan Michael; Linde, Andrei; Shmakova, Marina (2004). "Current observational constraints on cosmic doomsday". Journal of Cosmology and Astro-Particle Physics. 2004 (12): 006, doi:10.1088/1475-7516/2004/12/006, accessed on 30 Nov 2025

498 Stahler, S. W. & Palla, F. (2004). The Formation of Stars. Weinheim: Wiley-VCH. ISBN 3-527-40559-3, accessed on 30 Nov 2025

499 Adams, Fred C.; Laughlin, Gregory (1997). "A dying universe: the long-term fate and evolution of astrophysical objects". Reviews of Modern Physics. 69 (2): 337–372, doi:10.1103/RevModPhys.69.337, accessed on 30 Nov 2025

500 Tegmark, Max (May 2003). "Parallel Universes". Scientific American. 288 (5): 40–51. arXiv:astro-ph/0302131. Bibcode:2003SciAm.288e..40T. doi:10.1038/scientificamerican0503-40, accessed on 04 Feb 2026

501 Werlang, T.; Ribeiro, G. A. P.; Rigolin, Gustavo (2013). "Interplay Between Quantum Phase Transitions and the Behavior of Quantum Correlations at Finite Temperatures". International Journal of Modern Physics B. 27: 1345032. arXiv:1205.1046. Bibcode:2013IJMPB.2745032W. doi:10.1142/S021797921345032X, accessed on 30 Nov 2025

502 Xing, Xiu-San; Steinhardt, Paul J.; Turok, Neil (2007). "Spontaneous entropy decrease and its statistical formula". arXiv:0710.4624, accessed on 04 Feb 2026

503 Linde, Andrei (2007). "Sinks in the landscape, Boltzmann brains and the cosmological constant problem". Journal of Cosmology and Astroparticle Physics. 2007 (1): 022, doi:10.1088/1475-7516/2007/01/022, accessed on 30 Nov 2025

504 Yurov, A. V.; Astashenok, A. V.; González-Díaz, P. F. (2008). "Astronomical bounds on a future Big Freeze singularity". Gravitation and Cosmology. 14 (3): 205–212, doi:10.1134/S0202289308030018, accessed on 30 Nov 2025

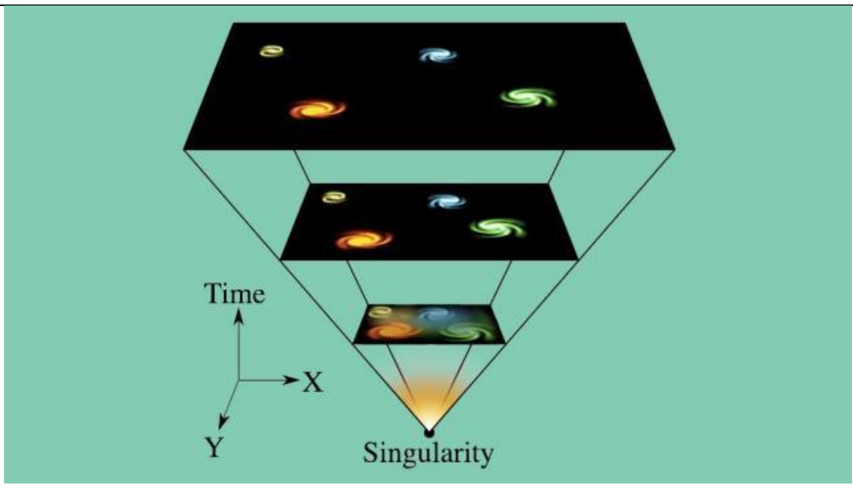

Figure 15: The Big Freeze theory suggests, the universe expansion will continue and have no end[505]

In "Time Without End: Physics and Biology in an Open Universe," published in 1979, scientist Freeman Dyson[506] suggested a scenario for the far future in which intelligent life may process an endless number of ideas to attain a type of immortality.[507] Initially, this idea—known as "Dyson's eternal intelligence"—was based on the open cosmos, a cosmological model that extends indefinitely. The universe would continue to cool as it expands, although more slowly, in the case of a zero cosmological constant, which would result in a flat or open universe devoid of dark energy.[508] According to Dyson's theory, sentient entities might store a limited quantity of energy and use it in ever decreasing amounts. These creatures would hibernate for extended periods of time after each thinking process, which allowed the cosmos to chill even further. It is theoretically possible to process an endless number of ideas over an infinite subjective time even with a finite energy reserve since the lowest energy needed for a computation (a thought) lowers as the universe's ambient temperature falls. The discovery of an accelerating expansion driven by a positive cosmological constant, however, suggests that the universe will not continue to cool indefinitely and that distant regions will become causally disconnected, which would prevent the indefinite survival Dyson envisioned.[509]

7.3 The Big Rip. The Big Rip is a hypothetical cosmological model in physical cosmology that describes the ultimate fate of the universe. According to this model, at some point in the future, dark energy's gravitational pull will gradually tear apart the universe's matter, including stars, galaxies, atoms, and subatomic particles, to the point where particle distances will infinitely increase.[510] The Big Rip is a fictitious, cataclysmic conclusion to the cosmos in which space's rapid expansion overwhelms all other forces and ultimately destroys all structures.[511] This scenario would tear apart solar systems, planets, galactic clusters, galaxies, and eventually atoms and subatomic particles. The process results in the violent and total breakdown of all matter if dark energy or "a form sometimes called phantom energy" becomes stronger over time.[512] The hypothesis is predicated on the notion that dark energy, which propels the expansion of the universe, may get more potent with time. The first consequence would be the disintegration of galaxy clusters. Individual galaxies and then solar systems would be torn apart by the expansion's strength. Planets would be torn off their stars in the last seconds, then the stars themselves.[513] Atoms would eventually lose their ability to stick together, and even subatomic particles would break apart.

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[505] https://bigthink.com/guest-thinkers/the-big-freeze/, accessed on 04 Feb 2026
[506] George Dyson (June 2022). "Freeman John Dyson. 15 December 1923—28 February 2020". Biographical Memoirs of Fellows of the Royal Society. 73: 197–226. doi:10.1098/RSBM.2021.0050. ISSN 0080-4606, accessed on 30 Nov 2025
[507] Dyson, F. J. (1979). Time without end: Physics and biology in an open universe. Reviews of Modern Physics, 51(3), 447–460. https://doi.org/10.1103/RevModPhys.51.447, accessed on 30 Nov 2025
[508] Dyson, Freeman J. (1979). Disturbing the universe. New York: Harper & Row. ISBN 0-06-011108-9. OCLC 4956480, accessed on 30 Nov 2025
[509] Dyson, Freeman J. (1979-07-01). "Time without end: Physics and biology in an open universe". Reviews of Modern Physics. 51 (3): 447–460. doi:10.1103/RevModPhys.51.447, accessed on 30 Nov 2025
[510] https://www.space.com/universe-the-big-rip-can-we-stop-it, accessed on 30 Nov 2025
[511] Ellis, George F. R.; Maartens, Roy & MacCallum, Malcolm A. H. (2012). Relativistic Cosmology. Cambridge, UK: Cambridge University Press. pp. 146–147. ISBN 978-0-52138-115-4, accessed on 04 Feb 2026
[512] Vikhlinin, A.; Kravtsov, A. V.; Burenin, R. A.; et al. (2009). "Chandra Cluster Cosmology Project III: Cosmological Parameter Constraints". The Astrophysical Journal. 692 (2): 1060–1074, doi:10.1088/0004-637X/692/2/1060, accessed on 04 Feb 2026
[513] Caldwell, Robert R.; Kamionkowski, Marc; Weinberg, Nevin N. (2003). "Phantom Energy and Cosmic Doomsday". Physical Review Letters. 91 (7) 071301. arXiv:astro-ph/0302506. Bibcode:2003PhRvL.91g1301C. doi:10.1103/PhysRevLett.91.071301, accessed on 28 Nov 2025

Figure 16: Nobody can stop the Big Rip?514

Let's imagine a time in the future when the cosmos breaks apart much too quickly. The clusters appear first; their galaxies being drawn apart. The galaxies then vanish. The planets and stellar systems will follow. Atoms themselves come next. In the end, space-time is shattered, making the cosmos uninhabitable. But the Big Rip is a possible future. This seems frightening and almost unthinkable, but what is most shocking is that there is some data that appears to be directly pointing to our demise. The present Hubble constant describes a rate of acceleration of the cosmos that is great enough to increase the distance between local objects like galaxies, which are bound together by gravity, but not huge enough to destroy them.[515] All material things in the universe, beginning with galaxies, would ultimately disintegrate into unbound elementary particles, radiation, and other forms in a limited amount of time if the Hubble constant were to steadily climb to infinity.[516] The cosmos ends as what is essentially a singularity when the energy density, scale factor, and expansion rate all reach infinite values. A more abrupt huge rip may happen in the unique scenario of phantom dark energy, which is thought to have negative kinetic energy and would cause a faster rate of acceleration than other cosmological constants predict.[517] Since the Big Rip depends on dark energy acting in a certain manner, it is a theoretical possibility rather than the most probable result. According to available evidence, dark energy is approximately constant, and this model does not anticipate a Big Rip.[518] According to Universe Today, some experimental evidence has suggested options that would increase the likelihood of this scenario, although the precise form of dark energy is yet unknown.[519]

7.4 The Big Crunch. The Big Crunch is a speculative scenario for the universe's ultimate fate in which the universe's expansion eventually reverses and re-collapses, bringing the cosmic scale factor to zero. This could lead to a reformation of the universe beginning with another Big Bang.[520] However, the overwhelming weight of available data suggests that this theory is incorrect. Rather, astronomical data indicate that the universe's expansion is speeding rather than being halted by gravity, indicating a significantly higher probability of a Big Chill or Big Rip.[521],[522] However, some physicists have suggested that a dark energy fluctuation may lead to a "Big Crunch-style" catastrophe. A symmetric perspective on the universe's ultimate destiny is the Big Crunch theory. Similar to how the Big Bang hypothesis began as a cosmic expansion, this theory postulates that the universe's average density will be sufficient to halt its expansion and cause it to start shrinking. The outcome is unclear; a straightforward

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[514] https://www.space.com/universe-the-big-rip-can-we-stop-it, accessed on 04 Feb 2026

[515] Livio, M. (2011). "Lost in translation: Mystery of the missing text solved". Nature. 479 (7372): 171–173. Bibcode:2011Natur. 479..171L. doi:10.1038/479171a, accessed on 04 Feb 2026

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[517] Ludwick, Kevin J. (2017-09-14). "The viability of phantom dark energy: A review". Modern Physics Letters A. 32 (28): 1730025. arXiv:1708.06981. doi:10.1142/S0217732317300257. ISSN 0217-7323, accessed on 04 Feb 2026

[518] https://www.americanscientist.org/article/tearing-apart-the-universe, accessed on 04 Feb 2026

[519] https://www.universetoday.com/articles/what-is-the-big-rip, accessed on 04 Feb 2026

[520] Wang, Yun; Kratochvil, Jan Michael; Linde, Andrei; Shmakova, Marina (2004). "Current observational constraints on cosmic doomsday". Journal of Cosmology and Astroparticle Physics. 2004 (12): 006, doi:10.1088/1475-7516/2004/12/006, accessed on 04 Feb 2026

[521] Falk, Dan (22 June 2020). "This Cosmologist Knows How It's All Going to End". Quanta Magazine,

[522] Perlmutter, Saul (April 2003). "Supernovas, Dark Energy, and the Accelerating Universe". Physics Today. 56 (4): 53–60. Bibcode:2003PhT....56d..53P. doi:10.1063/1.1580050, accessed on 04 Feb 2026

estimate would see the universe's matter and spacetime collapse into a dimensionless singularity, returning to the Big Bang, but at these scales, unidentified quantum phenomena must be taken into account.[523]

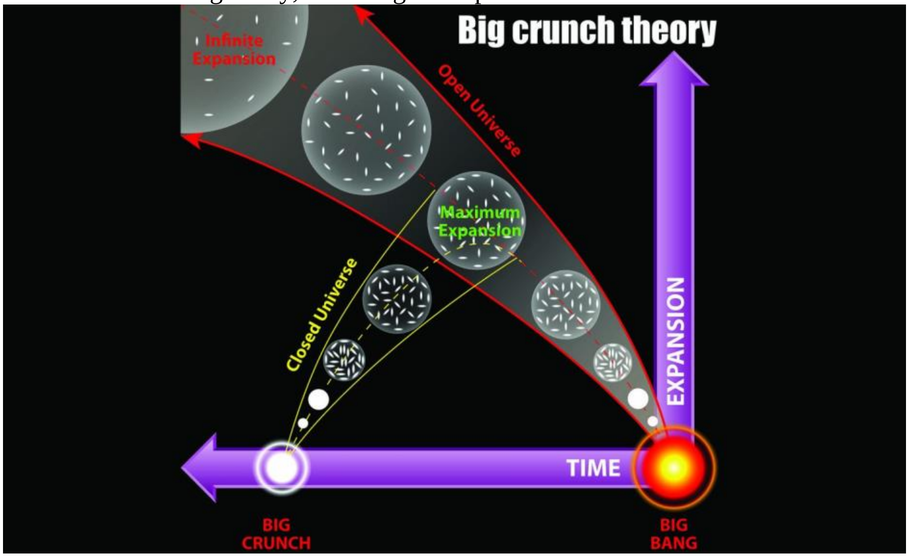

Figure 17: Universe may end with Big Crunch524

Since measurements have only been available for a brief period of time and might reverse in the future, recent information indicates that this scenario is improbable but has not been ruled out.[525] In this case, the Big Bang may happen just after a previous universe's Big Crunch. If this occurs often, a cyclic model—also referred to as an oscillatory universe—is produced.[526] The universe may thus be made up of an endless series of finite universes, each of which ends with a Big Crunch that doubles as the Big Bang of the subsequent universe. The second law of thermodynamics is incompatible with the cyclic cosmos because entropy would accumulate from oscillation to oscillation and ultimately lead to the universe's heat death.[527] The cosmos is not closed, according to current evidence. Cosmologists have given up on the oscillating universe model as a result of this. The cyclic model adopts a somewhat similar concept, but it avoids heat death because of an expansion of the branes that reduces the entropy that was created in the preceding cycle.[528]

7.5 The Big Bounce. A cosmological scenario for the beginning of the known universe is the Big Bounce theory.[529] It was initially proposed as a stage of the oscillatory universe or cyclic model explanation of the Big Bang, in which the first cosmic event was caused by the collapse of an earlier universe.[530],[531] Inflation theory arose as a solution to the horizon issue, which had arisen from improvements in observations exposing the large-scale structure of the cosmos, and it began to lose significant attention in the early 1980s.[532] A scientific theory about the origin of the known universe is called the Big Bounce. It comes from the explanation of the Big Bang known as the oscillatory universe or cyclic recurrence, in which the collapse of an earlier universe caused the initial cosmic event.[533] One interpretation of the Big Bang hypothesis of cosmology holds that the cosmos was initially endlessly dense.

523Rovelli, Carlo (2008). "Quantum gravity". Scholarpedia. 3 (5): 7117, doi:10.4249/scholarpedia.7117, accessed on 04 Feb 2026

524https://www.earth.com/news/universe-will-end-in-a-big-crunch-scientists-predict-when-cosmological-constant/, accessed on 04 Feb 2026

525 Wang, Yun; Kratochvil, Jan Michael; Linde, Andrei; Shmakova, Marina (2004). "Current observational constraints on cosmic doomsday". Journal of Cosmology and Astro-Particle Physics. 2004 (12): 006, doi:10.1088/1475-7516/2004/12/006, accessed on 04 Feb 2026

526 Singh, Parampreet (September–December 2014). "Loop Quantum Cosmology and the Fate of Cosmological Singularities" (PDF). Bull. Astr. Soc. India. 42 (3–4): 121. arXiv:1509.09182, accessed on 04 Feb 2026

527 Dyer, Alan (2007-07-24). Insiders: Space. Simon & Schuster Books for Young Readers. pp. 40–41. ISBN 978-1-4169-3860-6, accessed on 04 Feb 2026

528 Tolman, R. C. (1987) [1934]. Relativity, Thermodynamics, and Cosmology. New York: Dover. ISBN 978-0-486-65383-9. LCCN 34032023, accessed on 04 Feb 2026

529 Abelev, B.; Adam, J.; Adamová, D.; Aggarwal, M. M.; Aglieri Rinella, G.; Agnello, M.; Agostinelli, A.; Agrawal, N.; Ahammed, Z.; Ahmad, N.; Ahmed, I.; Ahn, S. U.; Ahn, S. A.; Aimo, I.; Aiola, S. (2014-11-10). "Beauty production in pp collisions at s=2.76 TeV measured via semi-electronic decays" (PDF). Physics Letters B. 738: 97–108. doi:10.1016/j.physletb.2014.09.026, accessed on 04 Feb 2026

530 Novello, M.; Bergliaffa, S. E. Perez (2008-07-01). "Bouncing cosmologies". Physics Reports. 463 (4): 127–213. arXiv:0802.1634. Bibcode:2008PhR...463.127N. doi:10.1016/j.physrep.2008.04.006, accessed on 04 Feb 2026

531 Finelli, Fabio; Brandenberger, Robert (2002-05-15). "Generation of a scale-invariant spectrum of adiabatic fluctuations in cosmological models with a contracting phase". Physical Review D. 65 (10) 103522. arXiv:hep-th/0112249. Bibcode:2002PhRvD.65j3522F. doi:10.1103/PhysRevD.65.103522, accessed on 04 Feb 2026

532 https://web.archive.org/web/20240917034537/https://press.discovery.com/us/sci/programs/how-universe-works/,

533 Ashtekar, Abhay; Pawlowski, Tomasz; Singh, Parampreet (2 October 2006). "Quantum nature of the big bang: Improved dynamics". Physical Review D. 74 (8) 084003. arXiv:gr-qc/0607039. Bibcode:2006PhRvD.74h4003A. doi:10.1103/PhysRevD.74.084003, accessed on 04 Feb 2026

This description seems to contradict other more well recognized theories, particularly the uncertainty principle of quantum physics.[534]

Figure 18: Big Bang vs. Big Bounce?535

Consequently, a different interpretation of the Big Bang idea has emerged as a result of quantum mechanics, namely that the universe tunneled into existence and had a limited density compatible with quantum mechanics before growing in a way controlled by classical physics.[536] Also, if the universe is closed, this theory would predict that once this universe collapses it will spawn another universe in an event similar to the Big Bang after a universal singularity is reached or a repulsive quantum force causes re-expansion. In simple terms, this theory states that the universe will continuously repeat the cycle of a Big Bang, followed by a Big Crunch. Inflation was found to be inevitably eternal, creating an infinity of different universes with typically different properties, suggesting that the properties of the observable universe are a matter of chance.[537] The horizon issue was thought to have a potential predictive and falsifiable answer in the form of an alternate idea that featured a Big Bounce. As of 2022, the investigation was still ongoing.[538,539,540]

[534] Werner Heisenberg (1989), Encounters with Einstein and Other Essays on People, Places and Particles, Princeton University Press, p. 53, accessed on 04 Feb 2026

[535] https://medium.com/predict/the-big-bang-vs-big-bounce-theory-of-the-universe-8a64cbb80e3c, accessed on 04 Feb 2026

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[539] Lehners, Jean-Luc; Steinhardt, Paul J. (2013). "Planck 2013 results support the cyclic universe". Physical Review D. 87 (12)123533. arXiv:1304.3122. Bibcode:2013PhRvD.87l3533L. doi:10.1103/PhysRevD.87.123533. ISSN 1550-7998, accessed on 04 Feb 2026

[540] Brandenberger, Robert; Peter, Patrick (2017). "Bouncing Cosmologies: Progress and Problems". Foundations of Physics. 47 (6): 797–850. arXiv:1603.05834. Bibcode:2017FoPh...47.797B. doi:10.1007/s10701-016-0057-0, accessed on 04 Feb 2026

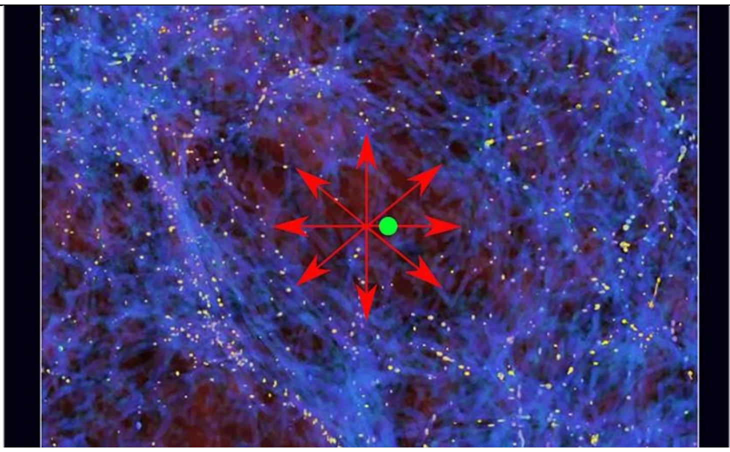

Figure 19: Some scientists believe our Milky Way galaxy may be inside a giant 'cosmic void' in the universe541

7.6 The Big Slurp. According to this idea, the cosmos is now in a false vacuum and might suddenly turn into a genuine vacuum. Understanding the Higgs field, which pervades the cosmos, is essential to comprehending the false vacuum collapse hypothesis.[542] Its potential determines its strength, much as an electromagnetic field does. As long as the cosmos is at its lowest energy state, a genuine vacuum exists; otherwise, the false vacuum idea is meaningless. The vacuum may tunnel into a lower-energy level, however, if it is not at its lowest energy state or is a fake vacuum.[543],[544] We refer to this as vacuum decay.[545] The cosmos might be drastically changed by this: in some cases, even the different physical constants could have different values, which would have a significant impact on the fundamentals of matter, energy, and spacetime. Another possibility is that all buildings will be demolished at once, with no notice.[546] However, because galaxies that are more than 4,200 megaparsecs (13 billion light-years) apart are moving away from one another faster than the speed of light, and the Big Slurp itself cannot expand faster than the speed of light, only a portion of the universe would be destroyed by the Big Slurp, leaving the majority of the universe unaffected.[547] The visible universe is presently around 46 billion light years in all directions from Earth, to put this into perspective.[548] It is believed that the universe is at least that big.

According to one of the most recent findings, our universe may be in grave danger if the Higgs boson really exists at the right mass. "If you use all the physics that we know now and you do what you think is a straightforward calculation, it's bad news," says a theoretical physicist at the Fermi National Accelerator Laboratory in Batavia, Illinois, at least. For many years, a lot of physicists have been debating the notion that our universe is on the verge of instability. In particular, physicists Frank Wilczek and Michael Turner proposed this unpleasant scenario in a 1982 paper published in Nature: "without warning, a bubble of true vacuum could nucleate somewhere in the universe and move outwards at the speed of light, and before we realized what swept by us our protons would decay away."[549] In many tens of billions of years, the universe would undergo a catastrophic event as a "bubble" formed by quantum fluctuations from some sort of alternate universe with a lower-energy state might appear in ours, expanding and ultimately destroying us, according to (Lykken) calculations (which depend on the mass of the Higgs being correct or off by a tiny margin of one percent).[550] He added, "At the speed of light, to boot." More intriguingly, his calculations raised a philosophical challenge that eventually led him to question if the condition of our universe has a role in the creation of stars, galaxies, planets, matter, and ultimately life.

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541 https://www.earth.com/news/milky-way-galaxy-may-be-inside-a-giant-void-in-the-universe-explains-hubble-tension/, accessed on 04 Feb 2026

542 Goulette, Marc (15 August 2012). "What should we know about the Higgs particle?" (blog). Atlas Experiment / CERN. Archived from the original on 13 January 2022, accessed on 04 Feb 2026

543 Stone, M. (1977). "Semiclassical methods for unstable states". Phys. Lett. B. 67 (2): 186–188. Bibcode:1977PhLB...67.186S. doi:10.1016/0370-2693(77)90099-5, accessed on 06 Dec 2025

544 Coleman, S. (1977). "Fate of the false vacuum: Semiclassical theory". Physical Review D. 15 (10): 2929–36. Bibcode:1977PhRvD.15.2929C. doi:10.1103/physrevd.15.2929, accessed on 04 Feb 2026

545 Cabibbo, N.; Maiani, L.; Parisi, G.; Petronzio, R. (1979). 'Bounds on the Fermions and Higgs Boson Masses in Grand Unified Theories', accessed on 06 Dec 2025

546 Hawking, Stephen W. & Moss, I. G. (1982). "Supercooled phase transitions in the very early universe". Physics Letters B. 110 (1): 35–38. Bibcode:1982PhLB.110...35H. doi:10.1016/0370-2693(82)90946-7, accessed on 04 Feb 2026

547 Cain, Fraser; Today, Universe. "How are galaxies moving away faster than light?". phys.org. Retrieved 2023-06-15, accessed on 04 Feb 2026

548 Crane, Leah (29 June 2024). de Lange, Catherine (ed.). "How big is the universe, really?". New Scientist. p. 31,

549 Dimensionless constants, cosmology and other dark matters (with M. Tegmark, A. Aguirre, and M. Rees) astro-ph/0511774 Phys Rev D 73 N2 (2006) [MIT-CTP-3710, accessed on 04 Feb 2026

550 Hawking radiation of charged blackhole through gauge and gravitational anomaly (with Satoshi Iso, Hiroshi Umetsu) hep-th/0602146 (2006) [MIT-CTP-3714], accessed on 04 Feb 2026

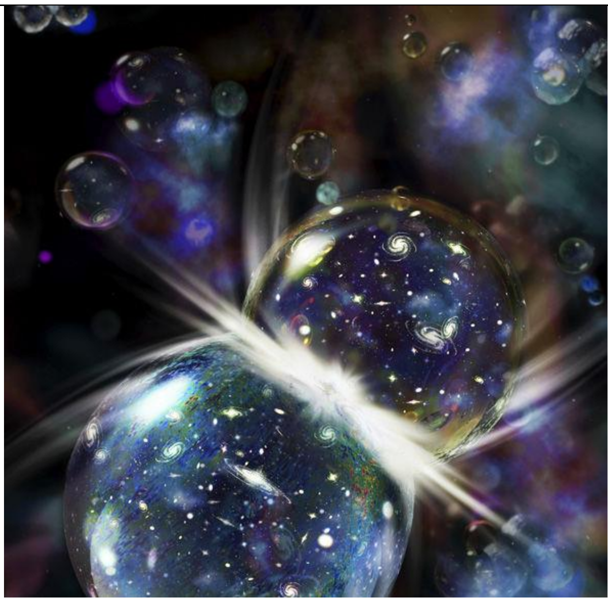

Figure 20: The ways that earth and the universe could die551

7.7 The Cosmic Uncertainty. Cosmic variance and basic physical laws are the two primary causes of the inherent limitations on our capacity to fully understand the cosmos. The statistical uncertainty that results from our limited ability to witness a single universe—a single sample with random fluctuations—is known as cosmic variance. There is a universal limit on how accurately some pairs of physical attributes (such energy and time) may be understood simultaneously due to fundamental laws like Heisenberg's uncertainty principle.[552] In reality, cosmologists are only ever able to investigate our single universe. As a result, we can only see one realization of things like the cosmic microwave background or the dispersion of galaxies on a wide scale.[553] Random quantum fluctuations in the early cosmos developed into the large-scale features we see today. This implies that the cosmos as a whole is not always represented by our observable area.[554] Measurements of cosmic attributes, such the density of matter or the features of early universe fluctuations, are always subject to statistical error due to cosmic variation. For instance, a survey area of the sky may coincidentally have a little greater or lower galaxy density.[555] Every scenario that has been discussed so far is predicated on a basic version of the dark energy equation of state. But as the name suggests, not much is currently understood about the mechanics of dark energy.[556] In the early stages of the Big Bang, the universe experienced an episode dominated by a distinct kind of dark energy if the idea of inflation is correct. However, inflation terminated, suggesting a more complicated equation of state than those thought to apply to modern dark energy. It's likely that the dark energy equation of state may shift once again, leading to an occurrence with unpredictable and hard-to-parameterize effects.[557] The possibilities of dark energy and dark matter's function in the cosmos are unclear as their nature is still mysterious, if not speculative.

551 https://www.express.co.uk/news/science/658752/End-of-the-world-The-ways-that-Earth-and-the-universe-could-DIE, accessed on 04 Feb 2026

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554 https://www.worldscientific.com/doi/10.1142/9789814355124_0014?srsltid=AfmBOoq1VXz9zrwaWZmWvpg3YGHW6Y_ljCeOVTE8GHnIZMG-yPp4UQT3, accessed on 06 Feb 2026

555 https://phys.org/news/2021-01-uncertainties-cosmic-expansion.html#google_vignette, accessed on 06 Feb 2025

556 Perlmutter, S.; Turner, M.; White, M. (1999). "Constraining Dark Energy with Type Ia Supernovae and Large-Scale Structure". Physical Review Letters. 83 (4): 670–673, doi:10.1103/PhysRevLett.83.670, accessed on 06 Feb 2026

557 Falk, Dan (2023-10-05). "The 'least crazy' idea: Early dark energy could solve a cosmological conundrum". Astronomy Magazine, accessed on 06 Feb 2026

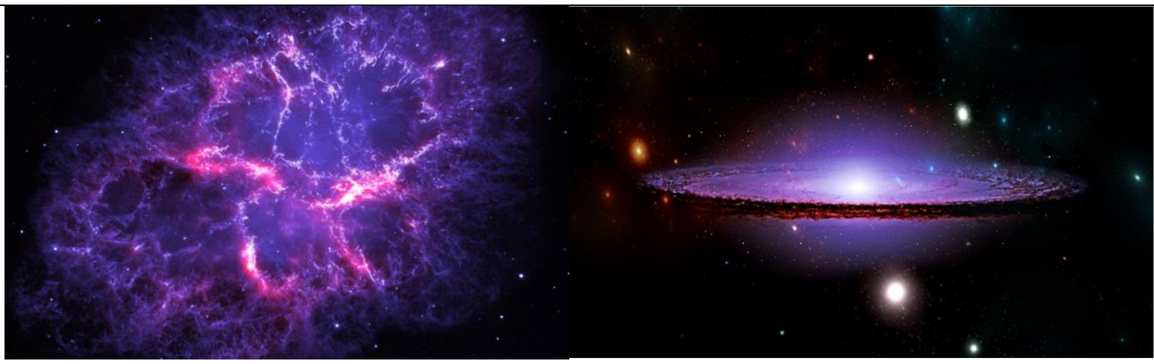

Figure 21: Cosmic uncertainty, there may antimatter worlds and Higgs particle 558,559

We will be able to make more hypotheses and verify our final line of defense in the event that the universe ends as we delve more into cosmology, bio-information theory, and the many theories of consciousness. One issue is a positive cosmic constant. Galaxies and other cosmic phenomena gradually "grow" apart due to an accelerating cosmos. There would be no way to access the energy stored in these locations. Unless, of course, the dark house—dark energy—is introduced. The nature of dark energy and its effects are mostly unknown. Thus, this is still unsettled. Going below the physical threshold required to sustain conscious awareness is the biggest barrier to attaining Dyson's perpetual intelligence. Even while organic lifeforms are undoubtedly inefficient at converting energy into computations (and awareness), it's possible that inorganic lifeforms or even other chemical architectures may produce consciousness with far less energy.

[558] https://www.newscientist.com/round-up/cosmic-uncertainty/, accessed on 06 Feb 2026
[559] https://www.livescience.com/strange-higgs-stole-antimatter-from-universe.html, accessed on 06 Feb 2026

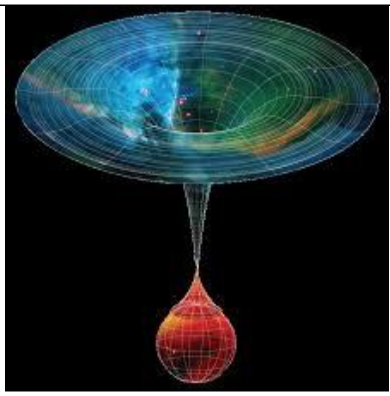

Figure 22: False vacuum decay and Big Slurp Theory560

The concept of a rigidly preset or programmed, clockwork cosmos was fatally undermined by the uncertainty principle. A quantum system's future motion can only be explained in terms of probabilities rather than absolutes as we are unable to determine its exact beginning state. Chaos theory shows that complex systems are very sensitive to beginning circumstances, even in classical, macroscopic systems, making long-term predictions—like weather forecasting or earth fast early warning—virtually unachievable. Some contemporary philosophers and physicists, such as Carlo Rovelli, investigate the nature of time itself, questioning our intuitive beliefs that the past and future are separate entities and proposing a nuanced connection between entropy, cause, and effect. In the end, physics has shifted from seeking perfect certainty to accepting reality's probabilistic character and realizing that the future is inevitably unpredictable and full of possibilities. Indeed, there are many dark rules in the environment we live in, and they undermine predicting ability by escalating mistakes and making measured quantities very susceptible to erratic outside influences.[561] Under unpredictable circumstances, there is no one solution in a dynamic environment. "Any approach to scientific inference that seeks to legitimize an answer in response to complex uncertainty is, for me, a totalitarian parody of a would-be rational learning process," as mathematician A. F. M. Smith has succinctly put it.'[562] Physics is an essential field that advances technology and transforms society in addition to expanding our knowledge of the cosmos. Physics has greatly influenced human civilization, from the discovery of basic principles to the creation of technologies that have revolutionized contemporary living. Furthermore, it tackles some of the most important issues about truth, existence, and the nature of the cosmos, inspiring interest and investigation to this day.[563]

[560] https://www.ctc.cam.ac.uk/activities/field-theory/Francesco_Muia_slides.pdf, accessed on 06 Feb 2026
[561] Robert B. Laughlin, A Different Universe. Reinventing Physics from the Bottom Down, Basic Books, A Member of the Perseus Book Group, Cambridge MA, 2006: 210, accessed on 06 Feb 2026
[562] A. F. M. Smith, "Present position and potential developments: Some personal views of Bayesian statistics," Journal of the Royal Statistical Association 147 (3): 245-259, accessed on 06 Feb 2026
[563]https://www.theguardian.com/books/2023/apr/22/physicist-michio-kaku-we-could-unravel-the-secrets-of-the-universe#:~:text=,https://www.theguardian.com/books/2023/apr/22/physicist-michio-kaku-we-could-unravel-the-secrets-of-the-universe#:~:text=, accessed on 06 Feb 2026

*Figure 23: The Earth is trapped in a big void and can't escape*564,565

The clockwork cosmos was blown apart by quantum theory and the general theory of relativity, which unequivocally demonstrated that human knowledge was, at best, inadequate and would likely stay that way indefinitely. Some locations in the cosmos, like black holes, might never provide any information at all. Chaos theory also illustrated how chaos is often located at the core of natural and social systems and highlighted our inherent limitations in understanding, predicting, and regulating the world around us. On the other hand, the "4D-balloon" concept, or more precisely the 3D-hypersurface of a 4D-hypersphere, is a cosmological model and pedagogical analogy used to explain the expansion and topology of the universe. It posits that our 3D universe is the "skin" of a 4D object, similar to how 2D beings would inhabit the 2D surface of a 3D balloon. However, a 3D torus, are also possible, making the 4D-balloon one of several potential, non-proven models. For decades cosmological models have loved to use a 4D hypersphere to model the universe because it perfectly seems to fit the observational data. Inappropriately, a 4D hypersphere has four spatial dimensions and our universe is limited to three, so although mathematically that model fits, intuitively for obvious reasons it's wrong since our universe has only three spatial dimensions. This model shows how a three-dimensional object can appear to be a 4-dimensional hypersphere, or hyper-shell to be more exact. This model gives an actual and very simple intuitive shape to the universe, is perfectly homogenous & isotropic, reproduces the Hubble parameter, and requires no weird dimensions.[566] Our Universe may have been 3D surface of 4D balloon. One of the goals of the science of cosmology is to discover whether our Universe is open, closed or critical.[567]

8. Conclusion

As per the most accepted theory of physics and highest number of scientists believe that, approximately 13.8 billion years ago, space and time began in a rapid, hot expansion. As the universe cooled, elementary particles formed. Around 380,000 years later, the universe cooled enough for stable atoms, mostly Hydrogen and Helium to form and releasing the 'after-

[564] https://www.facebook.com/wesaveblueplanet/posts/-astronomers-propose-we-could-live-inside-a-giant-cosmic-voida-recent-study-pres/837116198958138/, accessed on 11 Feb 2026
[565] https://www.youtube.com/watch?v=olJbmfwHm24, accessed on 11 Feb 2026
[566] https://www.facebook.com/groups/AstroCosmoNews/posts/3306929142945969/, accessed on 11 Feb 2026
[567] https://sites.ualberta.ca/~pogosyan/teaching/ASTRO_122/lect30/lecture30.html, accessed on 11 Feb 2026

glow' known as the CMB. Over billions of years, gravity caused gas to aggregate, forming the first stars and galaxies. Roughly 5 to 6 billion years ago, the universe began accelerating in its expansion, driven by a mysterious force called dark energy, which makes up about 68% of the universe. The JWST has discovered mature, massive, and highly evolved spiral galaxies existing only 200-300 million years after the Big Bang. Standard theories predicted that galaxies of this size and complexity should not have had enough time to form that early. JWST has revealed an overabundance of heavy elements like oxygen, nitrogen, and carbon in the very early universe, suggesting stellar evolution happened much faster than previously thought. There is a major conflict in science are measurements of the universe's expansion rate or Hubble constant using the early universe or CMB disagree with measurements based on modern, closer, and faster-moving objects. Some scientists suggest the universe is expanding via a 3D hypersurface of a 4D bubble, which might explain the early appearance of galaxies without requiring exotic, undiscovered dark matter particles. The concept that the Big Bang is just one of many, with different physical laws operating in other regions, is a major, though as-yet unproven, and may be alternative concept.

Our comprehension of the universe's genesis is one of physics' greatest accomplishments. Scientists have been able to investigate the underlying nature of space and time, the development of stars and galaxies, and the beginnings of the universe by using physical rules. Today, physics has made it possible for people to go beyond Earth. The concepts of classical mechanics, thermodynamics, and relativity are crucial to space exploration, which has resulted in trips to the moon, Mars, and beyond. New perspectives on planetary systems and the possibility of extraterrestrial life have been made possible by the finding of exoplanets, or planets outside of our solar system. As they look for answers to puzzles like dark matter, dark energy, and the ultimate destiny of the universe, physicists are pushing the limits of human knowledge with instruments like the Hubble Space Telescope and the soon-to-be James Webb Space Telescope. The current awareness that uncertainty is a basic, intrinsic element of nature, particularly at the quantum level, reveals a change from the classical idea of a completely predictable "clockwork" cosmos. The exact forecasting of future occurrences is inherently limited by this underlying uncertainty. Today, scientists have competing theories about how the universe ends. As per the Big Freeze theory, the universe expands forever, growing colder and more diffuse until no energy can interact. On the other hand, the Big Rip theory explain that dark energy's repulsive force increases, tearing apart galaxies, stars, and eventually atoms. At the same time the Big Crunch theory said, gravity overcomes expansion, causing the universe to collapse back into a single point.

Scientists, as enlightened philosophers believed that human reason and observation could reveal the ultimate truths of the cosmos. This new worldview has had a significant impact on art, literature, philosophy, science, and social interactions, even if we may not always be aware of it. By 'weighing' the universe—for instance, by calculating the respective contributions of matter, radiation, dark matter, and dark energy to the critical density—one might choose amongst the competing hypotheses described in this study. More specifically, data on distant supernovas, galaxy clustering, and cosmic microwave background anisotropies are used to assess difficult situations. These days, the 21st century starts with a modest acceptance of ambiguity. The book From Certainty to Uncertainty tracks the emergence and decline of the deterministic cosmos and demonstrates the changing effects that these seemingly unrelated fields now have on one another. Advanced artificial intelligence (AI), interplanetary travel, brainnets, or mind-internets, quantum computing, and the unveiling of cosmic secrets are the main topics of Michio Kaku's most recent universe predictions. Though climate change is still a direct concern, he predicts possible world ends like the Big Crunch and emphasizes how future technology might alleviate major issues, allow for human expansion like Mars colonization, and even allow direct experience sharing via brain interfaces. Thus, we may draw lessons from the past and make predictions about how we will govern our lives going forward. Physics will continue to be essential as we tackle the problems of the future, from space exploration to energy sustainability and beyond. Today, the narrative of universe is shifting from a smooth, uniform, slow-evolution model to a far more volatile, rapid-evolution, and potentially '4D-balloon' model based on new, early-galaxy data. We may expect that in the near future, we will be able to see the future of the cosmos and our existence on it more clearly.