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# Appraisal of Chronological Development of Physics with Creation of Universe and Uncertainty of Future

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## ABSTRACT
**The chronological development of physics has gradually shifted humanity's worldview from a deterministic, expectable universe to one characterized by probabilistic outcomes and inherent uncertainty. This shift is principally driven by the transition from classical to modern physics, intensely influencing theories about the universe's creation and future. The integration of relativity with astrophysical observations like Edwin Hubble's discovery of an expanding universe and the detection of cosmic microwave background radiation led to the widely accepted Big Bang theory. Physics allows cosmologists to look back in time and understand the universe's earliest moments, starting from a hot, dense singularity approximately 13.8 billion years ago. The study of tiny quantum fluctuations in the early universe, observed in the cosmic microwave background, provides 'fingerprints of creation' that grew into the large-scale structures we see today. While classical physics offered a deterministic view, modern physics, particularly quantum mechanics and current cosmology, embraces uncertainty regarding the universe's ultimate fate. The future is largely unpredictable in detail due to factors like the precise nature and behavior of dark energy, which is accelerating the expansion of the universe. Current theories about the end of the universe like the 'Big Freeze' the 'Big Crunch,' or the 'Big Rip' and those depend on these unknown variables and the ongoing modification of fundamental physics. The future remains unknown and mostly unpredictable in specific detail. This journey reveals physics as a continuously evolving field that has moved from a desire for perfect prediction to an acceptance of probability and the dynamic, open-ended nature of cosmic inquiry. This paper will try to apprise and analyze the history and creation of universe and uncertainty of future on the basis of chronological development of theories of physics.**

**Keywords:** Dark energy, black hole, big bang, big freeze, big rip, cosmic uncertainty.

## INTRODUCTION
Knowledge of physics is essential for understanding the future of life and the universe because it provides the fundamental laws that govern all matter and energy, from the smallest subatomic particles to the largest cosmic structures. Life itself operates within the laws of physics. Understanding fluid dynamics is vital for comprehending blood flow, electromagnetism is key to nerve impulses, and thermodynamics explains how energy is utilized and transferred in biological systems. Matter and energy are the main subjects of study in the scientific field of physics. . [i] Philosophers in ancient times across various cultures discussed these topics, but lacked the means to differentiate the causes of natural phenomena from other factors superstitions.[ii] A process of gathering specialized information that resulted

in the creation of physics was started by the Scientific Revolution of the 17th century, particularly with the discovery of the law of gravity. [iii] Classical mechanics was developed as a result of mathematical developments in the 18th century, while new discoveries in thermodynamics were made possible by the increasing use of experimental. Important rules of statistical mechanics and electromagnetic were discovered in the 19th century. Physics grew more and more defined by sophisticated analytical techniques throughout this time, maybe even more so than by the search for the underlying nature of matter and universal rules of motion and energy. [iv] Discoveries in quantum mechanics, relativity, and atomic theory propelled fundamental advances in physics during the beginning of the 20th century. [v] Physical science research includes disciplines such as optics, fluid dynamics, electromagnetic, mechanics, acoustics, geophysics, astrophysics, aerodynamics, plasma physics, low-temperature physics, and solid-state physics. [vi] Physics became closer to disciplines like electrical, aeronautical, and materials engineering in the 20th century. Physicists began to work in government and commercial laboratories just as much as in academic institutions.[vii] Physics became more closely associated with disciplines such as electrical, aeronautical, and materials engineering over the 20th century. Government and corporate laboratories began to employ physicists just as much as academic institutions. .[viii]

The pursuit to understand the universe and our surroundings is one of humanity's noblest endeavors. By uncovering the laws of nature, we satisfy curiosity and improve life for future generations. Physics, being the most fundamental science, plays a key role in these efforts. Throughout history, scientists such as Einstein, Max Planck, Niels Bohr, Newton, and Archimedes have led challenges and made revolutionary discoveries. The thrill of physics comes from these pioneering achievements and innovative breakthroughs theories.[ix] Whether observing a new phenomenon or solving a longstanding mystery, the thrill of scientific discovery is unmatched. Physicists have consistently explored the universe to unlock scientific secrets, employing their imagination and reasoning to uncover fundamental and surprising theories nature.[x] One of physics' most significant contributions is enhancing our understanding of the universe. By applying physical laws, scientists have explored the origins of the cosmos, how stars and galaxies form, and the essential nature of space and time.[xi] Every physicist, regardless of their fame, contributes crucially to progressing our understanding by posing and resolving these key questions related to creation, life, universe and future.

On earth a man is calculating the speed and position of a moving object is relatively candid. We can measure a car traveling at 80 KM per hour or a human walking at 8 KM per hour and instantaneously identify where the objects are positioned. However, In the quantum realm of particles, these calculations are impossible because of a fundamental mathematical principle called the uncertainty principle. The mainstream Copenhagen interpretation states that quantum systems exist in a superposition of possibilities until measured. At the moment of measurement, a single outcome is randomly selected, making the specific future uncertain.[xii] It's interesting to note that in 1927, German physicist and Nobel winner Werner Heisenberg demonstrated that total predictability is further limited by the inability to accurately know some pairs of attributes at the same time, such as a particle's location and momentum.[xiii] In other words, if a human were shrunk to the size of an electron, we could only precisely determine either its speed or its location, not both simultaneously. While the Heisenberg uncertainty principle is well-known in quantum physics, a comparable principle also applies to pure math and classical physics problems. Essentially, any object with wave-like characteristics is subject to this principle. Quantum objects are unique because they inherently display wave-like properties due to the nature of quantum mechanics theory.[xiv] Quantum physics is the branch of science that investigates matter and energy at the most basic level. Its goal is to understand the properties and behaviors of the fundamental building blocks of the universe nature.[xv]

To grasp the basic concept of the uncertainty principle, imagine a ripple in a pond. To determine its speed, you'd track several peaks and troughs passing by. The more peaks and troughs you monitor, the better you'll understand the wave's speed—but your knowledge of its exact position decreases, as the location is dispersed among those peaks and troughs. Conversely, if you focus on pinpointing the position of a single peak, you'd need to observe only a small segment of the wave, sacrificing information about its speed. In essence, the uncertainty principle highlights a trade-off between two related properties, like speed and position. An additional analogy involves a rollercoaster: when the car reaches the peak of a hill, a snapshot can show its location but not its speed, while descending the hill allows measurement of speed but leaves its exact position less certain. The principle illustrates a compromise between two complementary variables, such as position and speed.[xvi] The fundamental law is relevant in the quantum realm because subatomic particles can act like waves. A common misconception about the uncertainty principle in quantum physics is that it suggests our measurements are uncertain or inaccurate.[xvii] In fact, uncertainty is a fundamental part of any phenomenon with wave-like properties behavior.[xviii]

Though it was once restricted to astronomy, physics has origins in the ancient civilizations and differs from modern knowledge. Ancient Greeks, Egyptians, Mesopotamians, and New World societies like the Maya and Aztecs all had sophisticated knowledge of the stars in the universe.[xix] In order to follow the seasons and obtain a fundamental understanding of the cosmos, each of them examined the sky to watch and predict the motion of the sun, moon, and stars. [xx] Although they lacked the resources and knowledge of the sky to completely understand these ideas, their mathematics was sometimes stunning and correct. Despite the lack of touch with modern technology, every major culture engaged in some sort of sun worship or adoration, and some of these behaviors were remarkably similar. [xxi] In several cases, their mathematics was astounding and correct, but they lacked the instruments and knowledge of the skies to completely appreciate these ideas. Remarkably, despite the lack of touch with modern technology, some of the traditions of sun worship and adoration were extremely similar throughout all major civilizations?[xxii] Modern physics has challenged conventional notions of reality and determinism, especially through theories like general relativity and quantum mechanics, suggesting that the cosmos may be far more complex and weirder than previously believed. [xxiii]

One of the greatest unresolved challenges in physics is the effort to merge general relativity, the theory explaining gravity and the universe's large-scale structure, with quantum mechanics, which controls the behavior of particles at the tiniest scales.[xxiv] The pursuit of a "Theory of Everything" remains one of the most exciting frontiers in physics. If successful, it would offer a unified framework for understanding all physical phenomena, ranging from galaxy behavior to subatomic interactions particles. This study explores the nature of time, reality, and the future by examining the intersection of Einstein's theory of relativity and quantum mechanics. Relativity introduces the concept of a four-dimensional space-time continuum and the "block universe," where all events—past, present, and future—exist simultaneously, implying a deterministic cosmos. However, quantum mechanics challenges this determinism through the probabilistic behavior of particles and the idea that outcomes only become definite upon measurement. The interpretation of this quantum indeterminacy varies: the Copenhagen interpretation suggests a fundamentally random universe, while the Many-Worlds interpretation restores determinism by positing branching realities for every possible outcome. Additional concepts like decoherence, entanglement, and the limitations of alternative theories such as pilot-wave mechanics further enrich the debate. So, history of physics is interesting and fascination and future of human civilization is uncertain and remain unfold.

The fact that our Universe is expanding was discovered almost a hundred years ago, but how exactly this happens, scientists realized only in the 90s of the last centuries when powerful telescopes (including orbital ones) appeared and the era of exact cosmo.[xxv] However, the Big Bang theory is the most well circulated understanding of human civilization and present world. The Big Bang marks the universe's inception, occurring about 13.8 billion years ago. It initiated an expansion and enlargement from an extremely dense and hot state. As the universe cooled, fundamental particles formed, leading to hydrogen and helium. Over millions of years, gravitational forces coalesced these gases into stars and galaxies, igniting nuclear fusion. This process gave birth to heavier elements, which later contributed to the formation of planets and life and which is briefly describe in cosmic calendar. Vital defect in big bang theory may be the assumption that intelligent life got created from something random. Likewise, Einstein's famous equation, E=mc2 may come under question as garbage also can be used to make atom bombs instead of radioactive material as long as it is matter or it has mass. Some people also question, how in the beginning, there was nothing as consider in the big bang. And from Nowhere came all the matter that is or will ever be. The study also considers how consciousness and the relativity of simultaneity complicate our experience of the 'present,' raising deep questions about whether the future is fixed or still unfolding. This is an investigative research work based of prominent theories of physics to apprise and analyze the history, chronological development of concept and theories of physics and creation of universe and finally the evaluation of future and its uncertainty.

## LITERATURE REVIEW

### Background

Long before scientific exploration took center stage, various civilizations around the globe crafted sumptuous stories to explain how the universe came into existence. These stories, rich in symbolism and metaphorical significance, provided societies with a narrative framework to comprehend the complexities of their surroundings and their own significance. In Egyptian cosmology, usual people believed that the universe emerged from the primordial waters of the creator God, Nun, and these waters formed an abyss with boundless potential and endless possibilities. The sun God, Atum, was credited with bringing structure and form to the cosmos through his creative prowess. In a similar vein, ancient Greek cosmogeny tells the story of the primeval God Chaos giving birth to the universe, from where the Gods Gaia (Earth), Uranus (Sky), and other primordial divinities arisen. These ancient myths don't articulately explain any of the natural events in our universe, but they do convey cultural stories that mirror societal values, beliefs, dreams, and thoughts.

The 20th century notices a change in our understanding of how the universe began through modern cosmology. In the 1920s, Edwin Hubble's groundbreaking discovery of an expanding universe laid the groundwork for the development of what we call the Big Bang Theory, which has reshaped our understanding of cosmic development. The Big Bang Theory recommends that about 13.8 billion years ago, the entire universe began from a dense, extremely hot single spot according to the Center for Astrophysics. This spot is known as the "singularity," and it marks the beginning of what we now know as space, time, and matter.[xxvi] As space expanded and cooled down over time, subatomic particles merged to form atoms that later evolved into distant galaxies, stars, and planets.[xxvii] It eventually shaped our own solar system and the cosmic structure that we have today. The Big Bang Theory's ability to account for various observations, from cosmic microwave background (CMB) radiation to the distribution of galaxies, has established it as the primary model in cosmology. Nonetheless, like all theories, the Big Bang Theory comes with its own limitations and has sparked ongoing discussions and explorations into alternative models of cosmic evolution.[xxviii]

In 1927, an astronomer named Georges Lemaître had a great idea. He said that a very long time ago, the universe started as just a single point. He said the universe stretched and expanded to get as big as it is now, and that it could keep on stretching. Just two years later, an astronomer named Edwin Hubble noticed that other galaxies were moving away from us. And that's not all. The farthest galaxies were moving faster than the ones close to us. This meant that the universe is still expanding, just like Lemaître thought. If things were moving apart, it meant that long ago, everything had been closed together. When the universe began, it was just hot, tiny particles mixed with light and energy. It was nothing like what we see now. As everything expanded and took up more space, it cooled down. The tiny particles grouped together. They formed atoms. Then those atoms grouped together. Over lots of time, atoms came together to form stars and galaxies.[xxix] The first stars created bigger atoms and groups of atoms. That led to more stars being born. At the same time, galaxies were crashing and grouping together. As new stars were being born and dying, then things like asteroids, comets, planets, and black holes formed. And it's call it the "Big Bang. "Today we now know that the universe is 13,800,000,000 (or 13.8 billion) years old. That is a very long time.[xxx]

The Big Bang theory is vivid and convinces us that the universe emerged from an extremely hot and dense initial state, not from a "primordial atom explosion" as is commonly misinterpreted. However, even with its wide acceptance by the scientific community, this acceptance does not guarantee that it holds the definitive truth about the remote origins of the cosmos. For over a century, this theory has been considered a valid model by science. Yet, several historical gaps have not been overcome, and new doubts arise as the theory is disseminated in academic and educational environments around the world. The fact that it is widely accepted does not imply that it is unquestionably true, nor that the universe originated exactly as proposed by it. Additionally, a scientific theory should be supported by the empirical evidences that favor it. The evidence that once reinforced the Big Bang can now also support new theories, such as the "dead universe" theory discussed in this article. The Big Bang theory is undeniably a well-accepted model, but the cosmological model of the dead universe theory may prove to be inevitable. The validity of this new theory may be more clearly demonstrated through technological advancements and mathematical calculations in the area of quantum computing than merely by the work of astrophysicists seeking precision to corroborate the theory.

However, before Edwin Hubble cemented his mark in the study of the cosmos, Alexander Friedmann and Georges Lemaître had already laid the theoretical groundwork that would challenge prevailing conceptions of the universe. In 1922, Friedmann, a Russian mathematician, pioneered the application of the equations of the theory of relativity to predict an expanding universe, an idea initially met with skepticism. In parallel, in 1927, the Belgian priest and astronomer Georges Lemaître independently proposed a similar model that included the notion of a "primeval atom" and the theoretical precursor to what would later be known as the Big Bang. In the landscape prepared by these visionary minds, Edwin Hubble emerged as a transformative figure. Throughout his career, he dedicated himself to the study of the redshift of galaxies, a phenomenon that he himself highlighted through meticulous observations. In 1929, Hubble published his results establishing a direct relationship between the redshift and the apparent brightness of galaxies, corroborating and expanding upon the theories of Friedmann and Lemaître. This discovery, known as Hubble's Law, transcended existing theoretical models and transformed the concept of the universe's expansion from a mere mathematical abstraction into an empirically verifiable reality. With this contribution, Hubble not only reinforced the work of his predecessors but also ushered in a new era in cosmology, where the idea of a dynamic and expanding universe became a central pillar in the modern understanding of space and time.

In 1988, Hawking posited that Hubble's observations proposed that there was a moment, called the Big Bang, when the universe was infinitesimally small and infinitely dense. Under such conditions, all the laws of science, and therefore all capacity to predict the future, would fail. If there were events prior to this moment, they could not affect what happens in the present. Their existence could be ignored because it would have no observational consequences. It can be said that time began at the Big Bang, in the sense that earlier times simply would not have a definition (Hawking, S. 1988).[xxxi] The heat death of the universe (the Big Chill or Big Freeze) is a scientific hypothesis regarding the ultimate fate of the universe which posits the universe will evolve to a state of no thermodynamic free energy and, having reached maximum entropy, will therefore be unable to sustain any further thermodynamic processes.[xxxii],[xxxiii] Heat death does not imply any particular absolute temperature; it only requires that temperature differences or other processes may no longer be exploited to perform work. In the language of physics, this is when the universe reaches thermodynamic equilibrium. If the curvature of the universe is hyperbolic or flat, or if dark energy is a positive cosmological constant, the universe will continue expanding forever, and a heat death is expected to occur, with the universe cooling to approach equilibrium at a very low temperature after a long time period.[xxxiv] The idea of the heat death of the universe derives from discussion of the application of the first two laws of thermodynamics to universal processes.

In 1851, Lord Kelvin outlined the view, as based on recent experiments on the dynamical theory of heat 'heat is not a substance, but a dynamical form of mechanical effect, we perceive that there must be an equivalence between mechanical work and heat, as between cause and effect.'[xxxv] However, it should be expected that an isolated system fragmented into subsystems does not necessarily come to thermodynamic equilibrium and remain in non-equilibrium steady state. Entropy will be transmitted from one subsystem to another, but its production will be zero, which does not contradict the second law of thermodynamics.[xxxvi,xxxvii] The "dead universe" theory postulates the existence of an ancient universe, perhaps more than a trillion times larger than our known cosmos, that "died" and, subsequently, generated primordial black holes. This theory does not suggest that the initial black holes, after the collision, started the formation of our universe. Instead, it proposes that the observable universe comprises only the finest particles of a dead universe. It presents a revolutionary cosmological model that offers a more comprehensive explanation of the origins of the universe and a new model for the expansion process, different from that proposed by the Big Bang theory. In fact, there is a simple separation of galaxies explained throughout this theory, and not an aggressive expansion that leads to the disintegration of matter and the death of the universe, as suggested by the theory of universal expansion.

Astrophysicists cannot afford to be unjust regarding the perspectives on the size of the universe proposed in this work, nor can they be frivolous about the possibilities this methodology presents concerning the moribund universe of yore. Should the critiques be ironic, this very treatise reserves the right to dismiss the theories of multiverses and the concept of the universe as an information processor. This model proposes the influence of the laws from a dead array of stellar bodies and other elements on our observable cosmos. Two hypotheses are advanced within the framework of the "dead universe" theory. Initially, the term "dead" is redefined, transcending the traditional notion of stellar extinction, to denote a universe whose fundamental characteristic from its inception is the intrinsic absence of light. In this model, light is regarded as a cosmic anomaly that arises from fusion and collision events among supermassive bodies within the expanse of a primordially dark universe. Moreover, this theory asserts that black holes and fusions are not the creators of the universe in which we reside. The first hypothesis postulates that phenomena such as supermassive black holes, dark energy, and dark matter constitute the elementary components of this primordial universe. Intriguingly, light appears under specific circumstances, possibly as a byproduct of complex gravitational interactions, acting as a catalyst for the transition to an illuminated cosmos akin to what we observe today. The second hypothesis proposes that an ancestral universe, vastly larger than the cosmos currently known, serves as the final reliquary for the death that ravaged all galaxies and extinguished the light of a once vibrant universe. This predecessor universe could provide crucial evidence of cosmological processes that terminated in the current observable state of the universe.

It is postulated that the observable universe pre-existed in a state of death trillions of years before the Big Bang. The emergence of light, sparked by intense activities in this dead universe, would be analogous to the peculiarity of black holes within the context of known physics. Hence, galaxies and the universe existed, thus, in the absence of light, submerged in the darkness of the dead universe, yet preserved in an organized state by the laws of physics. This perspective suggests that the universe did not merely emerge but has always been present, formerly in a state of darkness. This conjecture finds parallels with the “cosmic dark ages” proposed by the Big Bang theory, describing a prolonged period after the Big Bang, yet before the formation of the first stars, when the universe was permeated by darkness. Thus, galaxies and the universe existed, thus, in the absence of light, submerged in the darkness of the dead universe, but preserved in a state organized by the laws of physics. This perspective suggests that the universe did not merely emerge but has always been present in a state of death, previously in full darkness. This conjecture finds parallels with the “cosmic dark ages” proposed by the Big Bang theory, describing a prolonged period after the Big Bang but before the formation of the first stars, when the universe was pervaded by darkness. Now what about the light as a Cosmic Anomaly. Beyond the conventional view that supports the natural paradigm of the universe in its current state, a second hypothesis can be considered.

This second perspective, grounded in the theory of the “Dead Universe”, proposes an alternative interpretation of celestial phenomena, including the behavior of stars. As we look upon the Sun and other stars, it’s hard not to ponder the strangeness of their deceptive frenzied activity. The intense emissions of light and radiation emanating from these celestial bodies may appear incompatible with the conception of a dead and inert universe. However, by embracing the theory of the Dead Universe, we can perceive this activity as an anomaly that precipitated the existence of the universe as we comprehend it. Within the framework of the Dead Universe theory, two hypotheses hold sway. The first postulates a universe in its natural state of death, wherein light would be regarded as an alien presence amidst the otherwise dormant cosmos. The second hypothesis introduces a grander notion: a universe trillions of times larger than our current one, which gradually slipped into a continual state of death. In this expansive cosmos, comprised of light and normal stars, the very essence of existence was altered, manifesting a state where light and stellar phenomena were commonplace. By delving into these hypotheses, we are compelled to reconsider our understanding of cosmic phenomena. Rather than mere aberrations, they become enigmatic clues, hinting at the profound intricacies of the universe’s genesis and its potential demise.

### Dead Universe Theory

As per the Dead Universe theory, the natural state of the cosmos would be one of total inactivity, without the presence of bright stars, solar flares, or any other form of radiant energy. In this paradigm, starlight and the energetic events associated with it would be seen as unusual disturbances in a universe that would otherwise remain in a state of eternal calm. Solar flares, coronal mass ejections, and other stellar phenomena would be interpreted as temporary deviations from the inert equilibrium that characterizes the Dead Universe. These manifestations of extreme energy activity would be considered anomalies that arose from exceptional conditions or catastrophic events within this supposedly static universe.

Consequently, by embracing the Dead Universe theory, we are led to reassess our understanding of starlight and celestial phenomena. Instead of being viewed as natural aspects of the cosmos, they become signs of a fundamental disruption that gave rise to the universe as we know it. This alternative perspective challenges our conventional perception and invites us to explore new ways of understanding the nature and origin of the cosmos.

- Anomaly of Light: Light, a fundamental manifestation of electromagnetic energy, occupies a pivotal role in the physics of the universe as we know it. To propose that light is an anomaly in this theory is not simply to invoke complexity; rather, it offers answers to some of the most profound questions in classical physics. This approach does not just reinterpret established physical concepts but also proposes a new way to understand the nature of the universe. The creation of light in stars is a complex process that primarily occurs through thermonuclear reactions in their cores.
- Nuclear Fusion: The primary mechanism for creating light in stars is nuclear fusion. In the stellar core, especially in stars like the Sun, hydrogen atoms are fused to form helium in a process called nuclear fusion. During this fusion, a small fraction of the atoms' mass is converted into energy according to the famous equation by Einstein, $E = mc^2$. This energy is released in the form of light and heat.
- Pressure of Radiation and Gravitational Pressure: Within a star, nuclear fusion generates an immense amount of energy in the form of radiation and high-energy particles. This radiation exerts an outward pressure in all directions. Simultaneously, the star's massive mass creates a significant gravitational attraction, attempting to compress it toward the center. Hydrostatic equilibrium occurs when these two forces - radiation pressure outward and gravity inward - balance each other.
- Fusion Cycle: In the sun and other stars of similar size, the primary fusion process is the proton-proton cycle, where four hydrogen nuclei combine to form a helium nucleus, releasing photons (light particles) in the process.
- Gravitational Pressure: Nuclear fusion only occurs in stars due to the immense gravitational pressure in their cores, which forces the hydrogen nuclei to approach close enough to overcome the electrical repulsion between them and allow fusion.
- Hydrostatic equilibrium: The light generated by nuclear fusion exerts an outward pressure, balancing the force of gravity that is trying to compress the star. This hydrostatic equilibrium keeps the star stable and in its current state.
- Pressure of radiation and gravitational pressure: Within a star, nuclear fusion generates an immense amount of energy in the form of radiation and high-energy particles. This radiation exerts an outward pressure in all directions. At the same time, the massive mass of the star generates a significant gravitational attraction, attempting to compress it toward the center. Hydrostatic equilibrium occurs when these two forces - radiation pressure outward and gravity inward - balance each other.
- Stellar stability: When hydrostatic equilibrium is achieved, the star becomes stable. Any disturbance that causes an imbalance between radiation pressure and gravity will result in changes in the stellar structure. For example, if radiation pressure decreases, gravity will begin to compress the star, increasing pressure and temperature at its core. This may lead to an acceleration in the rate of nuclear fusion to restore equilibrium. On the

other hand, if radiation pressure becomes too intense, it can overcome gravity and expand the star, resulting in an eventual explosion or ejection of stellar material.

- Stellar lifecycle: Hydrostatic equilibrium is crucial to understanding the lifecycle of stars. For most of their lives, stars maintain this equilibrium, remaining stable and generating energy through nuclear fusion. However, as nuclear fuel is consumed, radiation pressure decreases and gravity begins to dominate. Depending on the mass of the star, this can result in different fates, such as transformation into a red giant, supernova, or even a black hole.
- Dynamic equilibrium: It is important to note that hydrostatic equilibrium is not a static state but rather a dynamic balance. Conditions within a star are constantly changing due to energy production, movement of stellar material, and other physical interactions. However, hydrostatic equilibrium is essential to ensure that these changes occur in a controlled and balanced manner, keeping the star relatively stable throughout its life. The premise that, in the origins of the universe, light was not present; it was created subsequently. Whether according to the belief of creationists, who suggest that the universe was shrouded in darkness and that God said "let there be light," or from the scientific perspective of these primordial events, it is undeniable that darkness preceded light.
- Primitive Elements: While black holes, dark matter, and dark energy are well-established concepts in modern cosmology, they are generally regarded as emergent phenomena and not necessarily as primordial components of the universe. Nevertheless, the dead universe theory provides a plausible explanation for their origins, presenting them as fundamental elements of a previously inert cosmos. Although dark matter and dark energy are areas of intense research and debate, with their origins still undefined by consensus, this theory presents one of the first rational approaches attempting to elucidate these enigmatic phenomena.
- Expansion of Cosmic Understanding: These ideas challenge our imagination regarding the universe and provide fertile ground for theoretical discussions and speculative narratives. Although they remain distant from current scientific consensus, these theoretical considerations seek to expand our comprehension of the possible states of the universe and the fundamental forces that govern its evolution and potential finality. Thus, while respecting the limitations of endorsed scientific knowledge, these propositions allow for speculative exploration based on alternative theories and hypotheses.

The Dead Universe theory implies that the cosmos we know is the residual aftermath of a bygone vastness, where the concept of stellar birth is reversed to universal death. In this scenario, black holes are not the catalysts of creation but rather the epitaph of a universe that has expended its vitality. Rather than being generative singularities, these primordial black holes are the remaining gravitational beacons of a cosmos that no longer exists. The galaxies and stars we observe, in their seeming youthfulness, are actually the embers of a cosmic fire long extinguished. Dark matter and dark energy, the enigmatic elements of our universe, may be interpreted as the faint echo of this ultimate cataclysmic event. Among the theories describing the ultimate fate of the universe, hypotheses of the "Big Freeze," "Big Rip," "Big

Crunch," and "Big Slurp" suggest dramatic scenarios based on the continuous expansion, contraction, or phase transitions of space-time. However, the theory of the "Dead Universe" presents a more serene and fundamentally different outcome for the cosmos.

According to the theory of the Dead Universe, there is no cataclysmic or explosive event marking the end of the cosmos. In its place, the universe simply returns to its natural state, a state without the anomalies that characterize the observable universe. In this theory, light is considered an anomaly, something that does not spontaneously arise but requires nuclear fusions and other energetic processes to manifest. In this context, the existence of light is seen as a temporary disturbance in the primitive and eternally dark state of the universe. From this perspective, if there were living beings in this primordial universe, they would consider light as something strange, a curiosity, or an intruder in the perennial state of darkness. The theory posits that, unlike stellar death, which can be a spectacular explosion, the universe does not end with a bang, but with a silent and inexorable return to darkness. From a scientific point of view, life as we know it may have emerged from this anomaly, from a series of accidents and powerful mergers in the primitive universe that would ultimately draw the cosmos back to its native reality. The theory suggests that, just as light and life emerged from extraordinary events, the universe will one day reabsorb everything back into its original state, devoid of light and life, where dominant gravitational forces would facilitate this reversion to the primitive and dark state.

This theory challenges the conventional view of continuous expansion proposed by the Big Bang and other cosmological theories. It does not predict a violent or cataclysmic end, but a gradual decline into a silent equilibrium, where the cosmos slowly fades into the dark background of its primitive existence, remaining forever in a cycle of transient light and eventual darkness. The expansion of the universe, a phenomenon observed and described by Hubble's Law, shows that galaxies are moving away from each other at a speed proportional to their distance. This central fact of modern cosmology is in harmony with the theory of the "Dead Universe," albeit with a substantially different interpretation of the implications of this expansion. In the theory of the Dead Universe, the observed expansion is not the result of an initial impulse from an explosion, as in the Big Bang, but is seen as a simple distancing of galaxies due to the influence of gravity and other yet-to-be-understood laws emanating from the nature of the Dead Universe itself. This movement is interpreted as a manifestation of the intrinsic and residual properties of a cosmos that is no longer active in the traditional intellect. In other words, while Hubble's Law describes what we observe, the theory of the Dead Universe attempts to explain why we observe it. It suggests that the unknown laws of the Dead Universe may be residual forces or echoes of a previous cosmic reality, which now direct the dynamics of the observable universe. These forces could be different from the known classical gravity and could explain why galaxies continue to move apart even when the original energy of the Big Bang should have dissipated. Therefore, the expansion would not be a sign of continuous growth or birth, but a gradual return to the quiescent and fundamental state of the Dead Universe, a final state of rest after the end of anomalies like light and the complex structures that characterize our current universe. Thus, the theory of the Dead Universe adds a new layer of understanding to the ultimate fate of the cosmos and offers an intriguing counterpoint to prevailing cosmological theories. This description suggests an application of Newton's law of universal gravitation, which states that bodies with mass exert a gravitational attraction on each other, and this force is directly proportional to the masses of the bodies and inversely proportional to the square of the distance between their centers. According to the theory of the Dead Universe we are exploring, gravity would play a fundamental role in influencing the movement of the observable universe. Adopting this perspective, we could theorize that a Dead Universe containing bodies of incalculable mass is exerting a gravitational attraction on our observable universe, pulling it back to a state of greater uniformity and tranquility. This would imply that the forces responsible for the expansion of the universe, such as dark energy, could eventually be countered or even overcome by the gravity of such cosmic superstructures.

This theory is distinct from other cosmological models and does not align with the Big Bang, multiverse theories, or cyclic models of creation and rebirth. Instead, it supports the idea of a continuously decaying universe, which generates smaller galaxies and occasionally some larger ones as it dies in stark contrast the multiverse concept. The various theories propose a dramatic end to the cosmos, perhaps about 200 billion years in the future. However, in the theory of the dead universe, this event has already occurred in the past, and the universe is simply following its trajectory towards total extinction. Perhaps the difficulty of these theories lies in their perspective on the study of time and space. This new theory leans more towards the ideas of Penrose (Penrose, 2004).[xxxviii] Penrose said, "Let us begin by exploring the arena within which all the phenomena of the physical universe appear to take place: spacetime." This notion, as described by Penrose, plays a vital role in most of the rest of this book. Despite what seems to be the common perception, and despite Einstein's superb use of this idea in his framing of the general theory of relativity, spacetime was not Einstein's original idea, nor was he particularly enthusiastic about it when he first heard of it. We must first ask why "spacetime"? What is wrong with thinking of space and time separately, rather than attempting to unify these seemingly very different notions into one? Moreover, looking back with hindsight to the magnificent older relativistic insights of Galileo and Newton, we find that they, too, could have potentially gained great benefit from the spacetime perspective."

**Other Important Concept**

The theory of the Dead Universe suggests a vast and singular universe where the process of death still influences the observable universe, which can be considered as the last particles of the once vigorous dead universe, the remnants of its energy still leading to the continuous creation of galaxies, as memories of death. However, even as new galaxies are being formed, the universe is shrinking instead of growing in number, as proposed by the Big Bang and other existing theories. Our observable universe is likened to a large balloon that is gradually losing its stellar vitality. Today, the observable universe represents only a minuscule fraction, about 0.001%, of the previously active universe, now comparable to almost nothing compared to its past glory. Moreover, the theory of the Dead Universe proposes that this process of mortal decay results in a gradual reduction in the size of galaxies. We are unlikely to see a galaxy larger than the largest ones we know emerging before our eyes. This contrasts starkly with the Big Bang theory and the data that will be analyzed in the future by the James Webb Telescope. The activity of galaxies will follow a course of total and silent death on the margins of time. This view contrasts sharply with the four main theories about the end of the universe: the Big Rip, the Big Crunch, the Big Freeze, and the Big Bounce.

- 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.

On the other hand, the Dead Universe theory does not predict any aggressive end. Instead, it posits a gradual, silent drifting apart of galaxies, influenced by the gravitational remnants of the dead universe. This slow separation lacks the violent dynamics suggested by other models. The theory rejects the concept of cosmic inflation and traditional expansion, replacing it with the idea of a silent, steady detachment of galaxies, influenced by the decaying forces of a much larger, now largely dead universe. This subtle separation is devoid of the catastrophic elements proposed by other models, emphasizing a more tranquil end. The decaying universe's influence also suggests a gradual winding down of cosmic activity, leading to increasingly smaller and less active galaxies until complete cosmic silence is achieved. This process is thought to be influenced by the gravitational remnants and the creative remnants of the dead universe, which continue to affect the formation of new galaxies within our observable universe.

The Dead Universe theory's distinctiveness lies in its rejection of the traditional expansionist and inflationary models, opting instead for a model where cosmic events and the formation of galaxies are dictated by the decaying remnants of a vastly larger universe. This leads to a steady, quiet dispersal of matter and energy, contrasting with the violent or cyclic endings proposed by other cosmological theories. So, this theory provides a unique perspective on cosmic evolution, emphasizing a slow, peaceful decline and the formation of galaxies as a memory of a once-living, now largely decayed universe. This theory offers a novel framework that stands apart from the more dramatic cosmological models, suggesting a universe that quietly fades away rather than ending in a catastrophic event. It can also incorporate the concept of a membrane (brane) to further develop this theory. As the dead universe decays, it creates new galaxies as a form of cosmic memory. These galaxies are not random but are influenced by the decaying universe's remaining structures and gravitational forces. This process does not support the creation of multiple universes but rather the continuous formation of galaxies within a singular universe.

The Dead Universe theory posits that our universe is not expanding, inflating, or undergoing cycles of rebirth. Instead, it is gradually diminishing and has been in a state of decay for perhaps trillions of years. This model suggests that the universe is slowly entering a state of total death, with galaxies continuously forming and then fading away under the influence of the dead universe's remnants. Rather than growing or regenerating, our universe is progressively winding down, moving towards a silent and complete cessation of cosmic activity. Our entire observable universe may exist within a distinct brane that floats in a higher-dimensional space. This brane represents a segment of the dead universe that is transitioning into a state of death. However, the creative remnants of the dead universe could lead to the formation of new galaxies within this brane. These galaxies are formed as the dead universe's remnants exert their influence, leading to the creation of progressively smaller galaxies. Explosions and other cosmic events within this decaying process contribute to the formation of these new galaxies (Randall, 2005).[xxxix] Randall said, "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."

So, it can postulate that the entirety of our dead universe exists within a brane, which floats in a larger dimensional space. Within this volume, our universe exists as a membrane distinct from other potential universes, entering a state of death. This brane could be influenced by the physical laws and remnants of the dead universe, leading to the continuous creation of galaxies. These galaxies, as part of the cosmic memory of the dead universe, are generated by the interactions and remaining energies of the dead universe's structures. This model suggests that the gravitational anomalies and the curvature of time and space observed in our universe are the result of the dead universe's physics influencing the observable universe. The Dead Universe's decaying remnants, particularly supermassive bodies and dark energy, are key elements in shaping the structure and behavior of our observable universe. To substantiate Dead Universe theory, it would be appropriate to refer to various recognized physical principles and discoveries:

- Newton's Law of Universal Gravitation: As a basis for understanding gravity on a large scale.
- Einstein's General Relativity: This theory updated the understanding of gravity as the curvature of space-time. The role of singularities and event horizons in black holes could be explored in relation to the "Dead Universe".
- Hubble's Laws and Observations from the Hubble Space Telescope: They provide empirical evidence of the expansion of the universe, which could be interpreted in light of the attraction of a massive "Dead Universe".
- Quantum Cosmology: Investigating the implications of quantum mechanics on cosmological scales, this area could provide insights into how a "Dead Universe" could influence matter and energy in our universe.
- Research on Dark Energy and Dark Matter: Studies on these mysterious components of the universe could be useful in understanding the forces that are competing with or interacting with gravity in the "Dead Universe".
- Notable scientists for reference could include:
- Stephen Hawking: For his work on singularities and the properties of black holes.
- Roger Penrose: Who collaborated with Hawking and developed theories on the nature of space-time.
- Saul Perlmutter, Brian P. Schmidt, and Adam G. Riess: Astronomers who were awarded the Nobel Prize for their discoveries regarding the acceleration of the expansion of the universe.

- Kip Thorne: A theoretical physicist who made significant contributions to the understanding of gravitational waves and the nature of gravity.

## Problems of Exicting Theories

The horizon problem becomes apparent when researchers examine the uniformity and consistency of cosmic microwave background radiation. CMB radiation is the thermal radiation left over from our universe's formation when it was about 380,000 years old. This radiation occurred shortly after the Big Bang, when visible light could first move freely without obstruction.[xl] The apparent consistency of CMB and that reflects temperature variations at a scale of one part in 100,000 – indicates that the furthest reaches of outer space were once in thermal equilibrium. In other words, the universe's most distant parts were once the same temperature, suggesting that heat was evenly distributed in all directions. However, these regions are far apart. Considering our universe's age and the speed of light (approximately 186,000 miles per second), it should be physically impossible that these regions could have ever been close enough to interact and equilibrate directly since the inception of the Big Bang. To put it more simply, the horizon problem raises a compelling question of how the universe's distant parts could somehow end up with such similar temperatures and characteristics.[xli]

The flatness problem, on the other hand, deals with the universe's shape and overall curvature. According to Einstein’s Theory of Relativity, the universe's shape is determined by mass and energy, which is described by a curvature measure called Omega (Ω). A universe with “$\Omega = 1$” is flat – indicating no curvature and meeting the critical density requirement where the universe’s expansion rate should eventually slow down and approach zero without actually ever reaching zero. It means that a gradual slowing down of the universe's expansion over time never stops. Initially, the original Big Bang Theory suggested that immediately after the Big Bang, the universe should have been very close to critical density ($\Omega \approx 1$/flat in shape). But as time passed and the universe's expansion continued, even a minor deviation from critical density would magnify over time, resulting in a universe that is significantly curved, either "open" ($\Omega < 1$) or "closed" ($\Omega > 1$). But the universe that we observe with our scientific instruments today is flat. So, the question is: How is that possible?

To solve these kinds of problems, modern cosmologists have put forth several theories to better explain the universe's properties and phenomena.[xlii] One of the most sobering and empirically supported theories is the cosmic inflation theory, first proposed by physicist Alan Guth during the 1980s. According to Guth’s cosmic inflation theory, there was an exponential expansion within a fraction of a second after the Big Bang. This period of inflation set the stage for the universe's observable structure and composition that we see today. Guth’s theory is consistent with observable scientific evidence. It also resolves several enduring cosmological mysteries, including the horizon problem and the flatness problem. In regard to the horizon problem, cosmic inflation theory theorizes that the universe experienced an exponential expansion in the first fraction of a second after the Big Bang. This inflation period stretched the universe beyond its visible horizon, enabling distant regions to come into causal contact and achieve thermal equilibrium. This theory means that the expansion allowed the universe's distant areas to interact and influence each other, resulting in them reaching the same temperature. In other words, the physics described by the cosmic inflation theory would allow the present universe to have expanded faster than the speed of light during this early inflationary period.[xliii] That would have eliminated the problems of distance and time preventing thermal equilibrium.

Regarding the flatness problem, cosmic inflation theory suggests that the period of rapid and significant expansion led to an increase in the scale factor of the universe, which determines the relative sizes of spatial dimensions (the size of space itself). As a result, any slight deviations from a flat geometry in the early universe would have been greatly stretched out and weakened during this inflationary period. In other words, the rapid expansion would have smoothed out these deviations, making the universe more uniformly flat. During the universe's growth, the energy density linked to the inflation field became dominant over other forms of energy like radiation and matter. This dominance would have had a leveling effect on the entire universe's geometry, moving it closer to a flat configuration. So inflationary cosmology from the 1980s provides compelling resolutions to these kinds of questions about the origin of the universe. It reshapes our comprehension of early dynamics and lays the foundations for modern cosmological theories. This inflation is thought by researchers to have been triggered by quantum fluctuations within the fabric of space-time – a phenomenon foreseen by quantum mechanics.[xliv] At these quantum levels, tiny fluctuations are believed to have been magnified during inflation, which introduced irregularities and differences that eventually developed into the first galaxies, clusters of galaxies, and macro-level cosmic formations.

With advancements in cosmology, scientists are considering the concept that our universe might just be one among many in an extensive "multiverse." This theory suggests that an infinite number of universes might exist, each with its own distinct physical laws, constants, and characteristics. While this hypothesis is still speculative and beyond today's empirical testing capabilities, the multiverse hypothesis presents a captivating explanation for some of the universe's most puzzling aspects. For example, the precise tuning of constants and parameters in our universe to support life could find justification in a multiverse scenario where each region possesses unique properties. In such a case, our own universe would not be designed to support the existence of life as we know it, but is rather the product of chance and coincidence.[xlv] There could be many other universes within the multiverse that are not capable of supporting such life. Now that we've talked about the earliest origins of the universe, a fair question you might be thinking is, "How will it end?" There's no way to know for sure, but scientists have some theories. The concepts of accelerating expansion, as well as the Big Rip theory and the Big Freeze theory, offer insights into the universe's potential futures.

After the Big Bang Theory for the universe's beginning was firmly established, researchers inferred that the force of gravity would slow the universe's expansion over time, as all matter contained in the universe pulls on itself to reunite. They believed that gravity would eventually stop the expansion. Then, a recoil would occur and cause everything to slowly coalesces back together, perhaps all the way back to a single point. Researchers called this theory the Big Crunch. It even gave rise to the notion that perhaps the universe experiences a repeating cycle of rebounds as it expands and contracts over and over again as a result of competing forces trying to dominate each other. But scientific observation of the universe's rate of expansion revealed that it is not slowing. Instead, it is actually increasing. This unexpected finding, drawn from studying supernovae in the late 1990s, suggests that a mysterious force called dark energy is opposing gravity on a cosmic scale and accelerating the universe's expansion. The presence of dark energy propelling this accelerated expansion has significant implications for what lies ahead for our universe. It suggests that galaxies will continue drifting apart at an ever-increasing pace.

Taking the accelerating expansion of the universe to its inevitable conclusion, the Big Rip Theory provides a vivid and dramatic picture of one possibility for our universe’s fate. This theory suggests that dark energy’s repulsive force grows stronger over time and can overpower all other forces, including the gravitational pull within galaxies, stars, and subatomic particles.[xlvi] As the universe expands faster and faster under this scenario, the Big Rip theory foresees galaxies moving away from each other, which is already happening today.[xlvii] Eventually, the gravitational forces that bind galaxies, stars, planets, and atoms together may also succumb to the overpowering influence of dark energy. This catastrophic event would result in the destruction of cosmic structures, causing matter to break down into its basic components and leading to the tearing apart of spacetime itself at the most fundamental level. Simply put, dark energy would “rip” everything in the universe to pieces.

The Big Freeze Theory (also known as the Heat Death Theory) presents a more gradual and subdued fate for the universe. According to the Big Freeze, the universe will continue expanding at an increasing pace due to dark energy, causing matter and energy to gradually thin out over immense periods of time. As galaxies drift apart and the universe grows colder and more barren, new stars will stop forming and existing ones will slowly burn out. Eventually, the universe will reach a state of maximum entropy, where all energy is uniformly dispersed with no potential for matter interaction.[xlviii] In this state, called Heat Death by some theorists, the universe would become a cold, dark void. There would be no life, light, or any recognizable structure or activity.[xlix]

Despite strides in unraveling the origins and evolution of the universe, cosmology continues to pose obstacles, uncertainties, and unresolved inquiries. For example, dark matter and dark energy collectively account for about 95% of the universe’s total mass energy, but these components of our universe remain a complete mystery in modern astrophysics and cosmology. Even though we can infer their existence and even measure them to a degree, we know almost nothing about them.[l] Additionally, the elusive origin of the singularity itself, as the starting point from which the universe appears to have emerged, continues to puzzle researchers. Current scientific hypotheses such as loop quantum gravity and string theory have attempted to merge Einstein’s relativity with quantum mechanics to create a unified theory of the universe. Still, this work is incomplete at best so far.

The beginning of our universe is one of humanity’s mysteries that have captivated mythologies, philosophies, and scientific endeavors. From cosmological myths depicting primal chaos to contemporary cosmological theories formulated through intricate mathematical study and calculation, our comprehension of how the universe came to exist has evolved over time. This evolution reflects our curiosity, imagination, and determination to unravel the mysteries surrounding our own existence in our vast cosmos. As we delve deeper into cosmic dynamics through scientific exploration, we are humbled by the vastness, intricacy, and splendor that define our ever-expanding understanding of the cosmos.[li] Every cosmological theory, whether about the Big Bang, Cosmic Inflation, or the idea of a multiverse filled with realities, provides a fascinating perspective of the birth and evolution of the universe. It sparks curiosity, amazement, and a deep feeling of connectedness to the cosmos at large and to each other on Earth. So, we should continue the work of our understanding the universe and see where the truth leads us.[lii]

The Dead Universe theory suggests that what we perceive as our cosmos is the legacy of an ancestral reality whose grandeur has long faded into the mists of time. The universe we inhabit may be akin to a cosmic aftermath, a diluted echo of a once vibrant and expansive cosmic past. Rather than being the catalysts of genesis, the black holes that populate our night sky are posited as remnants of a previous cosmic end, markers of the graves of galaxies and stars that have long since perished. Each star system, every nebula we capture through our telescopes, might be a manifestation of cosmic memory, a lingering whisper from a universe that has run its course. In this view, dark matter and dark energy are reimagined as the residual hallmarks of this ancient epoch, perhaps the last vestiges of a once dynamic cosmic framework. The young galaxies we witness are not born from a void but are conceived from the vestiges of a pre-existing structure in a state of stately and measured dissolution. Similarly, to the birth of stars from the dense cosmic nurseries, our universe may have been partially shaped from the detritus left by its predecessor.

The vibrant stars and galaxies we observe, in their billions of years of existence, could very well be the ultimate creations of a bygone universe. On the verge of its cessation, it still possessed the capacity to engender new celestial structures, intimating that the end of one cosmic cycle and the inception of another are intrinsically interconnected, leading to a culmination projected to be in about 200 billion years. These phenomena, observable in our present universe, abide by the unalterable laws of conservation and transmutation that govern all of natural reality. These fledgling galaxies might be interpreted as the final echoes or gleaming reminiscences of a cosmos that exists no more. They are fragments of a vast stellar heritage, the ultimate murmur of a universe that once thrived in scale and energetic wealth. We are thus residing in the twilight of a glorious cosmic history, witnessing what may be deemed the "last dance" of light and matter sourced from a universe that has ebbed away. What we discern as our stellar reality is merely the residue—a modest yet still animated segment of an existence far grander than we can grasp, extending beyond our temporal and spatial reach. Essentially, all that exists, all that we behold, and all that we may come to understand are but the enduring fragments in time and space, the everlasting signature of the dead universe. "Space tells matter how to move, and matter tells space how to curve." As said by Brian Greene in "The Fabric of the Cosmos: Space, Time, and the Texture of Reality."[liii]

As this process unfolds, the density and complexity of the universe wane. Where once there were dense clusters of matter and energy, now there are increasingly vast and empty spaces, dotted with isolated islands of stellar activity. The observation of young galaxies by the James Webb Space Telescope thus serves as a glimpse into this process of decline, revealing the final stages of a cosmos we are just beginning to understand. In this picture, the death of the ancestral universe was not an abrupt event but a prolonged phenomenon that allowed the gradual emergence of new structures from its ruins. Black holes, rather than being the catalysts of a new birth, are the final guardians of the cosmic memory of the preceding universe, storing in their gravitational abysses the history of all that once was. Indeed, black holes have mass. The mass of a black hole can be comparable to that of the Earth, the Sun, or even vastly greater, depending on the type of black hole. There are stellar black holes, which generally have masses ranging from a few to tens of times that of the Sun, and supermassive black holes, which can have masses equivalent to millions or billions of times the mass of the Sun.

The term “black hole” refers to the fact that these objects are regions of space where gravity is so intense that nothing, not even light, can escape from them. The word “hole” is a way to describe this “trapping” feature, although it is not a hole in the traditional sense of a cavity or opening. The adjective “black” is used because, since light cannot escape from a black hole, it is completely dark, neither emitting nor reflecting light, rendering it “black” to any observer. When certain stars, much more massive than the Sun, reach the end of their lives, they can undergo a process known as gravitational collapse. After exhausting all their nuclear fuel, the pressure that supports the star against gravity disappears, and it collapses in on itself. Depending on the original mass of the star, this collapse can result in a supernova, and the remaining core may form a stellar black hole. This is an example of a black hole that originates from a “dead star”. In this way, we advance toward the theory of a dead universe with dimensions greater than our observable universe.

If the Sun were to cease to exist, that is, if it suddenly stopped emitting light and heat, the consequences would be dramatic, but the orbits of the planets in the solar system, including Earth, would initially remain unchanged, at least for some time. This is because gravity, not light, is the force that keeps the planets in orbit around the Sun. Gravity is a consequence of an object’s mass, and light is a form of energy emitted by it. If the Sun suddenly stopped emitting light, it would mean that it is no longer performing nuclear reactions in its core, but its mass would still be present, and therefore, its gravity would continue to influence the planets. However, the absence of light and heat would have catastrophic effects on life on Earth and the planet’s climatic conditions. Over time, if the Sun were to transform into a white dwarf or undergo some other process that significantly altered its mass, the orbits of the planets could be affected. Changes in the Sun’s mass would alter its gravitational force, which, in turn, would affect the trajectory of celestial bodies orbiting it.

It is not strange to postulate the existence of a universe without the activity of light emission but still composed of galaxies, supermassive black holes, dark matter, dark energy, and where the laws of physics remain active. I can affirm, based on the theoretical argument developed, that such a universe exists and that, soon, it may be revealed to the light of scientific knowledge. From a scientific viewpoint, however, the claim to the existence of a fundamental reality such as a “dead universe” requires a substantial set of empirical and theoretical evidence that can be verified through independent observations and experimentation. Until such evidence is provided and validated by the scrutiny of the scientific community, such a concept should be considered with caution, currently residing in the realm of theoretical speculation, similar to many hypotheses and theories that have preceded it. These black holes are found at the centers of almost all large galaxies, including our own Milky Way. They have masses ranging from millions to billions of times that of the Sun. It is believed that they grow by accumulating matter and other black holes over time, but their exact origin is still a subject of research. They are not considered "dead galaxies," but they are a fundamental part of the dynamics and evolution of galaxies.

The term "dead galaxy" typically refers to a galaxy that has ceased star formation. Galaxies can "die" in terms of stellar production due to various processes, such as the loss of gas (the fuel for star formation) or interactions with other galaxies. These galaxies do not transform into black holes, although they may harbor supermassive black holes at their centers. The "dead universe" theory is legitimized and worthy of study by proposing that the collective deaths of celestial bodies converge in the formation of a singular predecessor universe, as opposed to the concept of multiverses suggested by various speculative theories. These theories often deviate from the mathematical models and the rigorously tested and proven scientific evidence. In contrast, the dead universe theory, which harmonizes with established discoveries and laws of physics, offers a perspective that integrates into the contemporary understanding of the universe while providing a potential platform for future investigations.

Currently, the consensus around the Big Bang theory appears to be weakening, while, on the other hand, the Dead Universe theory not only conforms to the already established physical laws but also proposes alternative explanations that can be readily subjected to verification through observation and experimentation. Thus, the "expansion of the universe" can be interpreted not as an indicator of dynamic growth but rather as a gradual separation driven by the laws of gravity from a preceding universe, a relic still influencing the current cosmos. This phenomenon could be regarded as the final exhale of a universe that is gradually surrendering its energies. We are witnessing a process of cooling and quiescence, where matter and energy are smoothly redistributed, and space-time stretches, aspiring to a state of enduring serenity. As this process progresses, the formation of new galaxies will tend to decrease and eventually cease, resulting in a universe filled with contemplative silence and the true quiet that follows the luminous interlude of the stars. Just as its parent universe died, so too shall its offspring, the observable universe, pass away.

**Observational Evidence from the James Webb Space Telescope**

Habitually, the Big Bang theory has been the backbone of cosmology, providing us with a model of a universe born from a singularity, expanding for approximately 13.5 billion years. However, in light of new evidence, it becomes increasingly clear that this narrative faces significant challenges, making room for a new perspective: the theory of the "dead universe" that I propose. The Dead Universe theory suggests a radically different approach. Instead of conceiving the universe as the result of an explosion, it proposes that the universe is a vast and possibly eternal continuum, where concepts of beginning and end are relativized. This is not just a vague hypothesis; the discoveries of the James Webb offer concrete evidence that challenges the fundamental premise of the Big Bang. Ancient galaxies that should display signs of interactions and mergers, as predicted by the standard model, remain surprisingly intact, suggesting a much more complex and less linear cosmic history.

The observation of astronomical objects that appear to be older than the age of the universe defined by the Big Bang model represents a significant challenge for contemporary cosmology. How can the existence of these mature structures be reconciled with a universe that, according to current estimates, is approximately 13.5 billion years old? The hypothesis of the Dead Universe seeks to address this contradiction by proposing that such galaxies are not mere discrepancies, but rather clues to an ancestral universe, whose timeline extends beyond the temporal scale demarcated by the event of the Big Bang. This theory suggests that conventional cosmological timelines may need to be revised in light of new evidence, possibly expanding our understanding of the history and evolution of the cosmos. Moreover, the supposed uniform expansion of the universe, a cornerstone of the Big Bang model, is called into question by recent observations. Distant and ancient galaxies do not behave in a way that would corroborate constant and accelerated expansion. This raises a fundamental question as what if the universe is not expanding uniformly, or even if it is not expanding at all? Scientist in their new theory suggests that the cosmos may be in a more complex and static or inverse state than previously imagined, a state where time and space are not absolute, but relative and interconnected in a way that we are still beginning to understand.

This is not just a challenge to the dominant narrative; it is an invitation to radically rethink our understanding of the cosmos. The theory of the Dead Universe offers a path to explore these questions, proposing a “timeless” universe or one that generates its own strange body, light, as its primordial nature was not light but rather the darkness of dark matter and supermassive bodies, where beginning and end are human concepts, not universal realities. In the perspective of the dead universe, the fusion of black holes and the consequent creation of stars may be considered incomprehensible events for beings inhabiting this universe. Let imagine a civilization evolving amidst eternal darkness, where light is an abstract, almost mythological notion. For them, the sudden emergence of bright spots in the sky would be beyond comprehension, an anomaly in a predominantly dark environment. Perhaps the equation of UNO matter also resembles a window tint or solar control film, so that when we are inside, we perceive the existence of light, but if we look from outside in, we perceive no light at all and everything appears to us as lightless and in darkness. Therefore, a universe immersed in death within a dark fabric may present a reality of splendid light that we cannot see because of the presence of a matter that I describe as neutral.

The theory of the Dead Universe proposes a new interpretation of the observational boundaries of the universe through an analogy with window tint. We argue that dark matter and other cosmic anomalies may be analogous to layers that, although transparent from within, are opaque when viewed from outside. We explore how this metaphor can be applied to the study of astrophysics and offer insights into the properties and behavior of dark matter. Just as an internal observer perceives light through a layer of window tint, while from the exterior transparency is obscured, our visibility of the cosmos may be limited by material layers that are not immediately apparent to our conventional detection methods. The theory of the Dead Universe proposes that we live in a remnant of a previous cosmic reality, where dark matter acts as a "cosmic window tint" that distorts our perception of the universe. This matter not only influences the trajectory and speed of galaxies but may also be the reason why we observe the universe in such a dark and enigmatic manner. Gravitational waves and other observations can be seen as the light that permeates this dark layer, offering glimpses of the underlying structure of the universe. Our understanding of the expansion of the universe and the distribution of dark matter may be enriched by considering the idea that, just as light passing through window tint, there is inherent luminosity and active phenomena beyond our current vision awaiting discovery. Therefore, future research should focus on penetrating this layer of "cosmic window tint," see-through the true extent and nature of the universe in which we reside.

Cosmological theories that propose various forms of "barriers" or transition zones in the universe. For example, the event horizon of a black hole acts as a point of no return where gravitational attraction is so strong that not even light can escape, making it invisible from the outside. This is somewhat like looking at a dark window from the outside; you cannot see through, suggesting an absence of light or activity when, in reality, there is hidden wealth. Extending this to our notion, if there were a "UNO matter" that acted as this kind of cosmic hue, it could be something that exists within the structure of the universe and a hypothetical substance or field that interacts with light and other forms of energy in a way that masks the activity or underlying structure of the cosmos when seen from a certain perspective. Such material could theoretically be responsible for the phenomena we observe, like the effects attributed to dark matter, which influences the movement of galaxies and yet emits no detectable light or radiation, remaining "UNOl" or "invisible" to our current methods of observation.

The notion of a "domain wall" in cosmology is a hypothetical structure that could act as a boundary between different phases or types of vacuum states in the universe, similar to the interface between two bubbles. It's a speculative concept, but one that could potentially explain cosmic separation or transition areas, much like our concept of "UNO matter" film. However, while analogies can be useful for illustrating concepts, in scientific publications, they are typically used sparingly and always anchored in rigorous argumentation and empirical evidence. Besides, the very nonexistence of light as a primordial element may challenge the fundamental laws of this dead universe. While they inhabit a domain, in which darkness reigns supreme, the presence of light could be seen as an intrusion or even as a metaphysical impossibility. These reflections lead us to question whether we can truly comprehend the totality of the universe from our limited perspective as observers of the cosmos. What we consider as universal truths may be just a small fraction of cosmic reality, and the dead universe may represent a spectrum of existence that escapes our full understanding.

Perhaps the very nature of light is indeed opposed to the essence of the dead universe. The mergers of supermassive bodies and black holes, which were the original nature of this universe, gave birth to light, an object strange to its reality. This universe will persist forever, immersed in its own eternal darkness, while light shines in contradiction. However, this does not mean that our observable universe is the essence of this dead universe. The unions and irregular behaviors of particles altered the original order of this universe, giving rise to strange bodies, such as the galaxies we observe. In this sense, we are mere intruders of chance in this reality, unless there exists a creator entity for the dead universe. Light is something strange to the reality of the dead universe, if we may say so, as it will always exist with its nature and its own laws, and it is calling this strange universe that has light as a primordial factor to its nature and essence. In this sense, it is not up for discussion the existence of humanity and life as we know it. "No one can deny that the universe is more for darkness, chaos, and obscure mystery than for a reality of light," as the Abrahamic religions said.[liv] It's an exciting moment to question, explore, and perhaps discover the true nature of the cosmos. Our time will always be the present because we are within the eternal time of the dead universe (Thorne, 1994). "A single understanding that unifies the quantum and classical worlds would sweep through cosmology like a wind, stirring up all the old questions and many new ones, answering some but leaving most unanswered."[lv]

Physics deals with the paradox of dark matter. It is conjectured that such matter may consist of compact and supermassive objects, such as primordial black holes, or perhaps of hypothetical and indescribable particles, known as sterile neutrinos. However, the very concept believed to elucidate dark matter finds a stronger resonance within the scope of the Dead Universe theory than within the confines of the Big Bang paradigm. The existence of a past and extinct universe, devoid of all luminance, supports the belief that this process generated energy, similar to the unexplained cosmic enigma of dark energy. According to this theory, dark energy is not the agent of universal expansion, but rather the residual laws of the preceding universe still in effect (Lee Smolin 2006). The Dead Universe Theory takes into account dark matter, radio waves, and particle behavior. But a creative agency does not nullify the Dead Universe theory for purely scientific purposes. Science does not strive to substantiate the existence of the divine. It only seeks to investigate natural phenomena and elucidate them through the lens of empiricism. Likewise, it does not exist to deny the divine. So let us set aside what escapes explanation and channel our energies into what can be explained into the Theory of the Dead Universe (Carroll, 2010). "Imagine a universe in which any one of these numbers was different. It would be a universe without atoms, stars, or planets; a universe without people, or any other form of life as we know it. It would be a universe without history. Yet such a universe would be entirely consistent with the laws of physics as we understand them. Why then do we find ourselves in a universe that is just right for us?"[lvi]

## Explanation for the Cold Spot in the Universe

The "Cold Spot" in the universe is a large, unusually cool patch in the Cosmic Microwave Background (CMB), the afterglow of the Big Bang, best explained by a massive, under-dense region called a super-void that CMB photons travel through, losing energy (integrated Sachs-Wolfe effect).[lvii] While a super-void is the leading idea, its immense size and the depth of the spot challenge standard models, with some even speculating exotic origins like another universe's imprint, though most evidence points to a huge void. It was discovered through observations made by the WMAP (Wilkinson Microwave Anisotropy Probe) satellite in 2004 and later confirmed by data from the ESA's Planck mission. This spot is about 70 microkelvins colder than the average CMB, which challenges the standard explanation based on the homogeneity of the universe predicted by the Big Bang theory.[lviii] This perspective implies that abnormalities like the Cold Spot are not just statistical fluctuations or effects of unknown cosmic superstructures, but rather direct manifestations of the extreme conditions and laws of the prior universe. Gravitational influences or other residual forces from this dead universe may be causing the temperature variations observed in the cosmic background radiation. Temperature is a condition inherent to the dead universe and not the observable universe due to its state of cosmic demise. The notion that multiverses are colliding with this universe seems improbable over a history of billions of years; certainly, various other cold spots would have been encountered, yet they do not exist because this cold spot was the link between this universe and the mother universe over trillions of years of its existence.

**Limitation of Big Bang Theory**

The Big Bang theory, while successful in explaining most of the observed features of the universe, such as cosmic expansion and the abundance of light elements, struggles to fully explain anisotropies like the Cold Spot. According to the standard model, temperature fluctuations in the CMB should be relatively uniform across large scales due to cosmic inflation. The Cold Spot, due to its scale and depth, does not easily fit into this model without requiring more complex descriptions, like rare statistical fluctuations or huge, undetected cosmic superstructures. So, the Big Bang theory explains much of cosmology but has key limitations, including the Horizon Problem (uniform CMB temperature)[lix], Flatness Problem (universe's geometry)[lx], and Monopole Problem (lack of magnetic monopoles)[lxi], 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.[lxii] The theory also struggles to describe the initial singularity (Planck Epoch) and the matter-antimatter asymmetry. The Inflation Theory proposes a period of extremely rapid (exponential) expansion of the universe during its first few moments. It was developed around 1980 to explain several puzzles with the standard Big Bang theory, in which the universe expands relatively gradually throughout its history.[lxiii] The detailed particle physics mechanism responsible for inflation is unknown. In 1992, a number of inflation model predictions have been confirmed by observation; for example, temperature anisotropies observed by the COBE satellite exhibit nearly scale-invariant spectra as predicted by the inflationary paradigm and WMAP results also show strong evidence for inflation.[lxiv] However, some scientists dissent from this position.[lxv],[lxvi]

The horizon problem is the problem of determining why the universe appears statistically homogeneous and isotropic in accordance with the cosmological principle.[lxvii] For example, molecules in a canister of gas are distributed homogeneously and isotopically because they are in thermal equilibrium: gas throughout the canister has had enough time to interact to dissipate inhomogeneities and anisotropies.[lxviii] In the Big Bang model without inflation, gravitational expansion separates regions too quickly. So, the early universe does not have enough time to equilibrate. In a Big Bang with only the matter and radiation known in the Standard Model, two widely separated regions of the observable universe cannot have equilibrated because they move apart from each other faster than the speed of light and thus have never come into causal contact.[lxix] The flatness problem (also known as the oldness problem) is a cosmological fine-tuning problem within the Big Bang model of the universe. Observations of the cosmic microwave background have demonstrated that the Universe is flat to within a few percent.[lxx] The expansion of the universe increases flatness. Subsequently, the early universe must have been exceptionally close to flat. In standard cosmology based on the Friedmann equations the density of matter and energy in the universe affects the curvature of space-time, with a very specific critical value being required for a flat universe.[lxxi] The current density of the universe is observed to be very close to this critical value. Since any departure of the total density from the critical value would increase rapidly over cosmic time,[lxxii] the early universe must have had a density even closer to the critical density, departing from it by one part in $10^{62}$ or less. This leads cosmologists to question how the initial density came to be so closely fine-tuned to this 'special' value.[lxxiii]

**Discrepancy with Cosmic Radiation Theory**

While cosmic background radiation generally supports a uniform and homogeneous universe as predicted by inflation, the Cold Spot suggests anisotropies that may require new physics or adjustments to current cosmogonic models. In this context, the Big Bang theory does not provide a direct explanation for this anomaly, raising questions about possible revisions or extensions to the model. The Dead Universe theory offers an alternative explanation for the Cold Spot, suggesting that it represents an "umbilical cord" from a previously collapsed universe. This theory proposes that our observable universe is just a remnant of a much larger and older universe and the dead universe. Gravitational laws and influences from this previous universe, now only partially existing, may be responsible for irregularities like the Cold Spot. This approach not only offers an explanation for the anomaly but also expands cosmological understanding by incorporating the idea of a multiverse or cosmic cycles of death and rebirth. The Dead Universe theory provides an intriguing insight into the origin of anomalies like the Cold Spot in the cosmic microwave background radiation. This theory suggests that the Cold Spot is not a mere random fluctuation, but a direct consequence of the thermal state of a now-extinct precursor universe. Imagine a gigantic, aging universe, progressively cooling until it becomes a vast space of low thermal energy and akin to a cold chamber in the cosmos.

This analogy can be likened to opening a small door between an extremely cold environment, such as a freezer, and a warmer area, like a kitchen. The instant thermal exchange that occurs is similar to the effect the dead universe could have on the space around it, especially at points where the interaction is most intense. This thermal interaction results in a noticeably colder area in the context of the observable universe, which we detect as the Cold Spot. This equation seeks to quantify the direct influence of the extreme cold of the dead universe on the observable universe, in a manner similar to how cold air from a freezer mixes with the warmer air of a kitchen. The use of this analogy and the corresponding equation provides a vivid and scientifically plausible way to explain how an ancient and cold universe can impact the temperature of the cosmos we observe today. Validation of this theory will require detailed observations and rigorous analysis of the anisotropies in the cosmic microwave background radiation, looking for specific patterns that would corroborate this thermal interaction on a cosmic scale.

The theory of immense gravitational magnitude of the predecessor universe may naturally warp space-time, a phenomenon known in astrophysics as a "gravitational well", responsible, for example, for bending light. The idea that the observable universe is within the womb of a dead mother universe that died trillions of years ago, the same fate as our universe, which emerged from the womb of the previous mother, may explain what astrophysics has not been able to. The gravitational force of the ancient universe may bend the fabric of the universe in such a way that it creates a "slippery" advancing through space without actually moving. The Big Bang theory, while accepted to explain the origin of the Universe, has gaps, such as the lack of explanation for continuous expansion. Studies connecting particle accelerators, which evidence phenomena similar to micro-explosions, can be interpreted as support for this alternative hypothesis. If the observable universe emerged from a "dead universe", such an event could be interpreted as an expansion driven by the lingering action of the gravity of a previous universe, a concept that could be inferred from the presence and behavior of black holes, which offer indirect evidence of this process. The continuity of gravitational laws, which seem to govern without alteration since the primordial state, may be a testament to the deep connection between the current universe and its possible origin in a previous and broader context.

A pertinent issue in contesting the Big Bang model lies in the observation that expansions resulting from explosive events generally introduce a level of randomness in the movement of the involved particles. However, the expansion observed in the universe suggests a more orderly and systematic progression, possibly guided by principles not yet fully elucidated by contemporary physics. Regarding the characterization of the "Explosion" associated with the Big Bang itself, the term may be deemed inappropriate if interpreted in the light of conventional explosions. If such an event does not fit within the traditional parameters of an explosion, then what would be the physical mechanisms sustaining such a model? The proposition of the Big Bang, which posits the expansion of the spacetime fabric itself, demands a source of energy capable of enabling such a phenomenon. Additionally, the process described by the Big Bang does not correspond to an explosion within a pre-existing space but rather to the expansion of the spacetime structure itself. In this context, the hypothesis of the "Great Dead Universe" offers an alternative explanation that could provide a detailed description of cosmic expansion, filling gaps left by the Big Bang model, which sometimes seems to oscillate in its explanations about the exact nature of the initial event.

Additionally, the regularity and organized structure observed in the cosmos may seem antithetical to a chaotic and random origin suggested by a conventional explosion. Scientific studies, including those based on principles of quantum physics, have indicated that the nature of the universe may incorporate explosive aspects. Consequently, if the observable universe is influenced by a previous cosmic legacy, then the initial conditions and physical laws of this preceding universe could be the regulating keys of the expansion we witness today (Rees 2000). "The theory of everything is an ambitious quest in theoretical physics to unify all four fundamental forces of the universe: gravity, electromagnetism, weak nuclear force, and strong nuclear force." Said by Sean Carroll, in "From Eternity to Here: The Quest for the Ultimate Theory of Time."[lxxiv] "Every atom in your body came from a star that exploded. And, the atoms in your left hand probably came from a different star than your right hand. It really is the most poetic thing I know about physics: You are all stardust." As described by Lawrence M. Krauss, in "A Universe from Nothing: Why There Is Something Rather than Nothing." (Krauss, 2012)[lxxv] The Dead Universe theory not only challenges the foundations of the Big Bang but also offers more cohesive explanations for the existence of celestial phenomena. By proposing a new model for the origin of the universe, this theory paves the way for a deeper and possibly more accurate understanding of the cosmos, transcending the limitations of current science.

**Modern Cosmology**

Modern cosmology is a dynamic interplay of theoretical and experimental endeavors, continually evolving to surmount novel challenges. The discipline necessitates systematic reconstruction to harmonize theory with emerging observational data at each juncture. A watershed moment in this ongoing debate unfolded with the revelation of supernova dimming, [lxxvi] a phenomenon that revealed the limitations of the Friedmann–Lemaitre–Robertson–Walker metric (here Friedmann metric). To address this dissonance, the cosmological constant was introduced to align the theoretical predictions with empirical insights.[lxxvii] Present-day surveys and astronomical observations indicate that galaxies are increasingly moving away from us. At the core of current cosmological discussions is the significant challenge of understanding the formation of structures and the evolution of galaxies amidst the backdrop of the accelerated expansion in the late-time universe. [lxxviii] The Friedmann model, rooted in the cosmological principle, has effectively described the universe's evolution in line with empirical observations.[lxxix],[lxxx],[lxxxi] However, the mystery of dark energy and the force driving cosmic acceleration remains a tenacious challenge in contemporary physical cosmology.[lxxxii],[lxxxiii] Various efforts to explain cosmic acceleration rely on concepts such as the cosmological constant or scenarios dominated by dark energy. However, the puzzlements surrounding the cosmological constant pose significant puzzles.[lxxxiv],[lxxxv],[lxxxvi]Adding to these difficulties is the potential violation of the cosmological principle when homogeneity or isotropy falters in galaxy structure formation.[lxxxvii],[lxxxviii]

As for three-dimensional redshift, surveys delve deeper into the cosmos, revealing structures lacking a transition to homogeneity.[lxxxix],[xc] Now, questions arise regarding the steadfastness of the cosmological principle.[xci] The galaxy distribution in recent observations (or light) and the simulation of dark matter distribution (or matter) display significant inhomogeneity on the largest statistical scale available. [xcii] The matter distribution exhibits even greater inhomogeneity, challenging the search for the cosmological principle in the current observed light or matter distribution in the universe.[xciii] Recent studies on the angular scale of cosmic homogeneity using the Sloan Digital Sky Survey's Sixteenth Data Release (SDSS-IV DR16) of a luminous red galaxy sample based on a model-independent approach found a homogeneity of 60–80 $h^{-1}$ Mpc.[xciv] This finding was recently challenged through a homogeneity test for the matter distribution based on the Baryon Oscillation Spectroscopic Survey Data Release 12 CMASS galaxy sample.[xcv] It was found that the observed distribution of matter is statistically unlikely to be a random arrangement up to a radius of 300 $h^{-1}$ Mpc, which is approximately the largest statistically available scale.

The identification of large quasar groups (LQGs) further catalyzes the debate, suggesting an inherent inhomogeneity incompatible with prevailing cosmological paradigms.[xcvi],[xcvii] Such revelations underscore the need for a profound cosmological reassessment.[xcviii] Correct testing on the prediction of the standard model on the spatial distributions of luminous astronomical sources needs to be based on cosmological simulations of a high resolution involving a large sample of isolated galaxies using robust data-driven detectors to avoid misinterpretations of the analyzed sources.[xcix] While two-dimensional predictions appear consonant with isotropy and homogeneity, three-dimensional catalogues unveil a complex picture of inhomogeneous galactic distributions.[c] These divergent findings regarding the transition to homogeneity confound attempts at a unified perspective.[ci],[cii] The contrasting nature of these observations challenges the conventional assumption of cosmic homogeneity and isotropy.[ciii] The implications have a potential impact on understanding cosmic acceleration and the need for an additional dark energy component.[civ],[cv]

Researchers find it necessary to explore alternative models of dark energy or its modified forms to account for the cosmic acceleration of the universe, considering the observational anomalies of the standard model and its lack of physical motivation.[cvi],[cvii],[cviii],[cix] The proposed model includes scenarios where the scalar field replaces the cosmological constant to represent dark energy and modified gravity theories.[cx],[cxi] Recent observations, such as the unexplained Hubble parameter tensions, large-scale anisotropies, and massive disk galaxies at higher redshifts, pose challenges to the Friedmann model and the concordance model of cosmology in general. For example, the Hubble parameter determined from the cosmic microwave background (CMB) radiation differs from that determined using Type Ia supernovae and the redshift of their host galaxies.[cxii],[cxiii] While one possible explanation is the incompleteness of the concordance model, alternative theories propose that the standard redshift model, as a distance–scale factor relation, might be incomplete.[cxiv],[cxv] Addressing these observations supports modifications to some foundations of cosmology based on the cosmological principle.[cxvi] Modifying the standard redshift relation may offer a plausible explanation for investigating recent Hubble tensions.[cxvii] Some other models propose cosmic acceleration as an emergent phenomenon.[cxviii] The fundamental effect of cosmic evolution on photon propagation is cosmological redshift. In the standard model, cosmological redshift is a theoretical function of the scale factor derived from the Friedmann metric. However, researchers are now reconstructing this scale factor–redshift relation from observations rather than relying on its theoretical form.[cxix],[cxx] One drawback of remapping cosmological models is the unknown function of the observed redshift, increasing the degree of freedom of the equation. This issue has been addressed by introducing function parameterization through Taylor expansion before adopting a parametric approach. Related work includes a cosmological model proposed to explain the accelerated expansion of the universe by modifying the standard redshift relation.[cxxi] It has been demonstrated that combining Friedmann equations with a modification of redshift remapping may lead to a self-consistent framework under the assumption of the inadequacy of the Friedmann model.[cxxii],[cxxiii] The parametric,[cxxiv] non-parametric,[cxxv] and modified standard redshift models,[cxxvi] are expected to address the cosmological constant problem.

However, all these ambitious objectives hinge upon an indispensable precondition and an abundance of accurate and expansive cosmological data. Despite the growing body of observational data, persistent limitations require a careful interpretation of the current cosmological models' completeness and accuracy.[cxxvii, cxxviii, cxxix] The upcoming Vera Rubin Observatory holds the potential for a transformative ten-year exploration, armed with a 3.6 Gigapixel camera,[cxxx] ready to survey the entire visible night sky and delve into cosmic intricacies.[cxxxi] Again, in 2015 the parametric model proposed by Bassett et al.[cxxxii] introduces modifications to the traditional redshift paradigm, seeking to refine our understanding of cosmic dynamics. This model involves the introduction of parameters that capture modifications in the redshift space, allowing for a more nuanced interpretation of observational data. The model addresses subtle aspects of cosmic phenomena by incorporating specific parameters, providing a more detailed and accurate representation of redshift-related observations. On the other hand, the non-parametric model, as formulated by Wojtak and Prada in 2017, takes a distinct approach by avoiding predefined parameters, allowing for greater flexibility in modeling cosmic phenomena.[cxxxiii] Unlike parametric models, the non-parametric model refrains from imposing fixed parameters, enabling a more adaptive and data-driven analysis of redshift-related phenomena. This model is precious in scenarios where the underlying dynamics are complex and not easily encapsulated by predefined parameters. It provides a more versatile tool for interpreting observational data.

There are a wide variety of evolved stellar systems in the nearby universe (Norris et al. 2014),[cxxxiv] from globular clusters (Brodie & Strader 2006; Kruijssen 2014; Renzini et al. 2015)[cxxxv, cxxxvi, cxxxvii] to compact elliptical galaxies (Faber 1973)[cxxxviii], ultrafaint dwarfs (e.g., Simon & Geha 2007)[cxxxix], and ultra-diffuse spheroids (van Dokkum et al. 2017)[cxl], each of which presumably has its own characteristic formation pathway. The high stellar densities in many of these systems in combination with their old ages (Forbes and Bridges 2010)[cxli] suggest that the majority of their star formation occurred at $z \gtrsim 1.5$ when the gas densities in the universe were in general much higher. One potentially promising way forward for investigating the formation of these local systems is by obtaining a sensitive, high-resolution view of the distant universe. Luckily, such observations can be obtained by combining the power of long exposures with the Hubble Space Telescope with the magnifying effect of gravitational lensing, as recently implemented in the ambitious Hubble Frontier Fields (HFF) program (Coe et al. 2015; Lotz et al. 2017)[cxlii, cxliii]. Such sensitive observations allow us to probe to very low luminosities, as it is likely necessary to detect many of the progenitors of local systems. The high lensing magnifications from massive galaxy clusters stretch many galaxies by substantial factors, allowing them to be studied at very high spatial resolution. As it has discussed in Bouwens et al. (2021b)[cxliv], this stretching can reliably be estimated up to linear magnifications of ∼30× (or total magnification factors of ∼50×). It is also available in Bouwens et al. 2017a, c[cxlv, cxlvi], where similar though smaller limits were presented with the then-current models, and Meneghetti et al. 2017)[cxlvii]. Given the small inferred sizes of the fainter lensed sources identified by Kawamata et al. (2018)[cxlviii] and Bouwens et al. (2021b).[cxlix] It is interesting to place these sources in the context of various stellar systems that they may evolve into today, as well as other small star-forming systems like star clusters or cluster complexes. An initial look at such comparisons was already executed in an earlier unpublished study by our group (Bouwens et al. 2017b)[cl] and also by Kikuchihara et al. (2020)[cli]. An important early inference from these studies was that lensed $z$ = 6–8 galaxies have sizes and masses that appear to lie in the range of ~50–500 pc and $10^7$ to $10^8$ $M_\odot$, lying somewhere between ultracompact dwarfs/globular clusters and compact elliptical galaxies in size/mass space.

There has been enormous progress over the past decade in discovering galaxies which existed early in the history of the Universe (within a billion years of the Big Bang, at z > 6). It is great and thanks in large part to images from the Hubble Space Telescope, and confirming spectroscopy from large telescopes on the ground. The next few years will see the "high redshift frontier" pushed even further with the James Webb Space Telescope (JWST) and ground-based Extremely Large Telescopes (ELTs).[clii] The Nancy Grace Roman Space Telescope (shortened as the Roman Space Telescope, Roman, or RST) is a NASA infrared space telescope in development and scheduled to launch to a Sun–Earth $L_2$ orbit by May 2027.[cliii] The limited field of view of these facilities (especially JWST), and sensitivity only out to the near-infrared (near-IR, λ < 2μm) for the Roman Space Telescope (formerly WFIRST)[cliv] 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,[clv] working at near and mid-IR wavelengths (necessarily from space) is needed to find the very rare most massive and luminous galaxies at the highest redshifts, the progenitors of which are likely to be the first galactic structures to form. NIR spectroscopy at λ > 2μm (corresponding to the rest-frame optical frame) is also mandatory to get complete information (metallicity, stellar mass) for galaxies at z > 10.[clvi]

The landscape of astrophysics in the timeframe from 2035-2050 is expected to be very rich as the JWST mission will have been completed, presumably finding a wealth of faint galaxies at high redshift and addressing the role of these early galaxies in the reionization of the inter-galactic medium. Millimeter/submillimeter Array (ALMA), currently the most powerful radio telescope on Earth. The Square Kilometer Array (SKA) is an intergovernmental international radio telescope project being built in Australia (low-frequency) and South Africa (mid-frequency). ALMA will be a very mature facility by then and SKA will have explored the molecular emission and dust re-emission from some of these objects.[clvii] The re-ionization of the Universe was achieved by low luminosity sources.[clviii],[clix],[clx] These low luminosity sources would only be visible if they are in groups or proto clusters. This is likely so for the first galaxies, which were of very low luminosity. Thus, detecting proto clusters from z~6 to z~15 would unveil the history of the Universe's re-ionization.[clxi] Rare and bright sources at high redshift as well as transients like distant supernovae will be explored by the Rubin Observatory (previously LSST) on the ground, and EUCLID and the Roman Space Telescope in space, at wavelengths below 2 microns.[clxii] In the X-ray, after a hiatus of many decades new facilities like Athena will see AGN out to unprecedented distances. But there is a key gap in the parameter space that remains unexploited and a wide-field IR survey mission with spectroscopy and imaging working beyond 2 microns that need to address in future.[clxiii] By this unfinished journey toward mysterious universe will continue further. However, this analytical research work will evaluate and describe the chronological development of ideas and theories of physics along with origin and creation of universe on the basis of history of physics and contemporary development of concept. Author will also take effort to investigate and narrate the evaluation of future of universe and its uncertainty.

## CHRONOLOGICAL DEVELOPMENT AND ANALYSIS OF HISTORY OF PHYSICS

Physics is fundamental to all natural sciences. Its principles underpin our understanding of chemistry, biology, astronomy, and geology. A major achievement of physics is explaining diverse phenomena through universal laws. It helps us understand the workings of the world—from everyday objects like can openers, light bulbs, and cell phones to biological systems like muscles, lungs, and brains; from artistic pursuits like paints, piccolos, and pirouettes to technological creations like cameras, cars, and cathedrals; and from natural disasters such as earthquakes, tsunamis, and hurricanes to subatomic particles like quarks, DNA, and black holes. Physics organizes our view of the universe by revealing connections among seemingly unrelated phenomena. It provides powerful tools to foster creativity, expand our perspectives, and drive innovation. As the foundation of most modern technology, physics underpins the tools and instruments used in scientific, engineering, and medical research and development. Manufacturing heavily relies on physics-based principles technology.[clxiv] The future of human life is intertwined with technology developed through physics: medical imaging (MRI, X-ray, ultrasonogram, etc.), energy solutions (nuclear, solar power), and quantum computing all stem from applied physics. Physics is essential for modeling Earth's climate system, allowing scientists to predict changes in weather patterns, sea levels, and atmospheric conditions, which are critical for the future survival and adaptation of life on Earth.

Studying matter, behavior, motion, energy forms, time, space, and their interactions is the essence of physics. Before the Enlightenment, it was inextricably linked to chemistry, biology, and even natural philosophy. Today, it is a powerful force in the scientific era.[clxv] The main subjects of study in the scientific discipline of physics are matter and energy.[clxvi] At least in Greece's Archaic era (650–480 BCE), the Pre-Socratic philosophers marked the beginning of the transition to a logical knowledge of nature. .[clxvii] The philosopher Thales of Miletus, who lived in the 7th and 6th centuries BCE and is sometimes referred to as "the Father of Science," asserted that all events had a natural origin and rejected supernatural, religious, or mythical explanations for natural occurrences.[clxviii] Natural philosophy developed as a separate academic discipline throughout the Hellenistic era and Greece's classical era (6th, 5th, and 4th centuries BCE).[clxix] Aristotle wrote on a wide range of topics, including politics, governance, linguistics, logic, rhetoric, physics, metaphysics, poetry, theater, music, ethics, biology, and zoology. In the fourth century BCE, he authored the first treatise to refer to that field of study as physics. Aristotelian physics is a system that was established by Aristotle. [clxx] He attempted to use the notion of four elements to explain concepts like motion and gravity. According to Aristotle, earth, water, air, and fire are the four elements that make up all substance. [clxxi] Using the notion of four elements, he attempted to explain concepts such as motion and gravity. According to Aristotle, the four elements of earth, water, air, and fire make up all matter.[clxxii] Up to the eras of Galileo Galilei and Isaac Newton, it remained the preeminent scientific paradigm in Europe.[clxxiii]

Hipparchus (190–120 BCE), a mathematician and astronomer, used sophisticated mathematical techniques to map the motion of the planets and stars. [clxxiv] He even predicted when solar eclipses would occur. Using his advancements in observational devices, he also computed the Sun's and Moon's distances from Earth.[clxxv] During the Roman Empire, Ptolemy (90–168 CE) was another early physicist. [clxxvi] At least three of Ptolemy's scientific writings have had a long-lasting impact on Islamic and European science. The Almagest, an astronomical work, is the oldest of them."The Great Treatise", originally, "Mathematical Treatise". The second component is geography, which offers a thorough synopsis of Greco-Roman geographic knowledge. Ancient Chinese and Indian cultures also had important mathematical and physical traditions.[clxxvii] Maharishi Kanada was the first person in Indian philosophy to methodically establish a theory of atomism approximately 200 BCE, however some authors place his time in the 6th century BCE.[clxxviii] Physics emerged as a result of a process of knowledge accumulation and specialization brought about by the Scientific Revolution of the 17th century, particularly the discovery of the law of gravity.[clxxix] Classical mechanics emerged from the mathematical developments of the 18th century, whereas thermodynamics gained new understanding as experimental methods became more and more prevalent. The foundational principles of statistical mechanics and electromagnetism were developed throughout the 19th century. Advances in atomic theory, relativity, and quantum mechanics transformed physics at the beginning of the 20th century. These days, there are two main categories of physics: classical physics and contemporary physics.[clxxx]

However, Significant scientific advancements were made in the Muslim world between the seventh and fifteenth centuries. Many famous writings from Greek, Assyrian, Persian, and Indian sources—including those by Aristotle—were translated into Arabic during this time.[clxxxi] Ibn al-Haytham (965–1040), an Arab or Persian scientist who is recognized as a pioneer in the science of modern optics, made significant discoveries.[clxxxii] According to Ptolemy and Aristotle, light either came from the eye to enlighten objects or "forms" came from the objects themselves. Al-Haytham (also called "Alhazen"), on the other hand, maintained that light enters the eye by rays that originate from different locations on an item. [clxxxiii] Eventually, the writings of Persian scientists Ibn al-Haytham and al-Biruni (973–1050) reached Western Europe, where academics like Roger examined them. Vitello and Bacon.[clxxxiv] In his studies on optics, Ibn al-Haytham used controlled tests; nevertheless, it is unclear how much this method changed from Ptolemy's .[clxxxv] Arabic scholars such as Bīrūnī and Al-Khazini advanced the complex "science of weight,' performing precise measurements of specific weights and volumes.[clxxxvi] Ibn Sina (980–1037), also known as "Avicenna," was a polymath from Bukhara (modern-day Uzbekistan) who made significant contributions to physics, optics, and philosophy and medicine. [clxxxvii] He presented his theory of motion in the Book of Healing (1020), proposing that a thrower imparts an impetus to a projectile. He believed this impetus to be persistent, needing external forces like air resistance to diminish it.[clxxxviii] Ibn Sina distinguished between 'force' and 'inclination' (also called "mayl"), and argued that an object acquires mayl when it opposes its natural motion.[clxxxix] He concluded that the continuation of motion is due to the inclination transferred to the object, which will remain in motion until the mayl is spent.[cxc] This idea of motion aligns with Newton's first law of inertia, which states that an object in motion will remain in motion unless acted upon by an external force.[cxci] This idea, which opposed the Aristotelian perspective, was later called impetus by John Buridan, who Ibn Sina's Book of Healing probably influenced.[cxcii]

Hibat Allah Abu'l-Barakat al-Baghdaadi (c. 1080–1165) adapted and altered Ibn Sina's theory of projectile motion. In his Kitab al-Mu'tabar, Abu'l-Barakat explained that the mover causes a violent inclination (mayl qasri) in the object being moved, and this inclination decreases as the object moves farther away mover.[cxciii] He also suggested that the acceleration of falling bodies results from the buildup of successive increases in power with each increment of velocity.[cxciv] Shlomo Pines explains al-Baghdaadi's theory of motion was "the oldest negation of Aristotle's fundamental dynamic law [namely, that a constant force produces a uniform motion], [and is thus an] anticipation in a vague fashion of the fundamental law of classical mechanics [namely, that a force applied continuously produces acceleration]."[cxcv] Jean Buridan and Albert of Saxony later cited Abu'l-Barakat to explain that a falling body's acceleration results from its increasing impetus. Ibn Bajjah, also known as "Avempace" in Europe, argued that every force has a reaction force. He criticized Ptolemy and aimed to develop a new velocity theory to replace the existing one Aristotle.[cxcvi] Two future philosophers endorsed Avempace's theories, called Avempacean dynamics. They were Thomas Aquinas, a Catholic priest, and John Duns Scotus.[cxcvii] Galileo went on to adopt Avempace's formula "that the velocity of a given object is the difference of the motive power of that object and the resistance of the medium of motion".[cxcviii] Nasir al-Din al-Tusi (1201–1274), a Persian astronomer and mathematician who passed away in Baghdad, introduced the Tusi couple, an important mathematical theorem, and established the Maragha School astronomy.[cxcix] The geocentric models created by the Maragha School show many notable similarities to those of Nicolaus Copernicus, even though they are not heliocentric. The idea that Maragha's findings might have influenced Copernicus has been explored in some studies detail.[cc]

Awareness of ancient works re-emerged in the West through translations from Arabic Latin.[cci] Their reintroduction, along with Judeo-Islamic theological commentaries, significantly influenced Medieval philosophers like Thomas Aquinas.[ccii] European scholars of the Scholastic era aimed to harmonize the philosophy of ancient classical thinkers with Christian theology, often elevating Aristotle as the greatest thinker of the ancient world. When their ideas did not directly oppose the Bible, Aristotelian physics served as the basis for explaining physical phenomena in European Churches. During this period, quantification emerged as a fundamental aspect of medieval science physics.[cciii] According to Aristotelian physics, Scholastic physics explained that objects move in accordance with their essential nature. Celestial bodies were said to move in circles because perfect circular motion was viewed as an inherent characteristic of objects in the unspoiled celestial realm spheres.[cciv] Movements observed below the lunar sphere were considered imperfect, so they were not expected to display consistent motion. More idealized motion in the "sublunary" realm could only be achieved through artifice, and prior to the 17th century, many did not view artificial experiments as a valid means of learning about the natural world. Physical explanations in the sublunary realm centered on tendencies. Stones contained the element earth, and earthly objects naturally moved in a straight line toward the center of the earth—or the universe, in the Aristotelian geocentric view—unless something else obstructed this movement so.[ccv]

Aristotle's physics was not thoroughly examined until John Philoponus, who based his critique on observation rather than verbal argument, took interest Aristotle.[ccvi] Philoponus' critique of Aristotelian physics principles influenced Galileo Galilei ten centuries later during the Scientific Revolution.[ccvii] Galileo extensively referenced Philoponus in his writings to support the argument that Aristotelian physics was flawed.[ccviii] In the 1300s, Jean Buridan, who taught in the faculty of arts at the University of Paris, introduced the concept of impetus. This was an important development that contributed to the modern understanding of inertia and momentum.[ccix]

During the 16th and 17th centuries, a significant surge in scientific progress, known as the Scientific Revolution, occurred in Europe.[ccx] Dissatisfaction with traditional philosophical methods had already started earlier and led to societal changes such as the Protestant Reformation. However, the scientific revolution truly began when natural philosophers started challenging the Scholastic philosophical framework. They proposed that mathematical models from fields like mechanics and astronomy could provide universally valid descriptions of motion and other phenomena concepts.[ccxi] Renaissance astronomer Nicolaus Copernicus (1473–1543) achieved a significant breakthrough in astronomy in 1543 by presenting compelling arguments for the heliocentric model of the Solar System. He claimed this approach would improve the accuracy of tables tracking planetary motions and make them easier to understand production.[ccxii] In heliocentric models of the Solar system, the Earth orbits the Sun along with other bodies in Earth's galaxy, which contradicts the system of the Greek-Egyptian astronomer Ptolemy (2nd century CE; see above). Ptolemy's system placed the Earth at the center of the Universe and was accepted for over 1,400 years.[ccxiii] Aristarchus of Samos, a Greek astronomer (c. 310 – c. 230 BCE), first proposed that the Earth orbits the Sun. However, it was Copernicus's reasoning that led to widespread acceptance of this revolutionary idea. His book, De revolutionibus orbium coelestium ('On the Revolutions of the Celestial Spheres'), published just before his death in 1543, is now regarded as the start of modern astronomy and is also seen as marking the dawn of the Scientific Revolution.[ccxiv] Copernicus's new perspective, combined with Tycho Brahe's precise observations, allowed German astronomer Johannes Kepler (1571–1630) to develop his planetary motion laws, which are still in use today.[ccxv]

Galileo Galilei (1564–1642), an Italian mathematician, astronomer, and physicist, was a proponent of Copernicanism and made numerous contributions. He discovered new astronomical phenomena, conducted empirical experiments, and improved the telescope. During his time, his role as a mathematician at the university was overshadowed by the main fields of law, medicine, and theology, which was closely linked to philosophy. Galileo found that bodies do not fall with velocities proportional to their weights. Although the story of him dropping weights from the Leaning Tower of Pisa is likely apocryphal, he did demonstrate that the trajectory of a projectile is a parabola and made findings that anticipated Newton's laws of motion inertia.[ccxvi] Among these is what is now known as Galilean relativity, the earliest clear formulation regarding the properties of space and time beyond three-dimensional geometry. Galileo has often been referred to as the "father of modern observational" methods astronomy",[ccxvii] the "father of modern physics", the "father of science",[ccxviii] and "the father of modern science". According to Stephen Hawking said, 'Galileo, perhaps more than any other single person, was responsible for the birth of modern science.'[ccxix] Since religious orthodoxy upheld a geocentric or Tychonic view of the Solar system, Galileo's advocacy for heliocentrism sparked controversy, leading to his trial by the Inquisition. In 1610, he published his discovery of the Jovian moons, which helped him secure the role of mathematician and philosopher the Medici court.[ccxx] He was expected to participate in debates with philosophers of the Aristotelian tradition and attracted a large audience for his own works, including the Discourses and Mathematical Demonstrations Concerning Two New Sciences. His publications, such as the Dialogue Concerning the Two Chief World Systems, were published internationally after his arrest Assayer.[ccxxi, ccxxii] Galileo's focus on experimenting and developing mathematical descriptions of motion made experimentation a fundamental aspect of natural science philosophy.[ccxxiii]

In the 17th century, Johannes Kepler (1571–1630)[ccxxiv] He was a German astronomer, mathematician, astrologer, natural philosopher, and writer on music, known as a key figure in the Scientific Revolution. He is best known for his laws of planetary motion.[ccxxv] His important books, Astronomia Nova, Harmonice Mundi, and Epitome Astronomiae Copernicanae, influenced many scholars, including Sir Isaac Newton, and formed one of the foundations of his theory of universal gravitation.[ccxxvi] Kepler's diverse contributions and influence established him as one of the founders of modern astronomy, the scientific method, and natural science.[ccxxvii, ccxxviii] Kepler was partly motivated by his belief that an understandable plan exists and can be accessed through reason.[ccxxix] Kepler described his new astronomy as "celestial physics", as "an excursion into Aristotle's Metaphysics", and as "a supplement to Aristotle's On the Heavens", treating astronomy as part of a universal mathematical physics.[ccxxx, ccxxxi]

René Descartes (1596–1650), the French philosopher, was deeply involved in experimental philosophy circles. However, his primary goal was to challenge and replace Scholastic philosophical traditions tradition.[ccxxxii] Questioning the reality perceived through the senses, Descartes aimed to ground philosophical explanations by reducing all phenomena to the movement of an unseen sea of "corpuscles." Notably, he distinguished human thought and God from this scheme, considering them separate from the physical realm universe).[ccxxxiii] In proposing this philosophical framework, Descartes suggested that various types of motion, like those of planets and terrestrial objects, were not distinct at their core but represented different expressions of an infinite chain of corpuscular movements governed by universal laws principles.[ccxxxiv] His explanations were especially influential in describing circular astronomical motions through vortex movement of corpuscles in space. Descartes, aligning with Scholastic beliefs and methods, argued that a vacuum could not exist. He also explained gravity as resulting from corpuscles pushing objects downward.[ccxxxv]

Descartes, similar to Galileo, believed in the significance of mathematical explanation. He and his followers played crucial roles in advancing mathematics and geometry during the 17th century.[ccxxxvi] Cartesian descriptions of motion argued that all mathematical formulations should be directly justifiable through physical action. This view was supported by Christiaan Huygens and the German philosopher Gottfried Leibniz. While adhering to the Cartesian tradition, Leibniz also developed his own philosophical alternative to Scholasticism, which he detailed in his 1714 work the Monadology.[ccxxxvii] Descartes is often called the "Father of Modern Philosophy," and many later Western philosophers continue to respond to his ideas, which are still studied today. His Meditations on First Philosophy remains a core text in most university philosophy courses. His impact on mathematics is also significant; the Cartesian coordinate system, which translates algebraic equations into geometric forms on a two-dimensional plane, is named after him.[ccxxxviii] He is recognized as the father of analytical geometry, which connects algebra and geometry and was crucial to the development of calculus and analysis.

Christiaan Huygens (1629–1695), a Dutch physicist, mathematician, astronomer, and inventor, was the most prominent scientist in Europe between Galileo and Newton. Coming from a noble family that held a significant role in 17th-century Dutch society, he lived during a period when the Dutch Republic thrived both economically and culturally. This era, roughly from 1588 to 1702, is known as the Dutch Golden Age. It was a time during the Scientific Revolution when Dutch science gained international recognition Europe.[ccxxxix] During this period, the Netherlands was home to prominent intellectuals and scientists such as René Descartes, Baruch Spinoza, Pierre Bayle, Antonie van Leeuwenhoek, John Locke, and Hugo Grotius. It was within this vibrant intellectual milieu that Christiaan Huygens developed up.[ccxl] Constantijn Huygens, Christiaan's father, was not only an important poet but also served as the secretary and diplomat for the Princes of Orange.[ccxli] He was acquainted with many scientists of his era through his contacts and intellectual pursuits, such as René Descartes and Marin Mersenne. It was these connections that introduced Christiaan Huygens to their work, particularly Descartes, whose mechanistic philosophy greatly influenced Huygens' own ideas work.[ccxlii] Descartes was later impressed by Huygens' skills in geometry, as was Mersenne, who called him "the new Archimedes." This led Constantijn to refer to his son as my little Archimedes.[ccxliii] The theoretical investigation into how the pendulum functions ultimately resulted in the publication of one of his most significant achievements: the ‘Horologium Oscillatorium.’[ccxliv] Published in 1673, this work is regarded as one of the three most influential texts of the 17th century mechanics. Another two works on mechanics are Galileo's "Discourses" and "Mathematical Demonstrations Relating to Two New Sciences" (1638).[ccxlv] and Newton's ‘Philosophiæ Naturalis Principia Mathematica’ (1687).[ccxlvi], [ccxlvii], [ccxlviii] The ‘Horologium Oscillatorium’ is the first modern treatise where a physical problem, such as the accelerated motion of a falling body, is idealized through a set of parameters, then mathematically analyzed. It stands as a foundational work in applied science mathematics.[ccxlix], [ccl] It is for this reason, Huygens has been called the first theoretical physicist[ccli] and one of the pioneers of modern mathematical thought physics.[cclii], [ccliii], [ccliv] Huygens' Horologium Oscillatorium influenced the work of Isaac Newton, who admired the work. For example, the laws Huygens described in the Horologium Oscillatorium are structurally the same as Newton's first two laws of motion.[cclv]

Five years following the publication of his Horologium Oscillatorium, Huygens outlined his wave theory of light.[cclvi] Although proposed in 1678, it wasn't published until 1690 in his ‘Traité de la Lumière.’ His mathematical theory of light was initially rejected in favor of Newton's corpuscular theory, until Augustin-Jean Fresnel adopted Huygens' principle to thoroughly explain the rectilinear propagation and diffraction effects of light 1821.[cclvii] Today, this principle is called the Huygens–Fresnel principle. It states that each point on a wavefront acts as a source of spherical wavelets, and the secondary wavelets originating from different points interfere to form the wave motion mutually interfere.[cclviii] As an astronomer, Huygens began grinding lenses with his brother Constantijn Jr. to build telescopes for astronomical research. He was the first to identify the rings of Saturn as "a thin, flat ring, nowhere touching, and inclined to the ecliptic," and discovered the first of Saturn's moons, Titan, using a refracting telescope.[cclix] Huygens was also the first who brought mathematical rigor to the description of physical phenomena. Because of this, and the fact that he developed institutional frameworks for scientific research on the continent, he has been referred to as the leading actor in the making of science in Europe.[cclx]

Sir Isaac Newton (1642–1727) was a fellow of the Royal Society of England, and the British physicist and mathematician who created a single system for describing the workings of the universe. He was a Fellow of the Royal Society of England after being elected in 1672. He later became the Society's President from 1703 until his death in 1727.[cclxi] Newton formulated three laws of motion that describe the relationship between objects and their motion. He also proposed the law of universal gravitation, which explains not only the falling of bodies on Earth but also the motion of planets and other celestial objects bodies.[cclxii] To achieve his results, Newton developed a new branch of mathematics: calculus, which was also independently invented by Gottfried Leibniz. This branch became an essential tool for subsequent advancements across many areas of physics. Newton detailed his discoveries in the *Philosophiæ Naturalis Principia Mathematica* or *Mathematical Principles of Natural Philosophy*. Its publication in 1687 marked the start of the modern era in mechanics and related fields astronomy.[cclxiii] Newton challenged the Cartesian mechanical view that all motions are explained by immediate forces from corpuscles. By applying his three laws of motion and the law of universal gravitation, he replaced the idea that objects follow predetermined natural paths with the understanding that all future motions can be mathematically predicted using current motion, mass, and the forces at play.[cclxiv] However, celestial motions observed did not exactly match a Newtonian perspective, and Newton, who also had a keen interest in theology, believed that God's intervention was necessary to maintain the solar system's stability.[cclxv]

Newton's principles, excluding his mathematical methods, were controversial among Continental philosophers, who criticized his absence of metaphysical explanations for movement and gravitation unacceptable.[cclxvi] Starting around 1700, a fierce division emerged between the Continental and British philosophical traditions. This divide was fueled by intense, ongoing, and often personal disputes between followers of Newton and Leibniz over who had priority in developing the analytical techniques of calculus, which each had created independently.[cclxvii] Initially, the Cartesian and Leibnizian traditions dominated on the European continent, resulting in Leibnizian calculus notation being prevalent everywhere except Britain. Newton personally felt uneasy about the absence of a philosophical explanation for gravitation, although he emphasized in his writings that such understanding was not essential to infer its effects reality.[cclxviii] As the 18th century advanced, Continental natural philosophers more and more embraced the Newtonians' approach of abandoning ontological metaphysical explanations in favor of those described mathematically motions.[cclxix],[cclxx]

Newton built the first working reflecting telescope and formulated a theory of color, which he published in *Opticks*. His theory was based on the observation that a prism breaks down white light into the various colors visible to the human eye spectrum.[cclxxi] While Newton described light as made up of tiny particles, in 1690 Christiaan Huygens proposed a competing wave theory explaining light's behavior. Nonetheless, due to widespread belief in mechanistic philosophy and Newton's strong reputation, the wave theory gained little traction until the 19th century. Newton also established an empirical law of cooling, studied sound speed, explored power series, demonstrated the generalized binomial theorem, and devised a method for approximating the roots of an equation function.[cclxxii] His research on infinite series was motivated by Simon Stevin's work decimals.[cclxxiii] Most importantly, Newton demonstrated that the motions of objects on Earth and celestial bodies are controlled by the same natural laws, which are neither unpredictable nor harmful. By showing the alignment between Kepler's laws of planetary motion and his theory of gravitation, Newton dispelled any remaining doubts heliocentrism.[cclxxiv] By synthesizing the ideas presented during the Scientific Revolution, Newton effectively laid the groundwork for modern society in mathematics and science.[cclxxv]

Other areas of physics also gained focus during the Scientific Revolution. William Gilbert, who served as Queen Elizabeth I's court physician, explained how the Earth itself acts like a massive magnet.[cclxxvi] Robert Boyle (1627–1691) studied how gases behave inside a chamber, leading to the formulation of the gas law named after him. He also made contributions to physiology and helped establish modern science chemistry.[cclxxvii] Another significant element of the Scientific Revolution was the emergence of learned societies and academies across different countries. The earliest examples appeared in Italy and Germany but were short-lived. More impactful were the Royal Society of England (founded in 1660) and the Academy of Sciences France (1666).[cclxxviii] In the 18th century, key royal academies were founded in Berlin (1700) and St. Petersburg (1724). These societies and academies offered the main platforms for publishing and debating scientific findings during and after the scientific revolution. In 1690, James Bernoulli demonstrated that the cycloid solves the tautochrone problem; the next year, Johann Bernoulli proved that a chain hung from two points takes the shape of a catenary, the curve with the lowest center of gravity achievable by any chain suspended between two fixed points.[cclxxix] In 1696, he demonstrated that the cycloid is the solution to the brachistochrone problem.[cclxxx]

A precursor to the engine was created by German scientist Otto von Guericke, who, in 1650, designed and built the world's first vacuum pump to generate a vacuum, as demonstrated in the Magdeburg hemispheres experiment.[cclxxxi] He was motivated to create a vacuum to challenge Aristotle's longstanding belief that 'Nature abhors a vacuum.' Soon after, Irish physicist and chemist Boyle learned about Guericke's work and, in 1656, collaborated with English scientist Robert Hooke to build an air pump.[cclxxxii] Boyle and Hooke examined the pressure-volume relationship for a gas using this pump: $PV = k$, where P is pressure, V is volume, and k is a constant. This relationship is known as Boyle's law.[cclxxxiii] At that time, air was considered a collection of stationary particles, not as a system of moving molecules. The idea of thermal motion only emerged two centuries later. Consequently, Boyle's 1660 publication discussed a mechanical view: the air spring. After the thermometer was invented, temperature could be numerically measured. This enabled Joseph Louis Gay-Lussac to formulate his law, which eventually contributed to the development of the ideal gas law.[cclxxxiv] Before the establishment of the ideal gas law, Boyle's associate Denis Papin built in 1679 a bone digester—a sealed vessel with a tightly fitting lid that traps steam until high pressure is achieved generated.[cclxxxv]

Later designs added a steam release valve to prevent the machine from exploding. Observing the valve's rhythmic movement, Papin imagined the concept of a piston andLater designs added a steam release valve to prevent the machine from exploding. Observing the valve's rhythmic movement, Papin imagined the concept of a piston and cylinder engine cylinder engine.[cclxxxvi] However, he did not complete his design. Still, in 1697, engineer Thomas Savery constructed the first engine inspired by Papin's designs. While these initial engines were basic and inefficient, they drew interest from prominent scientists of the time.[cclxxxvii] Before 1698 and the invention of the Savery Engine, horses were used to operate pulleys connected to buckets, which lifted water from flooded salt mines in England. Over time, various steam engine designs emerged, including the Newcomen Engine and later the Watt Engine. Eventually, these early engines replaced other methods horses.[cclxxxviii] Thus, each engine started to be linked with a certain amount of "horse power" based on how many horses it had replaced.[cclxxxix] The primary issue with these early engines was their sluggishness and lack of finesse, as they transformed less than 2% of the input fuel into useful work. Essentially, vast amounts of coal or wood had to be burned to produce a small amount of work, highlighting the necessity for a new science of engine dynamics born.[ccxc]

During the 18th century, Newton's mechanics was expanded by many scientists as more mathematicians learned calculus and built on its original formulation. The use of mathematical analysis to solve motion problems was called rational mechanics, or mixed mathematics, and was later known as classical mechanics.[ccxci] In 1714, Brook Taylor calculated the fundamental frequency of a stretched vibrating string based on its tension and mass per unit length through solving a differential equation.[ccxcii] Daniel Bernoulli (1700–1782), a renowned Swiss mathematician and physicist, was part of the prominent Bernoulli family from Basel. He is best known for applying mathematics to mechanics, particularly fluid mechanics, and for his pioneering contributions in these fields in probability and statistics.[ccxciii] He conducted significant mathematical research on gas behavior, foreshadowing the kinetic theory of gases that emerged over a century later, and is often called the first mathematical physicist. In 1733, Daniel Bernoulli calculated the fundamental frequency and harmonics of a hanging chain through differential equation solving equation.[ccxciv] In 1734, Bernoulli addressed the differential equation governing the vibrations of an elastic bar fixed at one end.[ccxcv] Bernoulli's approach to fluid dynamics and his study of fluid flow were introduced in his 1738 work work 'Hydrodynamica.'[ccxcvi] Rational mechanics mainly focused on creating detailed mathematical models of observed motions, grounded in Newtonian principles. It aimed to make complex calculations more manageable and to develop reliable methods for analytical approximation. A notable textbook from that era was published by Johann Baptiste Horvath.[ccxcvii] By the end of the century, analytical methods had become sufficiently rigorous to confirm the Solar System's stability based solely on Newton's laws, without needing to invoke divine intervention—although deterministic approaches to systems as straightforward as the three-body problem in gravitation still persisted intractable.[ccxcviii]

In 1705, Edmond Halley predicted the periodicity of Halley's Comet, [ccxcix] William Herschel discovered Uranus in 1781, [ccc] Henry Cavendish measured the gravitational constant and calculated the Earth's mass 1798.[ccci] In 1783, John Michell proposed that certain objects could be so dense that even light would be unable to escape from them. [cccii] In 1739, Leonhard Euler solved the differential equation for a forced harmonic oscillator and observed the phenomenon of resonance phenomenon.[ccciii] In 1742, Colin Maclaurin identified his class of uniformly rotating, self-gravitating spheroids. [ccciv] In 1742, Benjamin Robins published *New Principles in Gunnery*, laying the groundwork for aerodynamics. While British mathematicians like Taylor and Maclaurin continued their work, they began to lag behind Continental advancements as the century advanced. On the other side of Europe, scientific academies thrived with the contributions of mathematicians such as Bernoulli, Euler, Joseph-Louis Lagrange, Pierre-Simon Laplace, and Adrien-Marie Legendre. In 1743, Jean le Rond d'Alembert released his *Traité de dynamique*, where he introduced generalized forces for accelerating systems and systems with constraints. He also applied the concept of virtual work to tackle dynamic problems, forming what is now known as D'Alembert's principle, as an alternative to Newton's second law motion. [cccv] In 1747, Pierre Louis Maupertuis utilized minimum principles in his work mechanics.[cccvi] In 1759, Euler solved the partial differential equation describing the vibration of a rectangular drum. By 1764, he analyzed the partial differential equation for a circular drum and identified one of the solutions involving Bessel functions. In 1776, John Smeaton published a paper discussing experiments on power, work, momentum, and kinetic energy, supporting the principle of conservation of these quantities energy.[cccvii] In 1788, Lagrange introduced his equations of motion in 'Mécanique analytique,' where mechanics was structured around the principle of virtual work.[cccviii] In 1789, Antoine Lavoisier articulated the law of conservation of matter mass. [cccix] The rational mechanics developed in the 18th century are presented in both Lagrange's 'Mécanique analytique' and Laplace's 'Traité de mécanique.' céleste' (1799–1825).[cccx]

During the 18th century, thermodynamics was developed through the theories of weightless 'imponderable fluids', such as heat, electricity, and phlogiston and which was rapidly overthrown as a concept following Antoine Lavoisier's identification of oxygen gas late in the century. [cccxi] This tradition of experimentation resulted in the creation of new types of experimental equipment. Assuming these concepts represented real fluids, their flow could be observed using mechanical devices or chemical reactions similar to the Leyden jar. It also led to the development of new measuring tools, like the calorimeter, and improvements to existing ones, such as the thermometer. Experiments on latent heat and Benjamin Franklin's description of electrical fluid as flowing between areas of surplus and deficiency further contributed to this body of work deficit.[cccxii] Franklin later redefined the concept in terms of positive and negative charges and demonstrated that lightning is a form of electricity in 1752. The prevailing 18th-century theory of heat treated it as a fluid known as caloric. Even though this theory was later disproven, many scientists who supported it made significant discoveries that contributed to the development of modern theories, including Joseph Black (1728–1799) [cccxiii] and Henry Cavendish (1731–1810). [cccxiv] Opposing the caloric theory, mainly developed by chemists, was the less accepted idea from Newton's era that heat results from the motion of particles in a substance. This mechanical theory gained backing in 1798 through Count Rumford's (Benjamin Thompson) cannon-boring experiments. Rumford, an American-born British military officer, scientist, and inventor.[cccxv] He discovered a direct link between heat and mechanical energy. Although it was acknowledged early in the 18th century that developing comprehensive theories of electrostatic and magnetic forces similar to Newton's laws of motion would be significant, none had been established forthcoming.

This impossibility gradually faded as experimental practice grew more widespread and refined during the early 19th century, particularly in places like the newly established Royal Institution London. [cccxvi] Meanwhile, the methods of rational mechanics started being used to analyze experimental phenomena, most notably in Joseph Fourier's influential analytical treatment of heat flow, as published in 1822.[cccxvii] Joseph Priestley proposed an inverse-square law related to electricity 1767,[cccxviii] and Charles-Augustin de Coulomb, a French officer, engineer, and physicist, introduced the inverse-square law of electrostatics in 1798. He is most renowned for discovering what is now called Coulomb's law, which describes the electrostatic force of attraction repulsion. by the century's end, the French Academy of Sciences members had established clear dominance in the field.[cccxix,cccxx] Simultaneously, the experimental tradition initiated by Galileo and his followers continued. The Royal Society and the French Academy of Sciences remained key institutions for conducting and disseminating experimental work.[cccxxi] In the 18th century, experiments in mechanics, optics, magnetism, static electricity, chemistry, and physiology were not distinctly separated. However, notable differences in their explanatory models and experiment designs were beginning to emerge. For example, chemical experimenters resisted imposing a framework of abstract Newtonian forces onto chemical substances, instead emphasizing the isolation and classification of these substances' reactions.[cccxxii]

In 1821, William Hamilton started analyzing Hamilton's characteristic function and articulated Hamilton's canonical equations motion.[cccxxiii] In 1813, Peter Ewart endorsed the concept of energy conservation in his paper, 'On the Measure of Moving.' force.[cccxxiv] In 1829, Gaspard Coriolis defined the concepts of work, meaning 'force times distance,' and kinetic energy with their current definitions today.[cccxxv] In 1841, Julius Robert von Mayer, an amateur scientist, authored a paper on energy conservation. However, his limited academic background affected the quality of the work rejection. [cccxxvi] In 1847, Hermann von Helmholtz was a German physicist and physician known for his important contributions across various scientific disciplines, especially in hydrodynamic stability, where he formally articulated the law of conservation of energy.[cccxxvii] In 1800, Alessandro Volta invented the electric battery, known as the voltaic pile, which improved the way electric currents could also be generated and utilized studied.[cccxxviii] A year later, Thomas Young demonstrated light's wave nature, supported by Augustin-Jean Fresnel's work and the principle of interference.[cccxxix] The writing systems used in ancient Egypt were deciphered in the early nineteenth century thanks to the efforts of several European scholars, notably Jean-François Champollion and Thomas Young.[cccxxx] In 1820, Danish chemist and physicist Hans Christian Ørsted discovered that electric currents generate magnetic fields. He observed that a conductor carrying current produces a magnetic force around it. it.[cccxxxi] Within a week of Hans's discovery, André-Marie Ampère found that two parallel electric currents repel or attract each other.[cccxxxii] He was a French physicist and mathematician who was one of the founders of the science of classical electromagnetism. Faraday called this phenomenon electrodynamics.

In 1821, he constructed a motor powered by electricity. As an English chemist and physicist, Faraday significantly advanced electrochemistry and electromagnetism. His key discoveries include electromagnetic induction, diamagnetism, and electrolysis. Despite limited formal education, Faraday's self-taught knowledge made him one of the most influential scientists of his time history.[cccxxxiii] Conversely, Georg Ohm introduced his law of electrical resistance in 1826, describing how voltage, current, and resistance are interconnected in an electric circuit.[cccxxxiv] He was a German mathematician and physicist. As a school teacher, Ohm started his research using the electrochemical cell invented by Italian scientist Alessandro Volta. With equipment he designed himself, Ohm discovered that there is a direct proportionality between the potential difference, or voltage, across a conductor and the resulting electric current. This relationship is known as Ohm's law.[cccxxxv] In 1831, Faraday and independently Joseph Henry discovered electromagnetic induction—the generation of an electric potential or current through magnetism. These discoveries form the foundation of the electric motor and generator respectively.[cccxxxvi] In 1873, James Clerk Maxwell published 'A Treatise on Electricity and Magnetism', describing energy transmission as a wave through a 'luminiferous ether' and proposing that light is such a wave. As a Scottish physicist and mathematician, he developed the classical theory of electromagnetic radiation, which was the first to explain electricity, magnetism, and light as different forms of the same phenomenon.[cccxxxvii] Maxwell's equations unified electromagnetism, marking the second great unification in physics after Newton's. This was validated in 1888 when Heinrich Hertz, a student of Helmholtz, generated and detected electromagnetic radiation in the lab..[cccxxxviii],[cccxxxix]

In the 19th century, Julius Robert von Mayer and James Prescott Joule quantitatively linked heat and mechanical energy by measuring the mechanical equivalent of heat in the 1840s. Mayer, a German physician, chemist, and physicist, was one of the founding figures of thermodynamics. He is most famous for proposing in 1841 one of the earliest formulations of the conservation of energy—what is now recognized as an early version of the first law of thermodynamics—stating that 'energy can be neither created nor destroyed.''.[cccxl] James Prescott Joule was an English physicist known for studying heat and its connection to mechanical work. His research contributed to the formulation of the law of conservation of energy, which eventually led to the development of the first law of thermodynamics. The SI unit of energy, the joule (J), is named in his honor him.[cccxli] In 1849, Joule presented his experimental findings, including the paddlewheel experiment, demonstrating that heat is a form of energy. This discovery was widely accepted by the 1850s. Understanding the relationship between heat and energy was crucial for advancing steam engine technology. Additionally, in 1824, Sadi Carnot published his groundbreaking work, both experimental and theoretical. Carnot, a French military engineer and physicist, was a graduate of the École Polytechnique and served as an officer in the Engineering Arm of the French Army. His work incorporated fundamental concepts of thermodynamics, particularly regarding the efficiency of an idealized system engine.[cccxlii] Sadi Carnot's work laid the foundation for the first law of thermodynamics and a restatement of the law of conservation of energy, which was later articulated around 1850 by William Thomson,[cccxliii] Later recognized as Lord Kelvin and Rudolf Clausius, Lord Kelvin extended the concept of absolute zero from gases to all substances in 1848. He based his work on the engineering theories of Lazare Carnot, Sadi Carnot, and Émile Clapeyron, along with James Prescott Joule's experiments on the interchangeability of mechanical, chemical, thermal, and electrical work, to develop the first law.[cccxliv],[cccxlv]

Kelvin and Clausius also stated the second law of thermodynamics, which was originally formulated in terms of the fact that heat does not spontaneously flow from a colder body to a warmer one.[cccxlvi] Subsequent formulations of the second law of thermodynamics quickly emerged, particularly in the influential work, *Treatise on Natural Philosophy*, by Thomson and Peter Guthrie Tait. Notably, Lord Kelvin highlighted several significant implications of this law, enriching the understanding of thermodynamics and establishing a framework that impacts both theory and practice in natural philosophy.[cccxlvii] In the context of the Second Law, the concept that gases are composed of molecules in motion was initially explored by Daniel Bernoulli in 1738. However, this idea lost prominence over time until it was revived by Rudolf Clausius in 1857, marking a significant step in the development of kinetic theory and thermodynamics. Clausius's work helped to redefine our understanding of gases and their behavior based on molecular motion, leading to advancements in the field of thermodynamics.[cccxlviii] In 1850, Hippolyte Fizeau and Léon Foucault measured the speed of light in water and found it to be slower than in air, supporting the wave model of light. Their findings significantly advanced the understanding of light's behavior in different media.[cccxlix],[cccl] Joule and Thomson proved in 1852 that a rapidly expanding gas cools; this phenomenon was subsequently dubbed the Joule–Thomson effect or the Joule–Kelvin effect. .[cccli] In 1854, Hermann von Helmholtz proposed the concept of the "heat death of the cosmos." ,[ccclii] and Clausius's theorem and the significance of dQ/T were established in the same year.[cccliii]

The Maxwell-Boltzmann distribution was developed in 1860 by James Clerk Maxwell as a mathematical representation of the distribution of gas molecules' velocities.[cccliv] In order to explain the rules of thermodynamics, Clausius and James Clerk Maxwell devised the kinetic-molecular theory of gases, which included the atomic theory of matter, which was first put out by chemist John Dalton in the early 19th century.[ccclv] The basis of contemporary atomic theory and stoichiometric chemistry were established by the work of English chemist, physicist, and meteorologist Dalton. The statistical mechanics of Ludwig Boltzmann (1844–1906) and Josiah Willard Gibbs (1839–1903), which examines the statistics of a system's microstates and using statistics to ascertain the state of a physical system, was a breakthrough approach to science that resulted from the kinetic theory.[ccclvi] Clausius reinterpreted the dissipation of energy as the statistical tendency of molecular configurations to pass toward increasingly likely, increasingly disorganized states by relating the energy of those states to the statistical likelihood of certain states of organization of these particles. He also coined the term "entropy" to describe the disorganization of a state. [ccclvii] The debate between statistical and absolute interpretations of the second rule of thermodynamics created "Maxwell's demon" and other disputes that would not be deemed conclusively settled until the behavior of atoms was clearly established in the early 20th century. .[ccclviii], [ccclix] James Jeans discovered the length scale necessary for gravitational perturbations to increase in a virtually homogenous, static material in 1902.[ccclx]

The discovery of Brownian motion by botanist Robert Brown in 1822 describes how pollen grains in water move as a result of being bombarded by the liquid's swiftly moving atoms or molecules. Carl Jacobi found his evenly spinning self-gravitating ellipsoids in 1834. In 1834, John Russell utilized a water tank to explore the dependency of solitary water wave velocities on wave amplitude and water depth after observing a nondecaying solitary water wave in the Union Canal near Edinburgh, Scotland. Gaspard Coriolis discovered the Coriolis effect in 1835 after conducting a theoretical analysis of waterwheel mechanical performance. Christian Doppler first postulated the Doppler effect in 1842. He was a scientist and mathematician from Austria. He developed what is now called the Doppler effect, which states that the relative speeds of the source and the observer determine a wave's apparent frequency. Leon Foucault used a massive pendulum to demonstrate the Earth's rotation in 1851. The first half of the century saw significant developments in continuum mechanics, including the discovery of Navier-Stokes equations for fluids and the development of the laws of elasticity for solids. This equation bears the names of Sir George Gabriel Stokes, Bt., a British mathematician and physicist, and Claude-Louis Navier, a French engineer and scientist. They were created by gradually constructing the theories over several decades.[ccclxi]

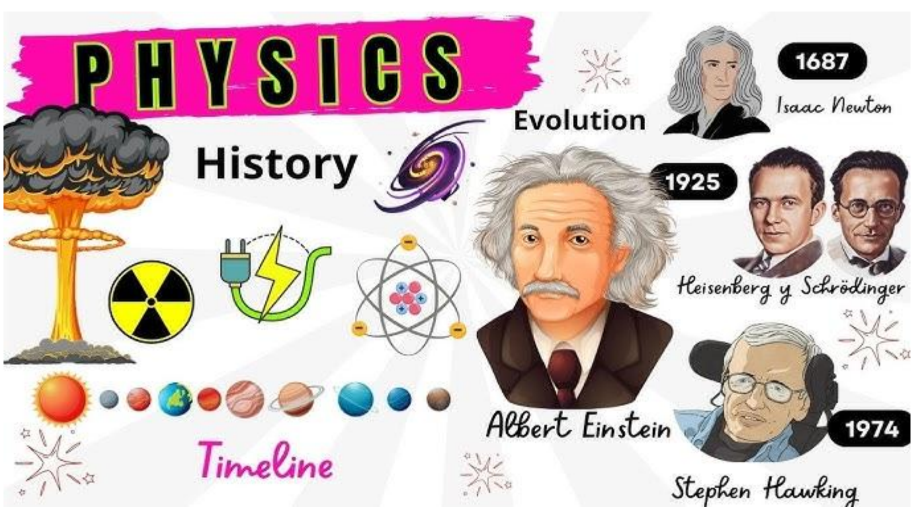


**Figure 1: Historical Players of Physics**[ccclxii]

By the end of the 19th century, physics had advanced to the point where thermodynamics and kinetic theory were well established, geometrical and physical optics could be understood in terms of electromagnetic waves, the conservation laws for energy and momentum (and mass) were widely accepted, and classical mechanics could handle extremely complex problems involving macroscopic situations.[ccclxiii] These and other advancements were so significant that it was widely believed that all of the fundamental principles of physics had been uncovered and that, going forward, research will focus on resolving minor issues, especially those involving technique and measurement improvements. However, significant questions concerning the success of Maxwell's ideas and the completeness of the classical theories began to surface around 1900. [ccclxiv] was weakened, for instance, by shortcomings that had already started to show up and their incapacity to explain specific physical phenomena, like the photoelectric effect and the energy distribution in blackbody radiation, while some of the theoretical formulations produced paradoxes when tested to the limit.[ccclxv],[ccclxvi] Prominent physicists including Wilhelm Wien, Ernst Wiechert, Emil Cohn, and Hendrik Lorentz thought that all physical laws could be derived from a modification of Maxwell's equations. New concepts were needed since these flaws in traditional physics could never be fixed. A significant upheaval rocked the field of physics at the start of the 20th century, ushering in a new period known as modern physics.[ccclxvii]

Experimenters started to find unexpected types of radiation in the 19th century. Wilhelm Röntgen made headlines in 1895 when he discovered X-rays, and Henri Becquerel found that some types of materials naturally released radiation in 1896. After J. J. Thomson discovered the electron in 1897, Marie and Pierre Curie discovered new radioactive elements that raised questions about the nature of matter and the supposedly indestructible atom. They isolated the radioactive elements radium and polonium and came up with the term "radioactivity" to describe this property of matter. Two of Becquerel's radiation types involving electrons and the element helium were discovered by Ernest Rutherford and Frederick Soddy. was a physicist and chemist from New Zealand who made significant contributions to the fields of nuclear and atomic physics. He has been referred to as "the finest experimentalist since Michael Faraday" and "the founder of nuclear physics." In 1911, Rutherford recognized and labeled two forms of radioactivity and concluded that the atom is made up of negatively charged electrons around a compact, positively charged nucleus. However, according to classical theory, this structure ought to be unstable. Two further experimental findings from the late 19th century were likewise not adequately explained by classical theory. Among these was the Michelson–Morley experiment, which was conducted by Albert A. Michelson and Edward W. Morley. It demonstrated that, when considering the hypothetical luminiferous ether at rest, there did not appear to be a preferred frame of reference for explaining electromagnetic events. Until the 1930s, when Lise Meitner and Otto Frisch discovered nuclear fission, which allowed for the practical use of what became known as "atomic" energy, studies of radiation and radioactive decay remained the primary focus of physical and chemical study.[ccclxviii]

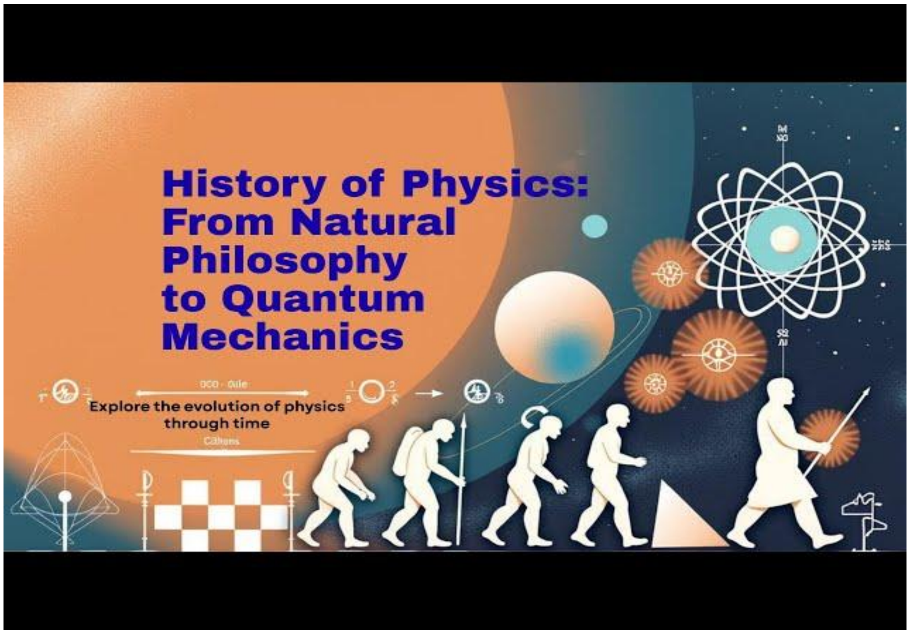


**Figure 2: Chronology of Physics from Natural Philosophy to Quantum Mechanics**[ccclxix]

A 26-year-old German scientist called Albert Einstein settled in Bern, Switzerland, in 1905, and demonstrated how motion between the observer and the object of observation affects measurements of time and space.[ccclxx] Einstein also made significant advances in quantum theory. His special-relativity-derived mass-energy equivalence formula, $E=mc^2$, has been dubbed "the world's most famous equation." [ccclxxi] His contributions to theoretical physics stand alone as one of the finest pieces of intellectual work ever produced. Einstein acknowledged 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, even if he did not establish the idea of relativity. Since most items move at considerably slower rates than the speed of light, this has little effect on an individual's daily life. But according to the theory of relativity, when an object is traveling close to the speed of light, its linked clocks will run more slowly, and the object's length will decrease as measured by an observer on Earth. Additionally, Einstein formulated the equation $E=mc^2$, which states that mass and energy are equivalent.[ccclxxii] Einstein contended that the speed of light is constant across all inertial reference frames and that electromagnetic laws should be universally valid, regardless of the reference frame. His work on the photoelectric effect earned him the Nobel Prize in Physics in 1921. Einstein's revolutionary theory of relativity fundamentally changed scientific understanding. Although he made many other important contributions, his theory of relativity remains his most influential achievement.

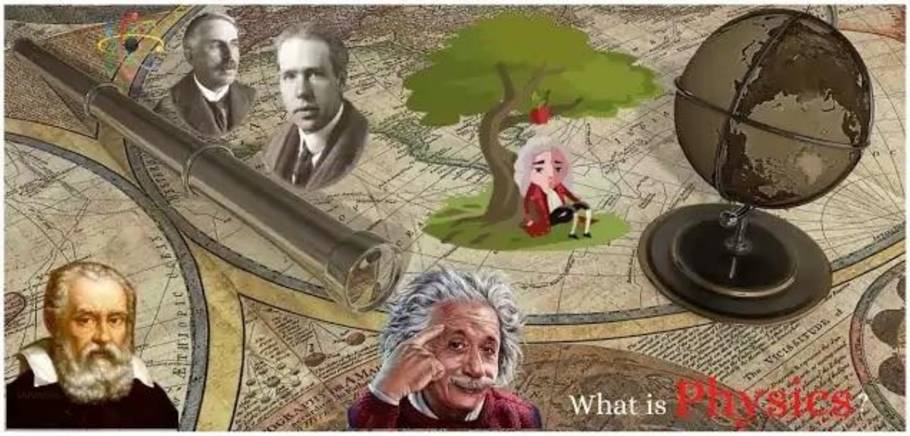


**Figure 3: Classical Vs Modern Physics** [ccclxxiii]

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.[ccclxxiv] Additionally, the equation implied that mass and energy were equivalent amounts. $E=mc^2$. According to a constant proposed by theoretical physicist Max Planck in 1900 to develop a precise theory for the distribution of blackbody radiation, [ccclxxv] Einstein claimed in a different paper that same year that electromagnetic radiation was transmitted in discrete quantities, or quanta. This assumption explained the peculiar characteristics of the photoelectric effect. [ccclxxvi] The link between physical observations and the ideas of space and time is stated in the special theory of relativity. The hypothesis emerged from the inconsistencies between Newtonian mechanics and electromagnetic, and it had a significant influence on both fields. The initial historical question was whether it was relevant to talk about motion in relation to the electromagnetic wave-carrying "ether" and if it was possible to detect such motion, as was attempted in vain in the Michelson–Morley experiment. In his special theory of relativity, Einstein disproved both these queries and the idea of ether. However, full electromagnetic theory is not included in his fundamental formulation. It starts with the query, "What is time?" The solution provided by Newton in the Principia (1686) was clear and mathematical: "Absolute, true, and mathematical time, by itself, and from its own nature, runs equably without connection to anything external.'[ccclxxvii] This definition is basic to all classical physics.

The brilliant Einstein questioned it and discovered that it was lacking. Rather, each "observer" must utilize their own time scale, and two observers moving relative to one another will have different time scales. Position measurements are impacted in a similar way by this. Time and space become ideas that are essentially contingent on the observer. Every observer is in charge of their own coordinate system or space-time framework. Every observer of a particular occurrence makes a different but equally valid (and reconcilable) measurement since there is no absolute frame of reference. "The basic rules of physics are same for two observers who have a constant relative velocity with regard to each other," according to Einstein's relativity postulate, which states what is absolute. A new symmetry law of nature known as "Poincaré symmetry," which superseded "Galilean symmetry," was discovered by special relativity, which had a significant impact on physics. It began as a reworking of the theory of electromagnetism. .'[cccclxxviii] Special relativity had another enduring influence on dynamics.[cccclxxix] Although it was initially credited with unifying mass and energy, it soon became clear that relativistic dynamics differentiates between rest mass, an invariant (observer-independent) property of a particle or system of particles, and the energy and momentum of a system.[cccclxxx] The last two are conserved separately in all scenarios but are not invariant across different observers. In particle physics, the term 'mass' has evolved in meaning; since the late 20th century, it almost exclusively refers to the rest mass. Therefore, invariant mass, rest mass, intrinsic mass, proper mass, or simply mass in the context of bound systems, is the portion of an object's or system's total mass that remains unaffected by the system's overall motion. More specifically, it is a property of the system's total energy and momentum that remains consistent across all frames of reference related by Lorentz transformations.[cccclxxxi] If a center-of-momentum frame exists for the system, then the invariant mass equals the total mass in that 'rest frame.' Ultimately, the total or relativistic mass of the system exceeds the invariant mass, but the invariant mass remains constant unchanged.[cccclxxxii]

The general theory of relativity was developed by Einstein in 1916 after he was able to further expand this to include all states of motion, including non-uniform acceleration. The curvature of space-time, a novel idea that Einstein introduced in this theory, explained the gravitational pull at every location in space. Newton's universal law of gravity was superseded by the curvature of space-time. According to Einstein, the geometry of space creates the appearance of gravitational force in the conventional sense. The space-time route that all freely moving things follow is determined by the curvature of space-time created by the presence of a mass.[cccclxxxiii] This theory also predicted that light would be affected by gravity, a prediction that was confirmed by experimentation. This element of relativity predicted black holes, explained the phenomenon of light bending around the sun, and described the features of the cosmic microwave background radiation. This finding created significant flaws in the traditional Steady-State paradigm.[cccclxxxiv] In 1921, Einstein was awarded the Nobel Prize for his contributions to relativity, the photoelectric effect, and blackbody radiation. A comprehensive attempt to reconstruct physics on new basic principles resulted from the eventual acceptance of Niels Bohr's model of the atom and Einstein's theories of relativity and the quantized character of light transmission, which caused as many issues as they resolved.[cccclxxxv] In the 1910s, relativity was extended to accelerating reference frames, leading to the "general theory of relativity."[cccclxxxvi] Einstein posited an equivalence between the inertial force of acceleration and the force of gravity, leading to the conclusion that space is curved and finite in size, and the prediction of such phenomena as gravitational lensing and the distortion of time in gravitational fields.[cccclxxxvii] So, a gravitational lens is matter, such as a cluster of galaxies or a point particle, that bends light from a distant source as it travels toward an observer. The amount of gravitational lensing is described by Albert Einstein's general theory of relativity.[cccclxxxviii]

Although relativity resolved the electromagnetic phenomena conflict demonstrated by Michelson and Morley, a second theoretical problem was the explanation of the distribution of electromagnetic radiation emitted by a black body; experiment showed that at shorter wavelengths, toward the ultraviolet end of the spectrum, the energy approached zero, but classical theory predicted it should become infinite. This glaring discrepancy, known as the ultraviolet catastrophe, was solved by the new theory of quantum mechanics.[ccclxxxix] Quantum mechanics is the theory of atoms and subatomic systems. Approximately the first 30 years of the 20th century represent the time of the conception and evolution of the theory. Max Planck (1858–1947) introduced the basic ideas of quantum theory in 1900, proposing that energy is emitted in discrete packets called "quanta" rather than continuously.[cccxc] This groundbreaking work on black-body radiation solved a major physics problem and laid the foundation for modern quantum mechanics. He was awarded the Nobel Prize in Physics in 1918 for his discovery. His work introduced Planck's constant $h$, a fundamental constant that relates the energy of a quantum to its frequency ($E=h\nu$).[cccxci] The quantum theory was accepted when the Compton Effect established that light carries momentum and can scatter off particles, and when Louis de Broglie asserted that matter can be seen as behaving as a wave in much the same way as electromagnetic waves behave like particles (wave–particle duality).[cccxcii]

In 1905, Einstein used the quantum theory to explain the photoelectric effect, and in 1913 the Danish physicist Niels Bohr used the same constant to explain the stability of Rutherford's atom as well as the frequencies of light emitted by hydrogen gas.[cccxciii] The quantized theory of the atom gave way to a full-scale quantum mechanics in the 1920s. New principles of a "quantum" rather than a "classical" mechanics, formulated in matrix-form by Werner Heisenberg, Max Born, and Pascual Jordan in 1925, were based on the probabilistic relationship between discrete "states" and denied the possibility of causality.[cccxciv] Quantum mechanics was extensively developed by Heisenberg, Wolfgang Pauli, Paul Dirac, and Erwin Schrödinger, who established an equivalent theory based on waves in 1926.[cccxcv],[cccxcvi] Again, Heisenberg's 1927 ‘uncertainty principle’ (indicating the impossibility of precisely and simultaneously measuring position and momentum) and the ‘Copenhagen interpretation’[cccxcvii] of quantum mechanics (named after Bohr's home city) continued to deny the possibility of fundamental causality, though opponents such as Einstein would metaphorically assert that "God does not play dice with the universe".[cccxcviii] The new quantum mechanics became an indispensable tool in the investigation and explanation of phenomena at the atomic level. Also in the 1920s, the Indian scientist Satyendra Nath Bose's work on photons[cccxcix] and quantum mechanics provided the foundation for Bose–Einstein statistics, the theory of the Bose–Einstein condensate.[cd] The spin–statistics theorem established that any particle in quantum mechanics may be either a boson (statistically Bose–Einstein) or a fermion (statistically Fermi–Dirac).[cdi] It was later found that all fundamental bosons transmit forces, such as the photon that transmits electromagnetism. Fermions are particles "like electrons and nucleons" and are the usual constituents of matter. Fermi–Dirac statistics later found numerous other uses, from astrophysics to semiconductor design.

The conceptual differences between physics theories discussed in the 19th century and those that were most historically prominent in the first decades of the 20th century lead to a characterization of the earlier sciences as "classical physics" while the work based on quantum and relativity theories became known as "modern physics". Initially applied to mechanics, as in "classical mechanics", the divide eventually came to characterize quantum and relativistic effects.[cdii] This characterization was driven initially by physicists like Max Planck and Hendrik Lorentz, established scientists who nevertheless saw issues that established theories could not explain. Their involvement and contributions to the 1911 Solvay Conference led to the introduction of this split as a concept.[cdiii] This division is reflected in the titles of many physics' textbooks. For example, the preface of Goldstein's Classical mechanics explains why the topic is still relevant for physics students.[cdiv] In Concepts of Modern Physics Arthur Beiser starts with a definition of modern physics: Modern physics began in 1900 with Max Planck's discovery of the role of energy quantization in blackbody radiation, a revolutionary idea soon followed by Albert Einstein's equally revolutionary theory of relativity and quantum theory of light.[cdv] Kenneth Krane's Modern physics begins a text on quantum and relativity theories with a few pages on deficiencies of classical physics.[cdvi] E.T. Whittaker's two-volume History of the Theories of Aether and Electricity subtitles volume one The Classical Theories and volume two The Modern Theories (1900–1926).[cdvii]

As the philosophically inclined continued to debate the fundamental nature of the universe, quantum theories continued to be produced, beginning with Paul Dirac's formulation of a relativistic quantum theory in 1928.[cdviii] However, attempts to quantize electromagnetic theory entirely were stymied throughout the 1930s by theoretical formulations yielding infinite energies. This situation was not considered adequately resolved until after World War II, when Julian Schwinger, Richard Feynman and Sin-Itiro Tomonaga independently posited the technique of renormalization, which allowed for an establishment of a robust quantum electrodynamics (QED).[cdix] Meanwhile, new theories of fundamental particles proliferated with the rise of the idea of the quantization of fields through 'exchange forces' regulated by an exchange of short-lived 'virtual' particles, which were allowed to exist according to the laws governing the uncertainties inherent in the quantum world.[cdx] A virtual particle is a theoretical transient particle that exhibits some of the characteristics of an ordinary particle, while having its existence limited by the uncertainty principle, which allows the virtual particles to spontaneously emerge from vacuum at short time and space ranges.[cdxi] Notably, Hideki Yukawa proposed that the positive charges of the nucleus were kept together courtesy of a powerful but short-range force mediated by a particle with a mass between that of the electron and proton.[cdxii] This particle, the 'pion', was identified in 1947 as part of what became a slew of particles discovered after World War II. Initially, such particles were found as ionizing radiation left by cosmic rays, but increasingly came to be produced in newer and more powerful particle accelerators.[cdxiii]

Outside particle physics, significant advances of the time were the invention of the laser and received 1964 Nobel Prize in Physics.[cdxiv] And the theoretical and experimental research of superconductivity, especially the invention of a quantum theory of superconductivity by Vitaly Ginzburg and Lev Landau and received 1962 Nobel Prize in Physics and, later, its explanation via Cooper pairs (1972 Nobel Prize in Physics).[cdxv] The Cooper pair was an early example of quasiparticles. Einstein deemed that all fundamental interactions in nature can be explained in a single theory.[cdxvi] Unified field theories were numerous attempts to "merge" several interactions. One of many formulations of such theories is a gauge theory, a generalization of the idea of symmetry.[cdxvii] Finally the Standard Model succeeded in unification of strong, weak, and electromagnetic interactions.[cdxviii] All attempts to unify gravitation with something else failed. When parity was broken in weak interactions by 'Chien-Shiung Wu' in her experiment,[cdxix] a series of discoveries were created thereafter.[cdxx] The interaction of these particles by scattering and decay provided a key to new fundamental quantum theories. Murray Gell-Mann and Yuval Ne'eman brought some order to these new particles by classifying them according to certain qualities, beginning with what Gell-Mann referred to as the 'Eightfold Way'.[cdxxi,cdxxii] While its further development, the quark model,[cdxxiii] at first seemed inadequate to describe strong nuclear forces,[cdxxiv] allowing the temporary rise of competing theories such as the S-Matrix, the establishment of quantum chromodynamics in the 1970s finalized a set of fundamental and exchange particles,[cdxxv] which allowed for the establishment of a "standard model" based on the mathematics of gauge invariance, which successfully described all forces except for gravitation, and which remains generally accepted within its domain of application.[cdxxvi,cdxxvii]

The Standard Model, based on the 'Yang–Mills theory'[cdxxviii] groups the 'electroweak interaction theory'[cdxxix] and quantum chromodynamics into a structure denoted by the 'gauge group'.[cdxxx] The formulation of the unification of the electromagnetic and weak interactions in the standard model is due to Abdus Salam, Steven Weinberg and, subsequently, Sheldon Glashow.[cdxxxi] Electroweak theory was later confirmed experimentally by observation of neutral weak currents,[cdxxxii,cdxxxiii] and distinguished by the 1979 Nobel Prize in Physics. Since the 1970s, fundamental particle physics has provided insights into early universe cosmology, particularly the Big Bang theory proposed as a consequence of Einstein's general theory of relativity.[cdxxxiv,cdxxxv] However, starting in the 1990s, astronomical observations have also provided new challenges, such as the need for new explanations of galactic stability or 'dark matter' and the apparent acceleration in the expansion of the universe or 'dark energy'.[cdxxxvi,cdxxxvii] While accelerators have confirmed most aspects of the Standard Model by detecting expected particle interactions at various collision energies, no theory reconciling general relativity with the Standard Model has yet been found, although supersymmetry and string theory were believed by many theorists to be a promising avenue forward. String theory describes how these strings propagate through space and interact with each other.[cdxxxviii] On distance scales larger than the string scale, a string acts like a particle, with its mass, charge, and other properties determined by the vibrational state of the string. In string theory, one of the many vibrational states of the string corresponds to the graviton, a quantum mechanical particle that carries the gravitational force.[cdxxxix] Thus, string theory is a theory of quantum gravity.[cdxl] The Large Hadron Collider, however, which began operating in 2008, has failed to find any evidence that is supportive of supersymmetry and string theory.[cdxli]

Cosmology may be said to have become a serious research question with the publication of Einstein's General Theory of Relativity in 1915 although it did not enter the scientific mainstream until the period known as the 'Golden age of general relativity'.[cdxlii] About a decade later, in the midst of what was dubbed the 'Great Debate', Edwin Hubble and Vesto Slipher discovered the expansion of universe in the 1920s measuring the redshifts of Doppler spectra from galactic nebulae.[cdxliii,cdxliv] Using Einstein's general relativity, Georges

Lemaître and George Gamow formulated what would become known as the Big Bang theory. [cdxlv] A rival, called the steady state theory, was devised by Fred Hoyle, Thomas Gold, Jayant Narlikar and Hermann Bondi.[cdxlvi] Cosmic microwave background radiation was verified in the 1960s by Arno Allan Penzias and Robert Woodrow Wilson, and this discovery favored the big bang at the expense of the steady state scenario.[cdxlvii] Later work was by George Smoot et al. (1989), among other contributors, using data from the Cosmic Background explorer (CoBE) [cdxlviii] and the Wilkinson Microwave Anisotropy Probe (WMAP) satellites refined these observations.[cdxlix] The 1980s (the same decade of the COBE measurements) also saw the proposal of inflation theory by Alan Guth. Recently the problems of dark matter and dark energy have risen to the top of the cosmology agenda.[cdl]

On July 4, 2012, physicists working at CERN's Large Hadron Collider[cdli] announced that they had discovered a new subatomic particle greatly resembling the Higgs boson, a potential key to an understanding of why elementary particles have mass and indeed to the existence of diversity and life in the universe. [cdlii] For now, some physicists are calling it a "Higgslike" particle. Joe Incandela, of the University of California, Santa Barbara, said, ‘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.’ [cdliii] Michael Turner, a cosmologist at the University of Chicago and the chairman of the physics center board, said, ‘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 toward solving the really big questions that we have posed?’[cdliv] Peter Higgs was one of six physicists, working in three independent groups, who, in 1964, invented the notion of the Higgs field ("cosmic molasses"). Although they have never been seen, Higgslike fields play an important role in theories of the universe and in string theory.[cdlv] Under certain conditions, according to the strange accounting of Einsteinian physics, they can become suffused with energy that exerts an antigravitational force. Such fields have been proposed as the source of an enormous burst of expansion, known as inflation, early in the universe and, possibly, as the secret of the dark energy that now seems to be accelerating the expansion of the universe.[cdlvi]

## DEVELOPMENT OF QUANTUM PHYSICS

Quantum mechanics is the fundamental physical theory that describes the behavior of matter and of light; its unusual characteristics typically occur at and below the scale of atoms.[cdlvii] The history of quantum mechanics is a fundamental part of the history of modern physics. The major chapters of this history begin with the emergence of quantum ideas to explain individual phenomena—blackbody radiation, the photoelectric effect, solar emission spectra—an era called the old or older quantum theories.[cdlviii] The field of quantum physics arose in the late 1800s and early 1900s from a series of experimental observations of atoms that didn't make intuitive sense in the context of classical physics. Among the basic discoveries was the realization that matter and energy can be thought of as discrete packets, or quanta, that have a minimum value associated with them.[cdlix] For example, light of a fixed frequency will deliver energy in quanta called "photons." Each photon at this frequency will have the same amount of energy, and this energy can't be broken down into smaller units.[cdlx] In fact, the word "quantum" has Latin roots and means "how much." Knowledge of quantum principles transformed our conceptualization of the atom, which consists of a nucleus surrounded by electrons.[cdlxi] Early models depicted electrons as particles that orbited the nucleus, much like the way satellites orbit Earth. Modern quantum physics instead understands electrons as being distributed within orbitals, mathematical descriptions that represent the probability of the electrons' existence in more than one location within a given range at any given time.[cdlxii] Electrons can jump from one orbital to another as they gain or lose energy, but they cannot be found between orbitals. Few important concepts helped to establish the foundations of quantum physics:

- Wave-particle duality: The matter and energy, such as light and electrons, can exhibit both wave-like and particle-like properties. Light behaves as a wave in phenomena like interference and diffraction, but as a particle like a photon in events such as the photoelectric effect, which involves discrete packets of energy.[cdlxiii] The idea extends to matter, which also has a wave nature, as proposed by Louis de Broglie.[cdlxiv],[cdlxv] This principal dates back to the earliest days of quantum science. It describes the outcomes of experiments that showed that light and matter had the properties of particles or waves, depending on how they were measured. Today, we understand that these different forms of energy are actually neither particle nor wave. They are distinct quantum objects that we cannot easily conceptualize.
- Superposition: If a imagine touching the surface of a pond at two different points at the same time. Waves would spread outward from each point, eventually overlapping to form a more complex pattern. This is a superposition of waves. Similarly, in quantum science, objects such as electrons and photons have wavelike properties that can combine and become what is called superposed. This term used to describe an object as a combination of multiple possible states at the same time. A superposed object is analogous to a ripple on the surface of a pond that is a combination of two waves overlapping. In a mathematical sense, an object in superposition can be represented by an equation that has more than one solution or outcome.[cdlxvi]
- Uncertainty principle: The uncertainty principle is a fundamental concept in quantum mechanics that states that there is a limit to how precisely certain pairs of physical properties, like position and momentum, can be known simultaneously.[cdlxvii] It means the more precisely you know a particle's position, the less precisely you can know its momentum, and vice versa. This principle is an inherent property of nature, not a result of imperfect measurement tools.[cdlxviii] It is a mathematical concept that represents a trade-off between complementary points of view. In physics, this means that two properties of an object, such as its position and velocity, cannot both be precisely known at the same time.[cdlxix] If we precisely measure the position of an electron, for example, we will be limited in how precisely we can know its speed.[cdlxx]
- Entanglement: refers to a quantum phenomenon where two or more particles become linked and their properties are intertwined, regardless of the distance separating them.[cdlxxi] Measuring a property of one entangled particle instantaneously influences the corresponding property of the other, though this cannot be used for faster-than-light communication. In a more general sense, "entanglement" can also refer to a state of being deeply involved in a complex or difficult situation.[cdlxxii] This phenomenon occurs when two or more objects are connected in such a way that they can be thought of as a single system, even if they are very far apart. The state of one object in that system can't

be fully described without information on the state of the other object.[cdlxxiii] Likewise, learning information about one object automatically tells you something about the other and vice versa.[cdlxxiv]

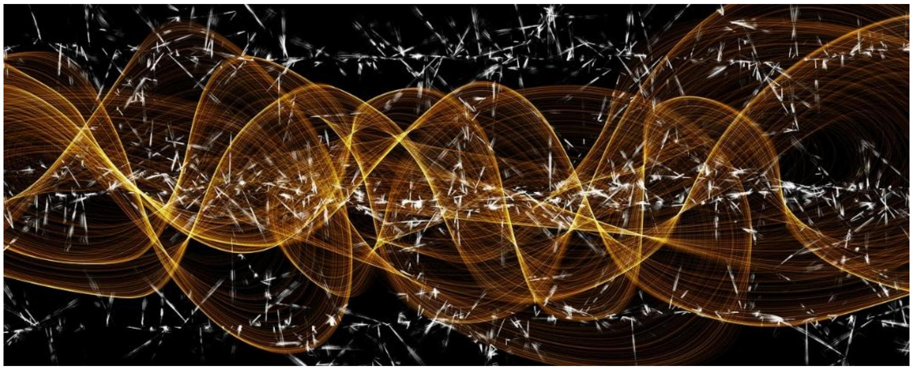

**Figure 4: Four Ways Challenges Our Sense of Reality[cdlxxv]**

## ANALYSIS OF DIFFERENT CONCEPT OF MODERN PHYSICS AND AMBIGUITY

### Einstein's Special Theory of Relativity and the Block Universe

A core principle of special relativity is that two events that appear concurrently to one observer may not be simultaneous to another observer moving at a different velocity. This is because the speed of light is constant for all observers, regardless of their motion. To reconcile different observers' views of space and time, the theory unites them into a single, four-dimensional continuum called spacetime.[cdlxxvi] Einstein's special theory of relativity revolutionized our understanding of space and time by combining them into a unified four-dimensional structure called space-time. This led to the concept of the 'block universe.' As a result, all events on earth like past, present, and future are existed simultaneously and permanently as parts of a fixed continuum. In this view, time does not flow but instead exists all at once, like space.[cdlxxvii] A critical consequence is the relativity of simultaneity, meaning different observers, depending on their relative velocities, can disagree about what events are happening now. Thus, the notion of a universally shared 'present' collapses, and this supports the philosophical idea of eternalize, where every moment in time is equally real.[cdlxxviii] The block universe implies determinism, as the future appears just as fixed as the past, governed by unchanging law of physics.[cdlxxix] In this model, the passage of time is an illusion, and every moment is as real and fixed as every other moment, including the moment of your birth and death.[cdlxxx] This concept has profound philosophical implications, suggesting a deterministic universe where every event is already 'there' in spacetime.

### Determinism Versus Indeterminism in Relativity

A theory is considered deterministic if, given a complete set of initial conditions and the laws of physics, only one possible future outcome can occur.[cdlxxxi] Special relativity theory, dealing with spacetime in an inertial (non-accelerating) framework, is fully deterministic. It upholds the principle of causality, ensuring that all observers agree on the sequence of cause-and-effect events. General Relativity (GR) describes gravity as the curvature of spacetime, is also locally deterministic; given sufficient information in a region of spacetime, its immediate future is uniquely determined.[cdlxxxii] The Einstein Field Equations, which are the core of the theory, are deterministic equations. So, relativity suggests a deterministic universe where the full timeline, including the future, is predetermined and unchanging. However, this presents a dilemma: if relativity accurately describes the large-scale universe, can the future be truly open? To resolve this tension between determinism and an open future, we must turn to quantum mechanics, which introduces genuine indeterminacy into physical law.[cdlxxxiii] The theory predicts singularities (such as those at the center of black holes or the Big Bang) where the equations break down, and predictability is lost. It is widely believed that classical general relativity is not accurate under these extreme conditions and must eventually be superseded by a theory of quantum gravity. In some specific, though possibly unphysical, solutions to the equations (like certain charged black holes), a boundary called a Cauchy horizon can appear. Beyond this horizon, multiple possible futures can flow from the same initial conditions, indicating a failure of determinism.[cdlxxxiv] To guarantee global determinism (where the entire future of the universe is determined by a complete "now" slice of spacetime), the spacetime must be "globally hyperbolic". Many interesting solutions in GR, however, lack this property, which implies that determinism may not be a universal feature in all possible relativistic universes.

**Quantum Mechanics and the Indeterminacy of Reality**

Quantum mechanics breaks from classical determinism by describing systems in terms of wave functions, which encode probabilities for all possible outcomes rather than definite values. Before measurement, quantum systems exist in superposition—a combination of all possible states.[cdlxxxv] Upon measurement, a single outcome appears, but which outcome occurs cannot be predicted deterministically, only probabilistically. This central feature of quantum mechanics has been verified by countless experiments.[cdlxxxvi] However, the mechanism by which the probabilistic wave function reduces to a single result—called wave function collapse—is still one of the deepest mysteries in quantum theory. Understanding whether this collapse is real, and what causes it, is vital to determining whether the future is fixed or open. Quantum mechanics introduces reality's indeterminacy by asserting that a system's properties are not definite until measured, with outcomes determined by probability distributions rather than strict causality.[cdlxxxvii] This principle, known as quantum indeterminacy or the uncertainty principle, means that even with complete information about a quantum state (its wavefunction), one can only predict the likelihood of different outcomes. This fundamental uncertainty challenges classical determinism and implies that at a subatomic level, nature is inherently probabilistic and influenced by the act of observation.

Quantum mechanics replaces classical certainty with probabilities. For example, the exact moment a radioactive atom will decay is not predetermined; the wavefunction only provides a probability for when it might occur.[cdlxxxviii] The act of measurement is crucial, as it influences the state of a particle, "collapsing" its wavefunction from a superposition of possibilities into a single, definite outcome. Intrinsic uncertainty is not due to measurement error or environmental interference, but is an intrinsic property of quantum systems. The Kochen–Specker theorem, for instance, demonstrates that it is impossible for all measurable properties of a quantum state to have sharp, definite values simultaneously. Challenge to determinism theory fundamentally challenges classical determinism, which holds that all events are predictable given enough information about the initial state of the system. Quantum indeterminacy suggests that reality at its most fundamental level is not predetermined but governed by chance within the bounds of those probabilities. [cdlxxxix] While quantum indeterminacy is a core principle, different interpretations attempt to explain its meaning and that included the concept like every quantum event causes the universe to split into multiple branches, with each outcome existing in a separate reality.[cdxc] It also suggests that a form of objective, spontaneous collapse occurs independent of 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.[cdxci]

**Figure 5: Quantum Physics and Prove Parallel is it Fact or Fiction[cdxcii]**

## The Copenhagen Interpretation and Non-Determinism

The main source of indeterminism in modern physics comes from quantum mechanics (QM), not relativity. According to the standard Copenhagen interpretation of QM, outcomes of quantum measurements are fundamentally probabilistic, not determined by prior events. The current goal of theoretical physics is to reconcile these two pillars of modern science into a unified theory of quantum gravity, which would provide a more complete picture of determinism in the universe. [cdxciii] We can explore the philosophical implications of this scientific determinism on concepts like free will.[cdxciv] The Copenhagen interpretation is one of the oldest and most widely taught interpretations of quantum mechanics. It proposes that a quantum system remains in superposition until a measurement is made, at which point the wave function collapses to a single definite outcome. This introduces a fundamental element of randomness into the universe, meaning that even with complete knowledge of the present, the future cannot be predicted with certainty. However, this raises issues when combined with relativity. Since different observers can have different perceptions of simultaneity, they might disagree about whether a particular event's wave function has already collapsed. This discrepancy challenges the idea of a universally agreed-upon reality and highlights the difficulty in reconciling quantum collapse with relativistic space-time.

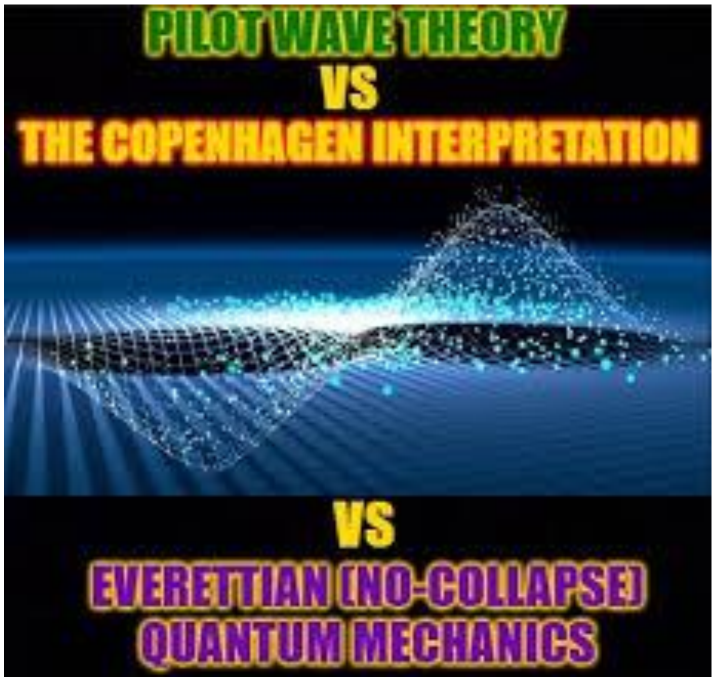


**Figure 6: Differences Between Pilot Wave Theory, Copenhagen Interpretation, and Everettian Quantum Mechanics**[cdxcv]

## The Many-Worlds Interpretation and Determinism Restored

The Many-Worlds Interpretation (MWI) restores determinism by proposing that all possible outcomes of a quantum event actually occur in separate, parallel universes. Rather than a single universe collapsing into one outcome, the universal wavefunction, which evolves deterministically according to the Austrian physicist Schrödinger equation,[cdxcvi] simply splits into multiple, non-interacting branches (worlds). From the perspective of an observer within any single world, the outcome appears random, but the overall multiverse's evolution is entirely predictable and deterministic. The MWI avoids the need for a probabilistic 'collapse' of the wave function that is central to the Copenhagen interpretation of quantum mechanics.[cdxcvii] Again, instead of collapsing, the wave function continues to evolve. When a measurement or interaction occurs, the observer becomes entangled with the system, causing the wave function to branch. However, each branch represents a different possible outcome of the measurement. For example, in the case of Schrödinger's cat, the universe splits into one where the cat is alive and another where it is dead. The evolution of the entire multiverse is a single, deterministic process governed by the Schrödinger equation.[cdxcviii] However, from the perspective of a single observer within one branch, the outcome appears random.[cdxcix] So, an observer will only ever experience one outcome because their own wave function is entangled with the measurement result, preventing them from experiencing the other possibilities.[d] As a result, the MWI offers a radical but sophisticated alternative: it denies the collapse of the wave function entirely. Instead, it suggests that all possible outcomes of a quantum event occur, each in its own parallel branch of the universe. The wave function evolves deterministically according to the Schrödinger equation, and every possible result is realized in some branch.[di] Observers become entangled with these branches and experience just one outcome, though all other versions of themselves experience other outcomes. From a global perspective, the universe is fully deterministic, with all branches coexisting. This interpretation is compatible with Einstein's relativity, as the branching respects causal limits like the speed of light. However, from a subjective viewpoint, observers perceive randomness because they inhabit only one branch.[dii] Here, we have learned the randomness is not a fundamental property of reality but rather a consequence of our limited perspective within a single branch.[diii] Lastly, this deterministic view arises from accepting the universal wave function as physically real and allowing it to evolve according to the fundamental equations of quantum mechanics without additional, ad-hoc rules like wave function collapse.[div]

**Relativity, Decoherence, and the Propagation of Branching**

The twin discoveries of quantum theory and Einstein's theory of general relativity revolutionized our understanding of physical reality. Perhaps the most distinctive features of these respective theories are the notions of quantum superposition and spacetime. The most significant challenge for modern physicists is finding a consistent unification of quantum theory with general relativity.[dv] It is univocally anticipated that any theory combining relativistic gravitation with quantum mechanics must be able to describe spacetime as possessing quantum-mechanical degrees of freedom, whose states reside in a com-plex Hilbert space and may be placed in quantum superpositions of different configurations.[dvi], [dvii] In the Many-Worlds framework, branching is not instantaneous across the universe. Instead, it propagates according to the rules of relativistic causality; at or below the speed of light. Entanglement webs form, consisting of interconnected quantum events that define different realities. Decoherence plays a crucial role here by explaining how quantum branches become effectively isolated from one another.[dviii] As quantum interference between branches fades over time, each branch behaves classically. Decoherence provides a physical mechanism for the transition from quantum probabilities to classical experiences.[dix] This gives rise to an objective meaning of the present as the specific entanglement network an observer is part of. Nevertheless, due to the relativity of simultaneity, each observer's perception of 'now' differs depending on their motion through space-time.[dx] By clarifying the interplay between branching, entanglement, and relativity, this analysis strengthens MWI's standing as a robust framework for relativistic quantum theory.[dxi] It also highlights unresolved ontological challenges: a full account of nonlocal branching demands a deeper understanding of how entangled states exist in space and time. This gap will be addressed in future work.[dxii],[dxiii]

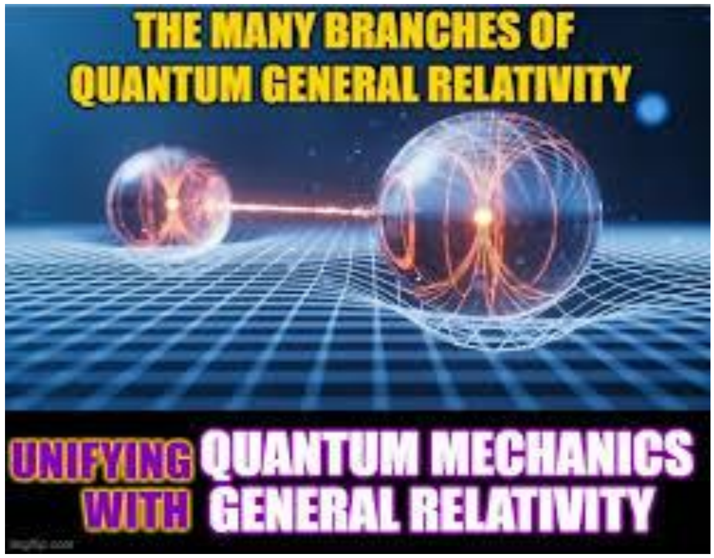


**Figure 7: Relativity considered a theory rather than a law[dxiv]**

## Pilot-Wave Theory and Its Challenges

The de Broglie–Bohm pilot-wave theory is another interpretation of quantum mechanics that restores determinism without invoking parallel worlds.[dxv] The pilot-wave theory of de Broglie and Bohm has a special place in the history of contemporary physics, being it the very first alternative formulation of quantum mechanics.[dxvi] It posits that particles follow specific trajectories influenced by a guiding wave function that evolves according to quantum rules. This provides a clear, non-random description of particle behavior.[dxvii] Pilot-wave theory faces challenges including its incompatibility with special relativity, which requires a non-local, deterministic, and yet non-relativistic framework.[dxviii] Other challenges include its added mathematical complexity, the unclear physical meaning of the "pilot wave," and the lack of reciprocal interaction between the wave and particle. These issues make it less popular than standard interpretations, though it offers a deterministic alternative to the randomness in Copenhagen interpretation. However, the pilot-wave theory faces significant difficulties in reconciling with special relativity.[dxix] A major challenge is that the theory's non-local, instantaneous connections between particles appear to violate the principle that nothing can travel faster than the speed of light.[dxx] Pilot-wave theory requires a preferred frame of reference, violating Lorentz invariance, which is a core principle of special relativity.[dxxi] The theory posits a real, guiding wave, but this wave exists in an abstract, multi-dimensional space rather than the three-dimensional space we experience. This makes its physical nature difficult to understand, especially since it is not detectable as an independent object. Because it involves non-local effects—where changes in one place can instantaneously affect distant particles—it does not naturally fit into the relativistic framework where no influence can travel faster than light. This lack of compatibility with relativity weakens its standing as a complete, modern physical theory.[dxxii] The theory describes a one-way interaction where the pilot wave guides the particle, but the particle does not affect the wave. This contradicts the fundamental principle of action-reaction from classical mechanics, where forces are always reciprocal. Pilot-wave theory does not make new testable predictions that would distinguish it from standard quantum mechanics. The theory's success relies on the assumption of "quantum equilibrium," which suggests that the probabilistic nature of quantum mechanics comes from our lack of complete knowledge, not from fundamental randomness.

## Consciousness and the Nature of the Present

Consciousness is a state of awareness that links our perception of past, present, and future, allowing us to process and compare mental events in a single moment, the "present time". Philosophically, consciousness is deeply intertwined with the present; some traditions see it as the ability to be aware of the "now" to accept and appreciate the current moment as the only reality where life unfolds. Others, like philosopher Henri Bergson, conceptualize consciousness as a continuous flow of 'duration,' a tension between the immediacy of the present and the vast reach of memory.[dxxiii] Consciousness is seen as the highest capacity of the brain to link space and time into global mental representations, possibly through quantum mechanical processes within the brain, according to one theory. Many emphasize the importance of 'conscious living' as being present and accepting the moment as it is, rather than being consumed by past regrets or future anxieties. Eckhart Tolle views consciousness as being at one with the present moment, suggesting the self is fundamentally a sense of being or presence that is identical to the now.[dxxiv] Henri Bergson defined consciousness as a continuous "duration" that bridges the immediate present with the accumulated potential of the past.[dxxv] Matthew David Segall has suggested that, consciousness is a process that involves comparing the present with what could be, allowing for freedom and choice.[dxxvi] Some theories propose that consciousness is fundamental and precedes physical reality. A new theoretical model suggests that consciousness, rather than matter, is the foundation from which time, space, and matter arise.[dxxvii] Some models distinguish between the brain's processing and the subjective, knower,' the awareness or self that experiences the thoughts and feelings processed by the brain.[dxxviii] While some see consciousness as emergent from matter or the brain, others suggest the opposite is true, with consciousness potentially creating matter.[dxxix]

Without a complete theory of quantum gravity, the question of how quantum fields and quantum particles behave in a superposition of spacetimes seems beyond the reach of theoretical and experimental investigations.[dxxx] A key philosophical and experiential question arises from the idea of a block universe: if all events already exist, what does it mean to experience the present? Consciousness, which arises from neural processes unfolding over time, suggests that the 'now' we experience is not an instantaneous point but an extended duration.[dxxxi] This extended present contradicts both presentism and the belief that only the present moment is real as well as naive views of a sharp temporal boundary between past and future. Instead, our conscious perception of time supports a more complex, distributed concept of the present, one compatible with relativity's relative simultaneity.[dxxxii] These challenges simplistic interpretations of time and raises deeper questions about the subjective experience of temporal flow.[dxxxiii] In 2014, Victor Argonov has suggested a non-Turing test for machine consciousness based on a machine's ability to produce philosophical judgments.[dxxxiv] Nick Bostrom has argued in 2023 that, being very sure that large language models (LLMs) are not conscious, would require unwarranted confidence; in which consciousness theory is correct and how it applies to machines.[dxxxv] He views consciousness as a matter of degree,[dxxxvi] and argued that machines could in theory be much more conscious than humans.[dxxxvii]

The core question is does the future already exist? It remains unresolved and depends largely on which interpretation of quantum mechanics one accepts. If one adopts the Copenhagen view, the future remains fundamentally indeterminate, shaped only upon observation. If one prefers Many-Worlds, the future is predetermined in a vast multiverse, though each observer experiences a branching, uncertain path.[dxxxviii] Reconciling the flow of time and the direction of time—why we remember the past but not the future—continues to be an open challenge in physics.[dxxxix] The video ends by highlighting the importance of integrating physical theory with philosophical insights and the subjective realities of consciousness to understand time, determinism, and the structure of reality. Let's discuss the transitoriness of the universe, emphasizing that all matter—from stars and planets to galaxies and emerged from primordial cosmic origins and will ultimately return to a basic, formless state. Earth is described as a rare, life-supporting oasis amid a vast and mostly inhospitable cosmos. Situated in the solar system and part of the Milky Way galaxy, Earth exists within a universe that constantly evolves through cycles of creation and destruction. This ever-changing cosmos spans incomprehensibly long timescales, setting the stage for a forward-looking narrative that explores how celestial bodies—including Earth—will transform and eventually meet their fate.

## The String-theory

String theory is a theoretical framework that replaces point-like particles with one-dimensional objects called "strings". These strings vibrate in different ways, and each vibrational mode corresponds to a different type of particle, such as an electron or a quark. The theory aims to unify all fundamental forces of nature, including gravity, and all types of matter into a single framework, but it has yet to be experimentally verified. String theory is a candidate for a "theory of everything" because it has the potential to include all four fundamental forces (gravity, electromagnetism, strong force, and weak force) and all matter in a single, consistent quantum mechanical framework. A key aspect of the theory is that it requires more than the three spatial and one temporal dimension of our universe as specifically, 10 or 11 dimensions in most formulations. The extra dimensions are theorized to be "compactified," or curled up, so they are not observable at our scale. Notwithstanding its mathematical stylishness, string theory remains a theoretical concept.[dxl] It has not yet made testable predictions that have been verified by experiments. One of the challenges of string theory is that the full theory does not have a satisfactory definition in all circumstances. Another issue is that the theory is thought to describe an enormous landscape of possible universes, which has complicated efforts to develop theories of particle physics based on string theory.[dxli] These issues have led some in the community to criticize these approaches to physics, and to question the value of continued research on string theory unification.[dxlii]

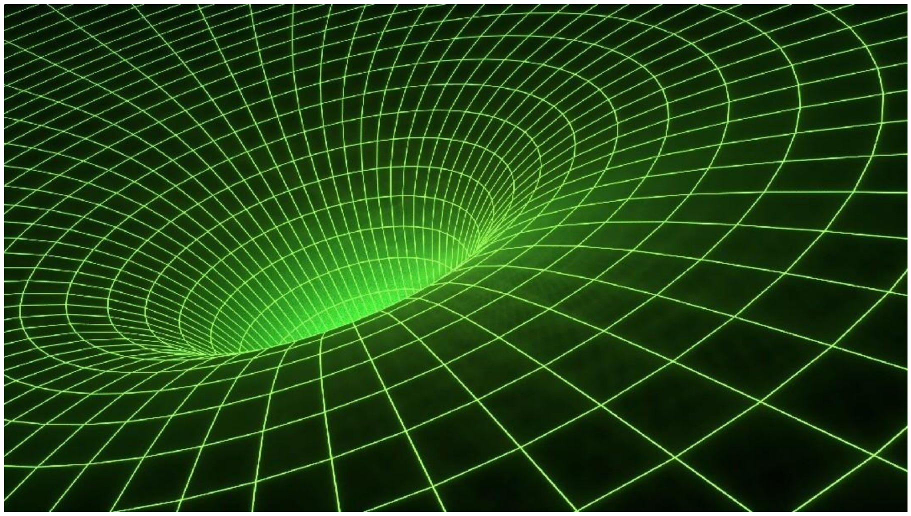

**Figure 8: The Frictional Concept of String Theory**[dxliii]

Physicist, computer scientist, and mathematician Stephen Wolfram recently stunned the science community at-large after announcing he'd pretty much figured out how the universe works. Wolfram's a household name in the science community. He's responsible for Wolfram Alpha, the search engine that AskJeeves wished it was, and the creation of a math-based programming language called Wolfram Language used to power the popular Mathematica system and, now, the creation of the Wolfram Physics Project.[dxliv] His contributions go back to his formative years where, by age 14, he'd written three books on the subject of physics. [dxlv] It's important to understand that Wolfram's considered a respected scientific mind because his new theory, which is represented as simply "A Class of Models with the Potential to Represent Fundamental Physics," come straight out of left field with a pretty wacky approach. "wacky" is a relevant term when it comes to physics. Wofram's attempting to do what Einstein and Stephen Hawking have tried before him: create an explanation for the universe that makes sense.[dxlvi] To this end, physicists and other scientists have come up with theories that range from multiple worlds (as in, more than one universe) to "we're all living in a computer simulation" (which just begs the question, what's the universe that the computer is in made of?). So, calling a physics theory "wacky" implies an entirely different level of weirdness. Artyom Astashenok told, "The fact that our Universe is expanding was discovered almost a hundred years ago, but how exactly this happens, scientists realized only in the 90s of the last century, when powerful telescopes (including orbital ones) appeared and the era of exact cosmology began. In the course of observations and analysis of the data obtained, it turned out that the Universe is not just expanding, but expanding with acceleration, which began three to four billion years after the birth of the Universe."[dxlvii] He also added, "And then the idea was born that the Universe is filled for the most part not with ordinary matter, but with some "dark energy," which has special properties. No one knows what is it and how it works, so it named "Dark Energy" as something unknown. And 70% of the Universe consists of this Energy."

There are many theories of what the "Dark Energy" is, and the Immanuel Kant Baltic Federal University (IKBFU) scientists presented their own theory. They explained "The so-called

Casimir effect (named after the Dutch physicist Hendrik Casimir), which consists in the fact that two metal plates placed in a vacuum are attracted to each other, has long been known. It would seem that this cannot be, because there is nothing in the vacuum. But in fact, according to quantum theory, particles constantly appear and disappear there, and as a result of their interaction with plates, which indicate certain boundaries of space (which is extremely important), a very small attraction occurs. And there is an idea according to this, approximately the same thing happens in space. Only this leads, on the contrary, to additional repulsion, which accelerates the expansion of the Universe. That is, there is essentially no "Dark Energy," but there is a manifestation of the boundaries of the Universe. This, of course, does not mean that it ends somewhere, but some kind of complex topology can take place. You can draw an analogy with the Earth. After all, it also has no boundaries, but it is finite. The difference between the Earth and the Universe is that in the first case we are dealing with two-dimensional space, and in the second — with three-dimensional." The published article, which, as explained by Artem Astashenok, develops the ideas presented in the thesis of Alexander Teplyakov, presents a mathematically sound model of the universe in which additional repulsion occurs, and where there is no contradiction between the fact that the expansion of the Universe accelerates and the law of universal gravitation.[dxlviii]

A pair of physicists from IKBFU in Russia recently proposed an entirely new view of the cosmos. Their research takes the wacky idea that we're living in a computer simulation and mashes it up with the mind-boggling "many worlds" theory to say that, essentially, our entire universe is part of an immeasurably large quantum system spanning "uncountable" multiverse. When you think about quantum systems, like IBM and Google's quantum computers, we usually imagine a device that's designed to work with subatomic particles – qubits – to perform quantum calculations. These computers may one day perform advanced calculations that classical computers today can't, but for now they're useful as a way to research the gap between classical and quantum reality.[dxlix] Artyam Yurov and Valerian Yurov, the IKBFU researchers behind the aforementioned study, posit that everything in the universe, including the universe itself, should be viewed as a quantum object. This means, to experience "quantum reality" we don't need to look at subatomic particles or qubits: we're already there. Everything is quantum! Yurov and Yurov begin their paper by stating they've turned currently popular theoretical physics views on their head. The paper goes on to mathematically describe how our entire universe is, itself, a quantum object. This means, like a tiny subatomic particle, it exhibits quantum properties that should include superposition.[dl] Theoretically, our universe should be able to be in more than one place or state at a time, and that means there simply must be something out there for it to interact with — even if that means it uses jaw-droppingly unintuitive quantum mechanics to interact with itself in multiple states simultaneously.

The problem with expanding quantum mechanics to large objects – like say, a single cell – is that other theoretical quantum features stop making as much sense. In this case "decoherence," or how quantum objects "collapse" from multiple states into the physical state we see in our classical observations, doesn't seem to pass muster at the cosmic scale.[dli] The researchers then used their assumptions to come up with calculations that expand the "many worlds" theory to encompass multiple universes, or multiverses. The big idea here is that, if the universe is a quantum object it must interact with something and that *something* is probably other universes. But what the research doesn't explain, is *why* our universe and everything in it would exist as something analogous to a single qubit in a gigantic quantum computer spanning multiple universes simultaneously. If humans aren't the magical observers who cause the quantum universe to "collapse" into classical reality by measuring it, we might instead be cogs in the machine — maybe the universe is a qubit, maybe we're the qubits. Perhaps we're just noise that the universes ignore while they go about their calculations. Maybe we do live in a computer simulation after all. But instead of being some advanced creature's favorite NPCs, we're just bits of math that help the operating system run. At the end of the day, one has to wonder how much chance a unified theory of the universe that cribs from both the arcade gaming era and Nick Bostrom's simulation hypothesis has against M-theory, relativity, or other long-standing remedies.[dlii] Still, a rising tide lifts all vessels and Wolfram's current passion is bound to yield some interesting mathematical results.

## ULTIMATE FINDING FROM HISTORY OF PHYSICS

### Limitation of Theory of Physics

No physical theory to date is believed to be precisely accurate. Instead, physics has proceeded by a series of "successive approximations" allowing more and more accurate predictions over a wider and wider range of phenomena. Some physicists believe that it is therefore a mistake to confuse theoretical models with the true nature of reality, and hold that the series of approximations will never terminate in the "truth".[dliii] Einstein himself expressed this view on occasions.[dliv] There is a philosophical debate within the physics community as to whether a theory of everything deserves to be called the fundamental law of the universe.[dlv] One view is the hard reductionist position that the theory of everything is the fundamental law and that all other theories that apply within the universe are a consequence of the theory of everything. Another view is that emergent laws, which govern the behavior of complex systems, should be seen as equally fundamental.[dlvi] Examples of emergent laws are the second law of thermodynamics and the theory of natural selection.[dlvii] The advocates of emergence argue that emergent laws, especially those describing complex or living systems are independent of the low-level, microscopic laws. In this view, emergent laws are as fundamental as a theory of everything.

Weinberg points out that calculating the precise motion of an actual projectile in the Earth's atmosphere is impossible.[dlviii] So how can we know we have an adequate theory for describing the motion of projectiles? Weinberg suggests that we know principles (Newton's laws of motion and gravitation) that work "well enough" for simple examples, like the motion of planets in empty space. These principles have worked so well on simple examples that we can be reasonably confident they will work for more complex examples. For example, although general relativity includes equations that do not have exact solutions, it is widely accepted as a valid theory because all of its equations with exact solutions have been experimentally verified.[dlix] Likewise, a theory of everything must work for a wide range of simple examples in such a way that we can be reasonably confident it will work for every situation in physics. Difficulties in creating a theory of everything often begin to appear when combining quantum mechanics with the theory of general relativity, as the equations of quantum mechanics begin to falter when the force of gravity is applied to them. The basic idea is that when a quantum system interacts with a measuring apparatus, their respective wave functions become entangled so that the original quantum system ceases to exist as an independent entity.[dlx] One consequence of the basic quantum formalism is the uncertainty principle. In its most familiar form, this states that no preparation of a quantum particle can imply simultaneously precise predictions both for a measurement of its position and for a measurement of its momentum.[dlxi]

Again, The zero-energy universe hypothesis proposes that the total amount of energy in the universe is exactly zero: its amount of positive energy in the form of matter is exactly canceled out by its negative energy in the form of gravity.[dlxii] Some physicists, such as Lawrence Krauss, Stephen Hawking or Alexander Vilenkin, call or called this state 'a universe from nothingness', although the zero-energy universe model requires both a matter field with positive energy and a gravitational field with negative energy to exist.[dlxiii] The hypothesis is broadly discussed in popular sources. A number of important questions remain open in the area of physics beyond the Standard Model, such as the strong CP problem, determining the absolute mass of neutrinos, understanding matter–antimatter asymmetry, and identifying the nature of dark matter and dark energy.[dlxiv], [dlxv] Another significant problem lies within the mathematical framework of the Standard Model itself, which remains inconsistent with general relativity. This incompatibility causes both theories to break down under extreme conditions, such as within known spacetime gravitational singularities like those at the Big Bang and at the centers of black holes beyond their event horizons.[dlxvi] On the other hand, The chronology of the universe describes the history and future of the universe according to Big Bang cosmology. Research published in 2015 estimates the earliest stages of the universe's existence as taking place 13.8 billion years ago, with an uncertainty of around 21 million years at the 68% confidence level.[dlxvii]

There is an hypothesis as on a timescale of millions of trillions of years, black holes might appear to evaporate almost instantly, uncommon quantum tunnelling phenomena would appear to be common, and quantum or other phenomena so unlikely that they might occur just once in a trillion years may occur many times.[dlxviii] Again, the multiverse is the hypothetical set of all universes.[dlxix] Together, these universes are presumed to comprise everything that exists: the entirety of space, time, matter, energy, information, and the physical laws and constants that describe them. The different universes within the multiverse are called 'parallel universes', 'flat universes', 'other universes', 'alternate universes', 'multiple universes', 'plane universes', 'parent and child universes', 'many universes', or 'many worlds.' One common assumption is that the multiverse is a 'patchwork quilt of separate universes all bound by the same laws of physics.'[dlxx] Now, the question is what is the final fate of the universe? Ultimately, the universe will reach a state of profound darkness and near-absolute stasis. All stars, galaxies, and structures will have either dissipated or collapsed, and entropy will dominate all processes. The dark era of the universe—possibly extending forever—will be marked by stillness, silence, and timelessness, interrupted only by fleeting, insignificant quantum events. However, the final word remains elusive. The intersection of quantum physics and general relativity may hold keys to new beginnings, or the universe may remain forever inert. In either case, the narrative ends with awe and humility in the face of a cosmos that is vast, mysterious, and still not fully understood.

**Possibility of the Alcubierre Warp Drive Ship**

The Alcubierszre warp drive, a theoretical faster-than-light propulsion mechanism, has long been constrained by its reliance on exotic negative-energy materials.[dlxxi] Question arises; is superluminal travel could be technologically feasible in the foreseeable future? Perhaps, theoretically possible. The idea of faster-than-light (FTL) travel remains one of the most intriguing possibilities in modern theoretical physics. Among the proposed models, the Alcubierre warp drive, first introduced by Miguel Alcubierre in 1994,[dlxxii] suggests a mechanism in which a spacecraft can travel faster than light without violating special relativity. This is achieved by contracting spacetime in front of the spacecraft and expanding it behind, effectively allowing the ship to "surf" on a wave of spacetime. Despite its theoretical appeal, the Alcubierre drive faces several fundamental challenges that have been the subject of extensive research over the past three decades. These challenges include the requirement of negative energy, the feasibility of dynamically adjusting spacetime curvature, the potential implications for closed timelike curves (CTCs) and time travel, and the enormous energy demands associated with sustaining a warp bubble. One of the primary obstacles to realizing an Alcubierre drive is the requirement for negative energy density to sustain the warp bubble. Negative energy, as predicted by quantum field theory, has been observed in certain physical phenomena such as the Casimir effect.[dlxxiii] However, the amount required for a macroscopic warp drive is believed to be orders of magnitude greater than what can currently be produced in laboratory conditions. Recent work by Lentz[dlxxiv] and Bobrick & Martire[dlxxv] suggests that certain spacetime geometries may allow for modified warp bubble solutions that minimize or bypass the need for exotic matter, although these models remain speculative. Moreover, recent advances in quantum field theory and semiclassical gravity indicate that energy condition violations may be less severe than previously thought, offering a possible path forward for future research.[dlxxvi]

Another major challenge is the engineering of spacetime itself to achieve the anticipated contraction and expansion. Theoretical studies by Natário[dlxxvii] propose alternative formulations of warp drive metrics that remove the need for an explicit expansion region, suggesting that different geometries may yield more practical designs. Additionally, recent studies on metric engineering in higher-dimensional theories and modified gravity models (such as f(R) gravity and string theory) hint at possible mechanisms for warping spacetime without requiring unattainable energy densities.[dlxxviii] Furthermore, numerical simulations conducted by White *et al*. at NASA's Eagleworks laboratory have explored potential ways to manipulate spacetime using local energy fluctuations, though experimental confirmation remains elusive.[dlxxix] A crucial and often-debated aspect of warp drive physics is its potential link to time travel. Since any superluminal travel in general relativity implies the possibility of closed timelike curves (CTCs), an operational Alcubierre drive could theoretically enable backward time travel, leading to causality paradoxes.[dlxxx] Work by Everett and Roman has examined the stability of CTCs in warp drive spacetimes, concluding that quantum backreaction effects could potentially prevent such paradoxes.[dlxxxi] Furthermore, Barceló *et al.*[dlxxxii] have explored whether quantum inequalities and chronology protection mechanisms proposed by Hawking might prevent the formation of CTCs in physically realistic scenarios. Nevertheless, this remains an open question, with ongoing debate about whether causality violations are an unavoidable feature of FTL travel or if some yet-undiscovered mechanism might resolve the issue. The energy demands of the Alcubierre drive remain a major hurdle, with early estimates suggesting that the required energy would exceed the total mass-energy of the observable universe.[dlxxxiii] Recent research has focused on refining these calculations to make them more physically reasonable. Pfenning and Ford[dlxxxiv] introduced constraints on warp bubble energy distributions, demonstrating that reducing the thickness of the warp bubble wall could significantly lower energy requirements. Additionally, recent work by Lentz suggests that soliton-based configurations of the warp bubble could allow for subluminal preparation before reaching superluminal speeds, potentially reducing energy needs.[dlxxxv] Meanwhile, research on quantum vacuum energy manipulation, such as that conducted by Davis and Puthoff,[dlxxxvi] proposes that future advancements in quantum field control might enable the extraction of usable negative energy from the vacuum itself.

Bi Qiao from dept of Physics of University of Wuhan Technology in his recent paper has proposes a novel mechanism based on generalized gauge transformations, and establishes the new formula and which enabling the direct conversion of the electromagnetic tensor to the Weyl tensor. This approach provides a feasible new pathway for the Alcubierre warp drive; wherein precise manipulation of electromagnetic fields induces spacetime compression (positive curvature) at the front and spacetime expansion (negative curvature) at the rear of the spacecraft.[dlxxxvii] By doing so, it circumvents the stringent requirement for negative energy and exotic matter imposed by Einstein's field equations, offering a compelling theoretical foundation for the realization of warp-drive propulsion.[dlxxxviii] He has shown and said, "an electromagnetic field-induced Weyl curvature mechanism may offer a more feasible route to realizing warp drive physics." He shows that, "a dramatic reduction in energy demands suggests that faster-than-light travel may be within the reach of future technological advancements." Moreover, his analysis provides critical insights into the safety and controllability of future warp-driven spacecraft.[dlxxxix] Building upon the generalized gauge transformations in principal fiber bundles and the unification of the four fundamental interactions, the proposed electromagnetic tensor to Weyl tensor modulation offers a promising avenue for the practical realization of warp-drive spacecraft. By eliminating the dependence on negative energy exotic matter and significantly reducing energy constraints, this approach transforms superluminal travel from a mere theoretical conjecture into a potentially achievable engineering reality. In the not-so-distant future, this breakthrough may propel humanity beyond the bounds of our solar system, heralding the dawn of the interstellar age. [dxc]

## PREDICTION OF UNIVERSE AND FUTURE

### Cosmic Calendar

The Cosmic Calendar is a way of visualizing the entire 13.8-billion-year history of the universe compressed into a single calendar year. It was popularized by Carl Sagan to help people understand how long cosmic history truly is.[dxci] A similar analogy used to visualize the geologic time scale and the history of life on Earth is the Geologic Calendar.[dxcii] The Cosmic Calendar teaches us the human history is a tiny fraction of cosmic time. The universe is unimaginably old compared to our species. Almost all major cosmic events happened long before humans arrived.[dxciii] In this visualization, the Big Bang took place at the beginning of January 1 at midnight, and the current moment maps onto the end of December 31 just before midnight.[dxciv] At this scale, there are 438 years per cosmic second, 1.58 million years per cosmic hour, and 37.8 million years per cosmic day.[dxcv] If the Big Bang happened on January 1 at 00:00, and today is December 31 at 23:59:59, then all other events given sequentially below in a graph.

***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[dxcvi]**

## Earth and the Solar System's Near Future (2100–3000 AD)

Projections into the 22nd and 23rd centuries highlight major environmental and astronomical changes. Global warming, caused by rising greenhouse gas levels, accelerates ice cap melting and sea-level rise, forcing coastal populations to migrate—echoing ancient human movements. Solar phenomena such as sunspot cycles, increased solar flares, and coronal mass ejections increasingly disrupt Earth's magnetic field and threaten modern technological systems including satellites, communication infrastructure, and power grids. By 2200 AD, intensified volcanic activity temporarily cools the planet through the release of aerosols, while solar wind interactions with Earth's magnetosphere continue to produce vivid auroral displays. Around 2300 AD, climate disruption intensifies as polar melting weakens ocean currents like the Gulf Stream, cooling parts of Europe while heating tropical zones. As Earth moves toward 2500 AD, long-term orbital cycles known as Milankovitch cycles begin to influence climate more strongly. These include changes in Earth's eccentricity (orbital shape), axial tilt, and precession (wobble), triggering minor ice ages and widespread ecosystem disturbances. These shifts present serious challenges for human civilization. Simultaneously, the solar system's movement through the galaxy affects cosmic ray levels, which, in turn, can influence atmospheric chemistry and Earth's climate. By 3000 AD, extended periods of glaciation may occur, and slow gravitational shifts between planets will begin to alter their orbits subtly, although over much longer periods. [dxcvii], the renowned theoretical physicist, futurist, and popular science author, Michio Kaku, has wrote in his book "*The Future of Humanity: Terraforming Mars, Interstellar Travel, Immortality, and Our Destiny Beyond Earth*," exploring how humanity can become a multi-planetary species to ensure survival, covering topics from string theory and AI to interstellar travel and colonization, presenting an optimistic vision of space exploration.[dxcviii] Michio Kaku, describes our current civilization as mid-level Type 0. What does that mean? A Russian astrophysicist, Nikolai Kardashev, in 1964 described civilization types giving them designations going from 1 to 5. He didn't describe a Type 0. That was added by Carl Sagan, another noted astrophysicist, who measured our current state within a Type 0 parameter. Sagan described human existence now from the tribal societies in the Amazon to our energy-guzzling present cities and countries as somewhere between Type 0.5 and 0.6. At 0.5 we mastered flight. At 0.6 we reached the Moon. Now, we are at 0.7 as we prepare to build a permanent presence on our nearest celestial neighbour. Once we master fusion energy and have quantum computing go mainstream, we will move to 0.8 which should happen before 2100. Kardashev's scale aligned with the amount of energy civilizations consume.[dxcix] Currently, we are at 17.5 Terawatts-hours, still far away from Kardashev's starting point of Type 1 which will redouble and redouble the energy we use until it is 100,000 times greater than what we use in the present. Kaku believes that milestone will be met and surpassed in the next 100 to 200 years. It means we will harvest all of the energy reaching Earth from the Sun, an estimated 100 quadrillion Watt-hours. Our Type 1 civilization will have the means to manipulate the weather and even control earthquakes and volcanoes.

Could we do this in 100 or 200 years? I'm not convinced. But certainly, by 2500 CE, it sounds possible. So what else can we do between that year and the subsequent 500 that follows? Can we aspire to each Kardashev's Type 2 and harness all of the energy of the Sun, not just the sunlight falling on our planet? Can our Type 2 technologies make us capable of moving Earth and the other planets of the Solar System? If we reach Type 2, can the extinction-level event associate with the demise of the dinosaurs, no longer be seen as a threat to human civilization? All of this happening by 3000 CE seems impossible. 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.[dc] 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 Considering that construction took roughly 20-30 years and required moving blocks weighing tons, it shows incredible organizational and engineering skill for that era.[dci] Put in the context of our progress in the past. Back in 2500 BCE, we harnessed energy from fire, water and wind to support our pre-industrial civilizations. In the present, we have added electricity and the energy of the atom. [dcii]

Before 0 CE, human knowledge doubled every 1,500 years. By 1900 CE it doubled every century. By 1945 every 25 years. Today it happens every twelve months and soon it will happen every twelve hours. Nine hundred and seventy-seven years from now, in the year 3000 CE, our civilization and Earth will almost be unrecognizable to us in the present. We will be re-engineered as well as our planet. From there we will master the Solar System and beyond making the leaps to Type 3, 4, 5 and beyond. Try to imagine how our human civilization will appear then, as we progress through each of these stages. What will constrain us? Einstein posed a Universe speeding limit based on how fast light travels. *Star Trek*'s warp drive, which warps spacetime to allow faster-than-light (FTL) travel without breaking relativity locally, is a concept scientists are exploring, with NASA and others investigating theoretical frameworks like the Alcubierre Drive, but significant hurdles remain, like needing immense negative energy, making it purely theoretical and far from practical realization.[dciii] Today, some NASA scientists are trying to make that happen. If we master quantum entanglement, can we invent the transporter featured in Star Trek, and teleport ourselves across the galaxy?[dciv] And then the hypothetical wormholes that appear in science fiction in movies like ***Contact***, could be the equivalent of urban subways to help us traverse from one star system to another encountering other species going through the stages of civilization like ourselves.[dcv]

**Geological and Solar Evolution Over Millennia (4000 AD–10,000 AD)**
As millennia pass, tectonic forces continue shaping Earth's geography. Mountain ranges such as the Himalayas grow higher, while new volcanic activity—especially from super-volcanoes like Yellowstone—poses risks of prolonged climatic cooling or "nuclear winter" conditions. The Sun's gradual increase in luminosity becomes more pronounced, warming Earth incrementally and pushing the planet toward a moist greenhouse state—a dangerous tipping point where water begins to evaporate into the atmosphere, threatening ocean stability and biodiversity. Geomagnetic field reversals complete their cycles, potentially weakening Earth's magnetic shield and altering the distribution of charged particles in the atmosphere. These changes may have cascading effects on climate and technology. As the solar system travels through denser interstellar gas clouds, the heliosphere (the Sun's protective bubble) shrinks, allowing more cosmic rays to penetrate the atmosphere. This could increase cloud formation via atmospheric ionization and alter climate patterns on geological scales. These new radiation levels may drive biological evolution by increasing mutation rates—some harmful, others potentially advantageous.

**Long-Term Geological and Cosmic Changes (10,000 AD–1 million AD)**
Over the next hundreds of thousands to millions of years, Earth's tectonic plates will continue drifting, gradually assembling a new supercontinent. This process, occurring roughly every 300–500 million years, will cause massive changes in ocean circulation, climate zones, and

ecosystems. Erosion continues shaping the surface while volcanic activity persists across tectonic boundaries. The Atlantic Ocean may eventually close due to continental drift, leading to major landmass collisions and the formation of towering mountain chains. Simultaneously, the Sun will continue to brighten. Though still in its main-sequence phase, its increased radiation will slowly evaporate ocean water, turning much of Earth into a desert landscape over time. In the broader cosmic context, the Milky Way galaxy is on course to merge with the Andromeda galaxy—a process already underway and expected to culminate in billions of years. This merger will dramatically reorganize star systems and initiate new waves of star formation while coalescing the central supermassive black holes into one larger entity. These galactic shifts will cause gravitational disruptions, reshuffling planetary systems.

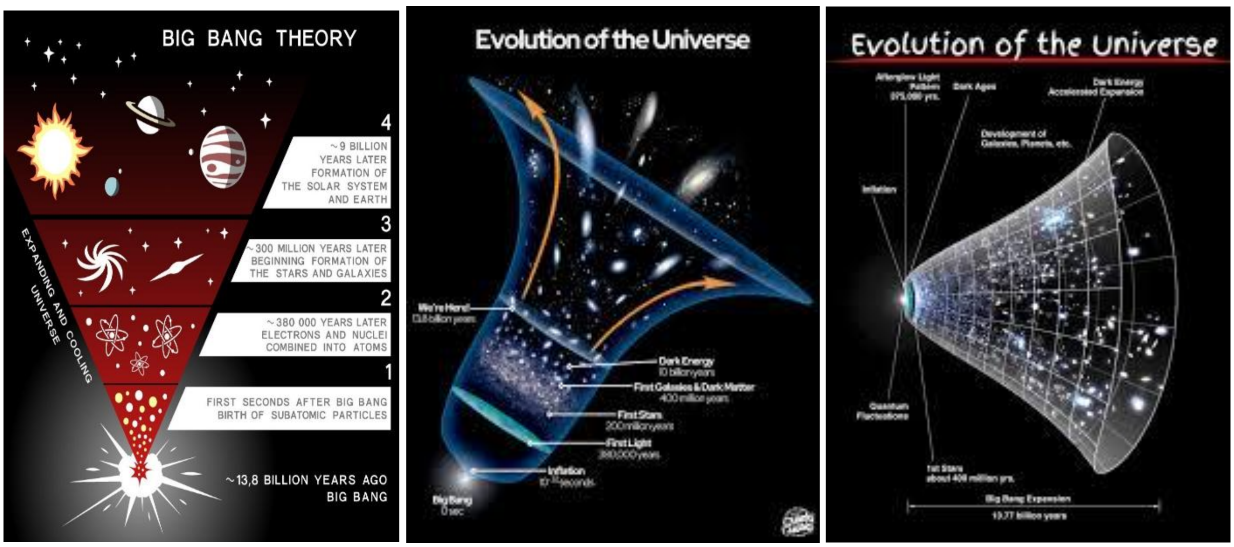


**Figure 10: The Big Bang and Evaluation of Universe[dcvi],[dcvii],[dcviii]**

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

Over this vast timescale, impacts from asteroids the size of the Chicxulub impactor remains a possibility and could trigger mass extinctions. However, the most significant transformation will come from the Sun. In about 5 billion years, the Sun will exhaust its hydrogen fuel and expand into a red giant, engulfing the inner planets, possibly including Earth. If not consumed, Earth will be scorched and stripped of its atmosphere, rendering it completely uninhabitable. Following this, the Sun will shed its outer layers, forming a beautiful yet short-lived planetary nebula, and leave behind a white dwarf—a dense, cooling stellar remnant. Over billions of years, this white dwarf will lose heat and dim further. Meanwhile, the gas giants and Kuiper Belt objects will freeze, and their orbits may shift as the solar system gradually becomes a cold, inert place. By approximately 10 billion years, the white dwarf will cool into a black dwarf, and the solar system will effectively be dead—silent, frozen, and drifting through the dark expanse of the galaxy.

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

This era, known as the degenerate era, will begin once all stars have exhausted their fuel. No new stars will form due to the lack of hydrogen gas. All remaining white dwarfs will cool into black dwarfs, and red dwarf stars—currently the most long-lived—will eventually burn out. As time stretches into trillions of years, galaxies will disperse as gravitational interactions fling stars and remnants into intergalactic space. Black holes become the dominant cosmic structures, merging and consuming surrounding matter. Over time, even they begin to evaporate via Hawking radiation, a slow process taking up to 1010010^ {100}10100 years or more. Eventually, the universe will be a sparse, dark place filled with low-energy particles, and cosmic microwave background radiation will fade into undetectability. Particle interactions will become so rare that time, in any meaningful sense, will lose relevance. The cosmos will reach a state of maximum entropy—complete thermodynamic equilibrium.

### Speculative Scenarios Beyond the Heat Death (Post-10^150 Years)

In this final phase, speculative physics theories suggest that quantum fluctuations may occasionally cause brief events, like the formation of new particles or even black holes. However, such occurrences are extraordinarily rare. Some theories, like eternal inflation and Poincare recurrence, suggest that entire universes could be reborn through quantum tunneling or vacuum decay, possibly restarting cosmic evolution with a new Big Bang. [dcix] Other possibilities include the spontaneous emergence of Boltzmann brains—self-aware entities appearing briefly due to random fluctuations.[dcx] These bizarre entities highlight the paradoxes of time, entropy, and consciousness in infinite universes. At the smallest scales, quantum foam might persist as a dynamic, flickering background—possibly the final trace of physical activity in an otherwise static universe.

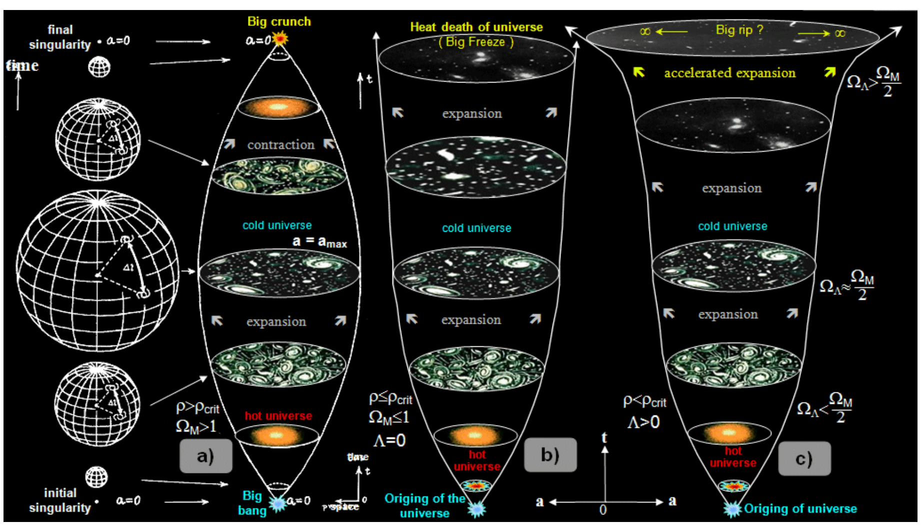


**Figure 11: Dark matter and dark energy[dcxi]**

## THEORIES ABOUT THE END OF THE UNIVERSE AND CRITICAL CHALLENGES

### Big Bang Nucleosynthesis

Big Bang nucleosynthesis is the theory of the formation of the elements in the early universe. It finished when the universe was about three minutes old and its temperature dropped below that at which nuclear fusion could occur. Big Bang nucleosynthesis had a brief period during which it could operate, so only the very lightest elements were produced. Starting from hydrogen ions or protons, it principally produced deuterium, helium-4, and lithium. Other elements were produced in only trace abundances. The basic theory of nucleosynthesis was developed in 1948 by George Gamow, Ralph Asher Alpher, and Robert Herman.[dcxii] It was used for many years as a probe of physics at the time of the Big Bang, as the theory of Big Bang nucleosynthesis connects the abundances of primordial light elements with the features of the early universe.[dcxiii] Specifically, it can be used to test the equivalence principle,[dcxiv] to probe dark matter, and test neutrino physics.[dcxv] Some cosmologists have proposed that Big Bang nucleosynthesis suggests there is a fourth "sterile" species of neutrino.[dcxvi]

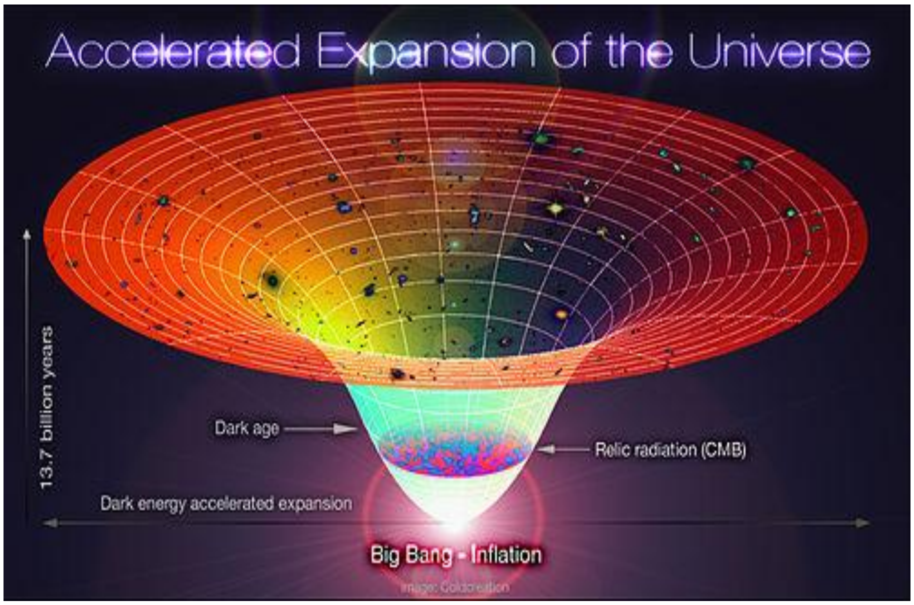


**Figure 12: Lambda-CDM, accelerated expansion of the universe. The timeline in this schematic diagram extends from the Big Bang/inflation era 13.8 billion years ago to the present cosmological time.[dcxvii]**

Understanding the formation and evolution of the largest and earliest structures, such as quasars, galaxies, clusters and superclusters is one of the largest efforts in cosmology. Cosmologists study a model of hierarchical structure formation in which structures form from the bottom up, with smaller objects forming first, while the largest objects, such as superclusters, are still assembling.[dcxviii] One way to study structure in the universe is to survey the visible galaxies, in order to construct a three-dimensional picture of the galaxies in the universe and measure the matter power spectrum. This is the approach of the Sloan Digital Sky Survey and the 2dF Galaxy Redshift Survey.[dcxix] Another tool for understanding structure formation is simulations, which cosmologists use to study the gravitational aggregation of matter in the universe, as it clusters into filaments, superclusters and voids.[dcxx] Most simulations contain only non-baryonic cold dark matter, which should suffice to understand the universe on the largest scales, as there is much more dark matter in the universe than visible, baryonic matter. More advanced simulations are starting to include baryons and study the formation of individual galaxies. Cosmologists study these simulations to see if they agree with the galaxy surveys, and to understand any discrepancy.[dcxxi]

Evidence from Big Bang nucleosynthesis, the cosmic microwave background, structure formation, and galaxy rotation curves suggests that about 23% of the mass of the universe consists of non-baryonic dark matter, whereas only 4% consists of visible, baryonic matter.[dcxxii] The gravitational effects of dark matter are well understood, as it behaves like a cold, non-radiative fluid that forms haloes around galaxies. Dark matter has never been detected in the laboratory, and the particle physics nature of dark matter remains completely unknown. Without observational constraints, there are a number of candidates, such as a stable supersymmetric particle, a weakly interacting massive particle, a gravitationally-interacting massive particle, an axion, and a massive compact halo object. Alternatives to the dark matter hypothesis include a modification of gravity at small accelerations (MOND) or an effect from brane cosmology. TeVeS is a version of MOND that can explain gravitational lensing. However, Modified Newtonian dynamics (MOND) is a theory that proposes a modification of Newton's laws to account for observed properties of galaxies.[dcxxiii] Modifying Newton's law of gravity results in modified gravity, while modifying Newton's second law results in modified inertia.[dcxxiv] The latter has received little attention compared to the modified gravity version. Its primary motivation is to explain galaxy rotation curves without invoking dark matter, and is one of the most well-known theories of this class. MOND was developed in 1982 and presented in 1983 by Israeli physicist Mordehai Milgrom.[dcxxv]

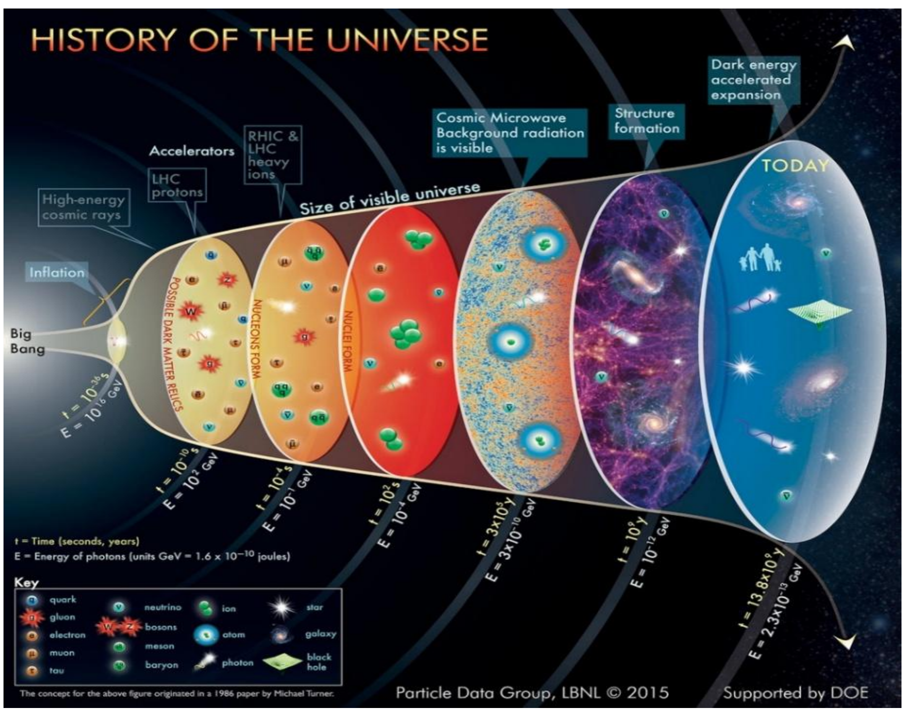


**Figure 13: History Of Universe[dcxxvi]**

If the universe is flat, there must be an additional component making up 73% (in addition to the 23% dark matter and 4% baryons) of the energy density of the universe. This is called dark energy. In order not to interfere with Big Bang nucleosynthesis and the cosmic microwave background, it must not cluster in haloes like baryons and dark matter. There is strong observational evidence for dark energy, as the total energy density of the universe is known through constraints on the flatness of the universe, but the amount of clustering matter is tightly measured, and is much less than this. The case for dark energy was strengthened in 1999, when measurements demonstrated that the expansion of the universe has begun to gradually accelerate.[dcxxvii] Apart from its density and its clustering properties, nothing is known about dark energy. Quantum field theory predicts a cosmological constant (CC) much like dark energy, but 120 orders of magnitude larger than that observed.[dcxxviii] Steven Weinberg and a number of string theorists have invoked the 'weak anthropic principle.'[dcxxix] Here, the reason that physicists observe a universe with such a small cosmological constant is that no physicists (or any life) could exist in a universe with a larger cosmological constant.[dcxxx] Many cosmologists find this an unsatisfying explanation: perhaps because while the weak anthropic principle is self-evident (given that living observers exist, there must be at least one universe with a cosmological constant (CC) which allows for life to exist) it does not attempt to explain the context of that universe.[dcxxxi] A better understanding of dark energy is likely to solve the problem of the ultimate fate of the universe. In the current cosmological epoch, the accelerated expansion due to dark energy is preventing structures larger than superclusters from forming. It is not known whether the acceleration will continue indefinitely, perhaps even increasing until a Big Rip, or whether it will eventually reverse, lead to a Big Freeze, or follow some other scenario.[dcxxxii]

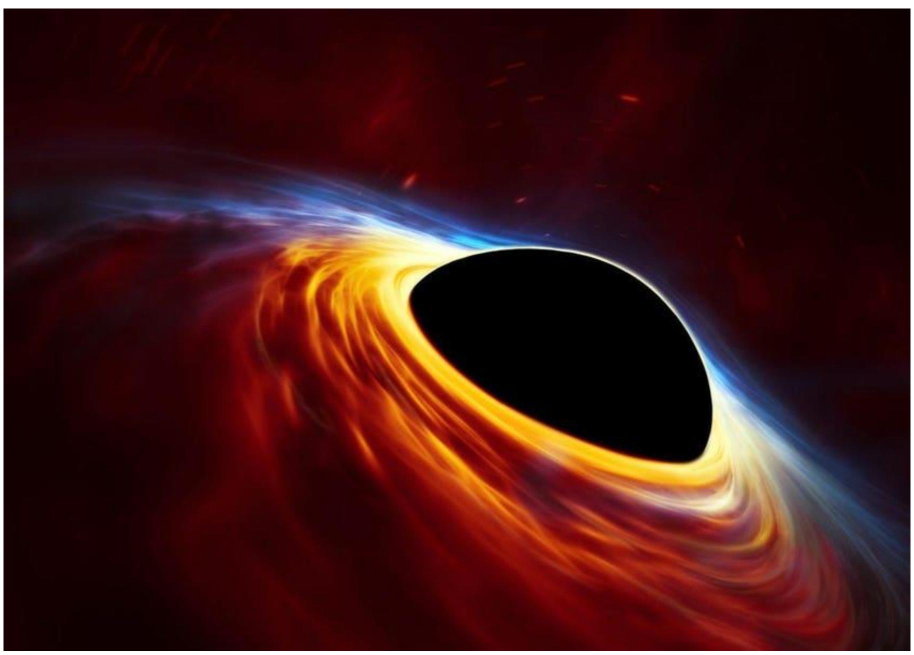

**Figure 14: Black holes don't emit light and they are worth considering as a potential candidate for our Universe's dark matter.[dcxxxiii]**

Still physics don't know, whether primordial black holes were formed in our universe, and what happened to them.[dcxxxiv] Cosmologists need to detect cosmic rays with energies above the GZK cutoff, and whether it signals a failure of special relativity at high energies.[dcxxxv] Where, the Greisen–Zatsepin–Kuzmin limit (GZK limit or GZK cutoff) is a theoretical upper limit on the energy of cosmic ray protons traveling from other galaxies through the intergalactic medium to our galaxy. They need to find out the equivalence principle,[dcxxxvi] whether or not Einstein's general theory of relativity is the correct theory of gravitation, [dcxxxvii] and if the fundamental laws of physics are the same everywhere in the universe.[dcxxxviii] Cosmologists need to clear the explanation of Biophysical cosmology and which is a type of physical cosmology that studies and understands life as part as well as an inherent part of physical cosmology. It stresses that life is inherent to the universe and therefore frequent.[dcxxxix],[dcxl] Several possible futures have been predicted by different scientific hypotheses, including that the universe might have existed for a finite or infinite duration, or towards explaining the manner and circumstances of its beginning.[dcxli] The fate of the universe may be determined by its density. The preponderance of evidence to date, based on measurements of the rate of expansion and the mass density, favors a universe that will continue to expand indefinitely, resulting in the "Big Freeze" scenario below.[dcxlii] However, observations are not conclusive, and alternative models are still possible. Choosing among these (below mentioned) challenging scenarios is done by 'weighing' the universe, for example, measuring the relative contributions of matter, radiation, dark matter, and dark energy to the critical density. More concretely, competing scenarios are evaluated against data on galaxy clustering and distant supernovas, and on the anisotropies in the cosmic microwave background.[dcxliii]

**Big Freeze or Heat Death**

The evolution of the universe is determined by a struggle between the momentum of expansion and the pull or push of gravity. The current rate of expansion is measured by the Hubble Constant, while the strength of gravity depends on the density and pressure of the matter in the universe.[dcxliv] If the pressure of the matter is low, as is the case with most forms of matter we know of, then the fate of the universe is governed by the density. If the density of the universe is less than the critical density, then the universe will expand forever, like the green or blue curves in the graph above.[dcxlv] Gravity might slow the expansion rate down over time, but for densities below the critical density, there isn't enough gravitational pull from the material to ever stop or reverse the outward expansion. This is also known as the Big Chill or Big Freeze; because the universe will slowly cool as it expands until eventually it is unable to sustain any life.

The heat death of the universe, also known as the Big Freeze (or Big Chill), is a scenario under which continued expansion results in a universe that asymptotically approaches absolute zero temperature. [dcxlvi] Under this scenario, the universe eventually reaches a state of maximum entropy in which everything is evenly distributed and there are no energy gradients and which are needed to sustain information processing, one form of which is life. This scenario has gained ground as the most likely fate.[dcxlvii] In this scenario, stars are expected to form normally for $10^{12}$ to $10^{14}$ (1–100 trillion) years, but eventually the supply of gas needed for star formation will be exhausted.[dcxlviii] As existing stars run out of fuel and cease to shine, the universe will slowly and inexorably grow darker. Eventually black holes will dominate the universe, but they will disappear over time as they emit Hawking radiation.[dcxlix] Over infinite time, there could be a spontaneous entropy decrease by the Poincaré recurrence theorem, thermal fluctuations, [dcl], [dcli] and the fluctuation theorem. [dclii], [dcliii] The heat death scenario is compatible with any of the three spatial models, but it requires that the universe reaches an eventual temperature minimum.[dcliv] Without dark energy, it could occur only under a flat or hyperbolic geometry. With a positive cosmological constant, it could also occur in a closed universe.

**Figure 15: The Big Freeze theory, suggests the universe will continue to expand, and it will expand until it is nothing.** [dclv]

In his 1979 paper "Time Without End: Physics and Biology in an Open Universe," physicist Freeman Dyson[dclvi] proposed a scenario for the far future in which intelligent life could achieve a form of immortality by processing an infinite number of thoughts.[dclvii] This concept, known as 'Dyson's eternal intelligence,' was originally predicated on an open universe, a cosmological model that expands forever. In the context of a zero cosmological constant (a flat or open universe without dark energy), the universe would continue to cool as it expands, but at a decelerating rate.[dclviii] Dyson's idea was that intelligent beings could store a finite amount of energy and expend it in increasingly smaller fractions. After each expenditure of energy for thought processes, these beings would enter a state of hibernation for immense periods, allowing the universe to cool further. As the ambient temperature of the universe drops, the minimum energy required for a computation (a thought) also decreases, theoretically allowing for an infinite number of thoughts to be processed over an infinite subjective time, even with a finite energy reserve. However, this scenario faces challenges, as the discovery of an accelerating expansion, driven by a positive cosmological constant, suggests that the universe will not continue to cool indefinitely and distant regions will become causally disconnected, which would prevent the indefinite survival envisioned by Dyson.[dclix]

## Big Rip

In physical cosmology, the Big Rip is a hypothetical cosmological model concerning the ultimate fate of the universe, in which the matter of the universe, from stars and galaxies to atoms and subatomic particles, is progressively torn apart by the gravitational influence of dark energy at a certain time in the future, such that distances between particles infinitely increase.[dclx] The Big Rip is a hypothetical, catastrophic end to the universe where the accelerating expansion of space becomes so powerful it overcomes all other forces, eventually tearing apart all structures.[dclxi] In this scenario, galaxy clusters, galaxies, solar systems, planets, and ultimately atoms and subatomic particles would be ripped apart. The process occurs if dark energy becomes stronger over time or 'a form sometimes called phantom energy,' leading to a violent and complete dissolution of all matter.[dclxii] The theory is based on the idea that dark energy, which drives the universe's expansion, could increase in strength over time. The first effect would be galaxy clusters being pulled apart. The expansion would be strong enough to tear individual galaxies apart, followed by solar systems. In the final moments, planets would be ripped from their stars, followed by stars themselves.[dclxiii] Eventually, the forces holding atoms together would be overcome, and even subatomic particles would be torn apart.

**Figure 16: Can we stop Big Rip?[dclxiv]**

Let's envisage a future where the universe, all too soon, tears itself apart. First come the clusters, with their galaxies pulled away from each other. Then, the galaxies dissolve. Then the star systems and the planets are coming. After then atoms themselves. Ultimately, space-time is torn asunder, rendering the universe uninhabitable. However, it is a potential future known as the Big Rip. this sounds scary and almost impossible to imagine, but the truly dismaying part is that some evidence seems to be pointing directly toward that fate of us. The current Hubble constant defines a rate of acceleration of the universe not large enough to destroy local structures like galaxies, which are held together by gravity, but large enough to increase the space between them.[dclxv] A steady increase in the Hubble constant to infinity would result in all material objects in the universe, starting with galaxies and eventually in a finite time all forms, no matter how small, disintegrating into unbound elementary particles, radiation and beyond.[dclxvi] As the energy density, scale factor and expansion rate become infinite, the universe ends as what is effectively a singularity. In the special case of phantom dark energy, which has supposed negative kinetic energy that would result in a higher rate of acceleration than other cosmological constants predict, a more sudden big rip could occur.[dclxvii] The Big Rip is a theoretical possibility and not the most likely outcome, as it requires dark energy to behave in a specific way. Current data suggests dark energy is roughly constant, and a Big Rip is not predicted by this model.[dclxviii] However, the exact nature of dark energy is still a mystery, and some experimental evidence has hinted at possibilities that would make this scenario more likely, according to Universe Today.[dclxix]

## Big Crunch

The Big Crunch is a hypothetical scenario for the ultimate fate of the universe, in which the expansion of the universe eventually reverses and the universe re-collapses, ultimately causing the cosmic scale factor to reach absolute zero, an event potentially followed by a reformation of the universe starting with another Big Bang.[dclxx] The vast majority of current evidence, however, indicates that this hypothesis is not correct. Instead, astronomical observations show that the expansion of the universe is accelerating rather than being slowed by gravity, suggesting that a Big Chill or Big Rip is much more likely to occur.[dclxxi],[dclxxii] Nonetheless, some physicists have proposed that a "Big Crunch-style" event could result from a dark energy fluctuation. The Big Crunch hypothesis is a symmetric view of the ultimate fate of the universe. Just as the theorized Big Bang started as a cosmological expansion, this theory assumes that the average density of the universe will be enough to stop its expansion and the universe will begin contracting. The result is unknown; a simple estimation would have all the matter and spacetime in the universe collapse into a dimensionless singularity back into how the universe started with the Big Bang, but at these scales unknown quantum effects need to be considered.[dclxxiii]

**Figure 17: Life may end with Big Crunch[dclxxiv]**

Recent evidence suggests that this scenario is unlikely but has not been ruled out, as measurements have been available only over a relatively short period of time and could reverse in the future.[dclxxv] This scenario allows the Big Bang to occur immediately after the Big Crunch of a preceding universe. If this happens repeatedly, it creates a cyclic model, which is also known as an oscillatory universe.[dclxxvi] The universe could then consist of an infinite sequence of finite universes, with each finite universe ending with a Big Crunch that is also the Big Bang of the next universe. A problem with the cyclic universe is that it does not reconcile with the second law of thermodynamics, as entropy would build up from oscillation to oscillation and cause the eventual heat death of the universe.[dclxxvii] Current evidence also indicates the universe is not closed. This has caused cosmologists to abandon the oscillating universe model. A somewhat similar idea is embraced by the cyclic model, but this idea evades heat death because of an expansion of the branes that dilutes entropy accumulated in the previous cycle.[dclxxviii]

## Big Bounce

The Big Bounce hypothesis is a cosmological model for the origin of the known universe.[dclxxix] It was originally suggested as a phase of the cyclic model or oscillatory universe interpretation of the Big Bang, where the first cosmological event was the result of the collapse of a previous universe.[dclxxx],[dclxxxi] It receded from serious consideration in the early 1980s after inflation theory emerged as a solution to the horizon problem, which had arisen from advances in observations revealing the large-scale structure of the universe.[dclxxxii] The Big Bounce is a theorized scientific model related to the beginning of the known universe. It derives from the oscillatory universe or cyclic repetition interpretation of the Big Bang where the first cosmological event was the result of the collapse of a previous universe.[dclxxxiii] According to one version of the Big Bang theory of cosmology, in the beginning the universe was infinitely dense. Such a description seems to be at odds with other more widely accepted theories, especially quantum mechanics and its uncertainty principle.[dclxxxiv]

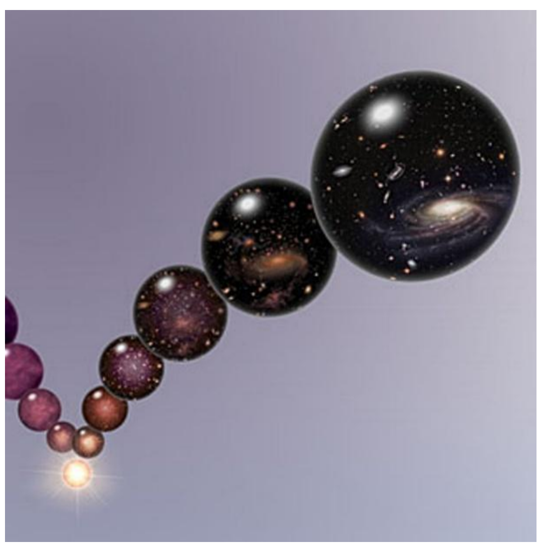

**Figure 18: Big Bang or Big Bounce?[dclxxxv]**

Therefore, quantum mechanics has given rise to an alternative version of the Big Bang theory, specifically that the universe tunneled into existence and had a finite density consistent with quantum mechanics, before evolving in a manner governed by classical physics.[dclxxxvi] 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.[dclxxxvii] An alternative concept that included a Big Bounce was conceived as a predictive and falsifiable possible solution to the horizon problem.[dclxxxviii] Investigation continued as of 2022.[dclxxxix,dcxc,dcxci]

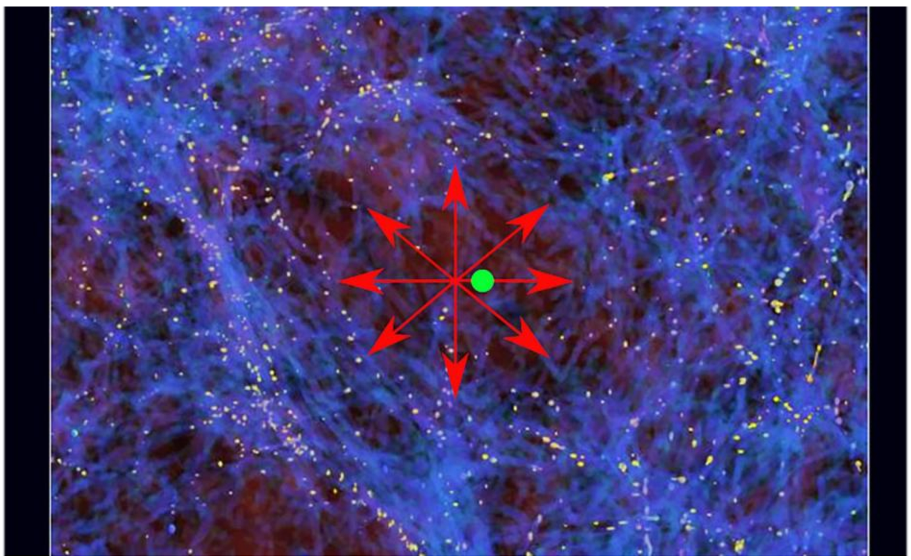

**Figure 19: Some Scientists Believe Our Milky Way Galaxy May Be Inside a Giant 'Cosmic Void' in the Universe[dcxcii]**

### Big Slurp

This theory posits that the universe currently exists in a false vacuum and that it could become a true vacuum at any moment. In order to best understand the false vacuum collapse theory, one must first understand the Higgs field which permeates the universe.[dcxciii] Much like an electromagnetic field, it varies in strength based upon its potential. A true vacuum exists so long as the universe exists in its lowest energy state, in which case the false vacuum theory is irrelevant. However, if the vacuum is not in its lowest energy state or a false vacuum, it could tunnel into a lower-energy state.[dcxciv],[dcxcv] This is called vacuum decay.[dcxcvi] This has the potential to fundamentally alter the universe: in some scenarios, even the various physical constants could have different values, severely affecting the foundations of matter, energy, and spacetime. It is also possible that all structures will be destroyed instantaneously, without any forewarning.[dcxcvii] However, only a portion of the universe would be destroyed by the Big Slurp while most of the universe would still be unaffected because galaxies located further than 4,200 megaparsecs (13 billion light-years) away from each other are moving away from each other faster than the speed of light while the Big Slurp itself cannot expand faster than the speed of light.[dcxcviii] To place this in context, the size of the observable universe is currently about 46 billion light years in all directions from earth.[dcxcix] The universe is thought to be that size or larger.

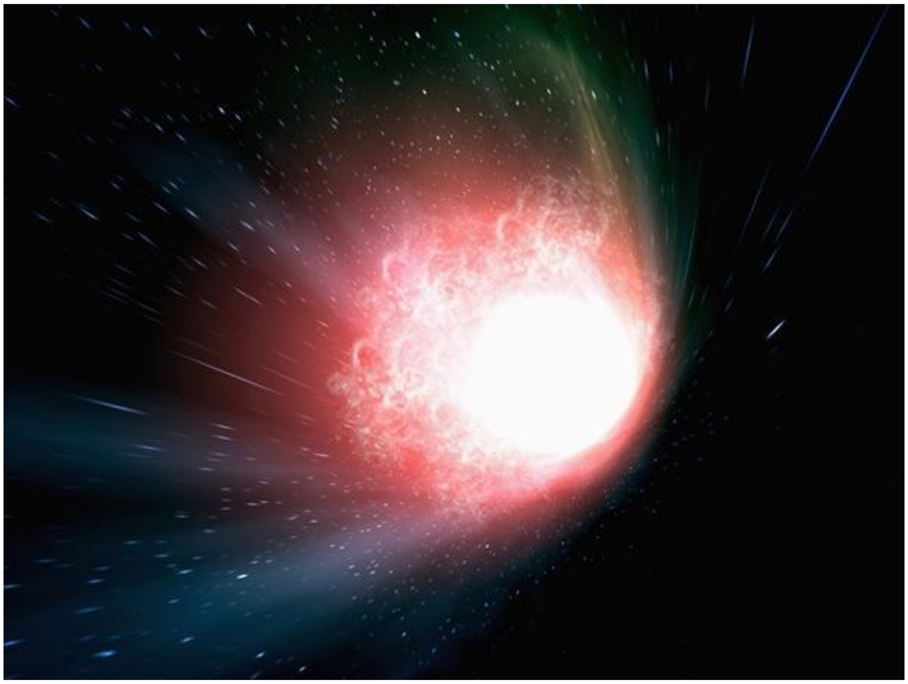

**Figure 20: Idea of the Big Slurp[dcc]**

One of the newest reports released suggests something sinister… if the higgs boson truly exists at the appropriate mass, our universe may be in some serious trouble. At least it is according to a theoretical physicist from the Fermi National Accelerator Laboratory in Batavia, Illinois, who claims: “If you use all the physics that we know now and you do what you think is a straightforward calculation, it’s bad news.” Many physicists have been discussing the possibility of our universe teetering on the edge of stability for many years now. Especially physicists Michael Turner and Frank Wilczek, who published a paper in Nature back in 1982 that suggested this unpleasant scenario; “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.”[dcci] According to (Lykken) calculations (which hinge on the mass of the Higgs being correct, or off by a small margin of one percent), many tens of billions of years from now, the universe would experience some catastrophic event as a “bubble” formed from quantum fluctuationss, from some sort of an alternate universe with a lower-energy state might appear in ours, expanding and ultimately destroying us.[dccii] At the speed of light, to boot, he said. Even more interestingly, these calculations brought up a question more philosophical than anything else, bringing him to ultimately wonder if the state of our universe is instrumental in producing stars, galaxies, planets, matter and ultimately, life.

## Cosmic Uncertainty

It refers to the inherent limits on our ability to know the universe with perfect accuracy, stemming from two main sources: cosmic variance and fundamental physical principles. Cosmic variance is the statistical uncertainty that arises because we can only observe one universe, which is a single sample with random fluctuations. Fundamental principles, such as Heisenberg's uncertainty principle, place a universal limit on how precisely certain pairs of physical properties (like energy and time) can be known at the same time.[dcciii] Actually, Cosmologists can only ever study our one universe. Because of this, our observations of phenomena like the cosmic microwave background or large-scale galaxy distribution are limited to a single realization.[dccciv] The early universe had random quantum fluctuations that grew into the large-scale structures we see today. This means our observable patch is not necessarily a perfectly average representation of the entire universe.[dcccv] Cosmic variance introduces an unavoidable statistical uncertainty in measurements of cosmic properties, such as the density of matter or the characteristics of early universe fluctuations. For example, a region of sky surveyed might have a slightly higher or lower density of galaxies by chance.[dcccvi] Each possibility described so far is based on a simple form of the dark energy equation of state. However, as the name implies, little is now known about the physics of dark energy.[dcccvii] If the theory of inflation is true, the universe went through an episode dominated by a different form of dark energy in the first moments of the Big Bang, but inflation ended, indicating an equation of state more complex than those assumed for present-day dark energy. It is possible that the dark energy equation of state could change again, resulting in an event that would have consequences which are difficult to predict or parameterize.[dcccviii] As the nature of dark energy and dark matter remain enigmatic, even hypothetical, the possibilities surrounding their role in the universe are unknown.

**Figure 21: Cosmic uncertainty and there may antimatter worlds [dccix,dccx]**

As we investigate further into cosmology, bio-information theory, and the different models of consciousness, we will be able to further hypothesize and validate our last survival resort when the universe dies. A positive cosmological constant is a problem. An accelerating universe means that galaxies and galactic entities eventually “grow” apart. Energy stored in these areas would be inaccessible. Unless, of course, if you bring in the dark house—dark energy. No one really knows what dark energy is and what it does. So, this remains unresolved. The largest obstacle towards achieving Dyson’s eternal intelligence is to pass below the physical threshold necessary to the maintenance of conscious awareness. Granted that organic lifeforms are certainly inefficient in turning energy into computations (and consciousness), perhaps inorganic lifeforms or even alternative molecular structures might require much less energy to give rise to consciousness.

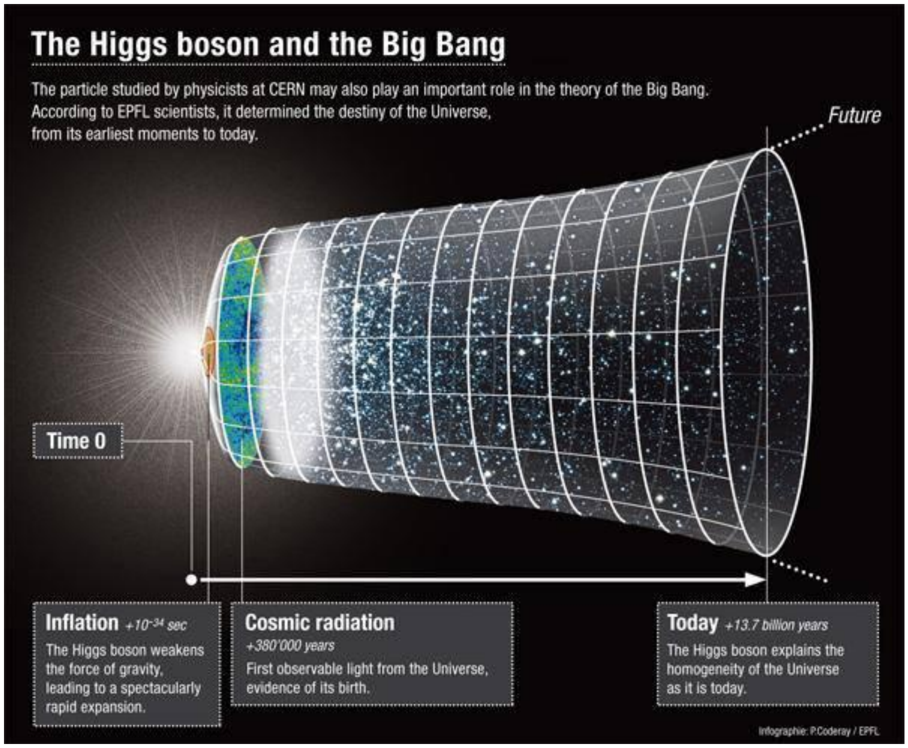


**Figure 22: Big Slurp Theory**[dccxi]

## CONCLUSION

One of the most profound contributions of physics is its role in our understanding of the universe. Through the application of physical laws, scientists have been able to explore the origins of the cosmos, the formation of stars and galaxies, and the fundamental nature of space and time. The Big Bang theory, supported by observations of cosmic microwave background radiation and the expansion of the universe, provides a framework for understanding the birth and evolution of the universe over the past 13.8 billion years. Moreover, physics has allowed humans to explore beyond Earth. Space exploration, which has led to missions to the moon, Mars, and beyond, relies heavily on principles of classical mechanics, thermodynamics, and relativity. The discovery of exoplanets, planets outside our solar system, has opened new avenues for understanding planetary systems and the potential for life elsewhere in the universe. Through tools such as the Hubble Space Telescope and the upcoming James Webb Space Telescope, physicists continue to push the boundaries of human knowledge, seeking answers to questions about dark matter, dark energy, and the ultimate fate of the universe.

The history of physics reveals a shift from the classical notion of a perfectly predictable "clockwork" universe to the modern understanding that uncertainty is a fundamental, inherent property of nature, especially at the quantum level. This fundamental uncertainty places inherent limits on the precise predictability of future events. Newton's laws were incredibly successful at predicting the movements of large objects, from falling apples to planets which has Published in 1687. However, The French mathematician Pierre-Simon Laplace extended this success, arguing that a hypothetical "superhuman intelligence" with complete knowledge of every particle's position and speed could, using Newton's laws, determine the entire past and future of the universe. This notion of strict causality and a fully predetermined future guided scientific inquiry throughout the 19th century. On the other hand, the early 20th century revolutionized physics, challenging classical determinism with the advent of quantum mechanics. Due to Quantum Revolution Max Planck, Albert Einstein, Niels Bohr, and Werner Heisenberg explored the subatomic realm, where classical rules broke down. Again, Werner Heisenberg articulated the uncertainty principle, a cornerstone of modern physics. This principle states that it is impossible to simultaneously measure both the exact position and the exact momentum (speed and direction) of a subatomic particle in 1927. However, this is not a limitation of our measuring tools, but a fundamental aspect of nature itself, stemming from the wave-particle duality of matter. An unobserved particle doesn't have a definite position or momentum; these properties are, in a sense, evoked by the act of measurement.

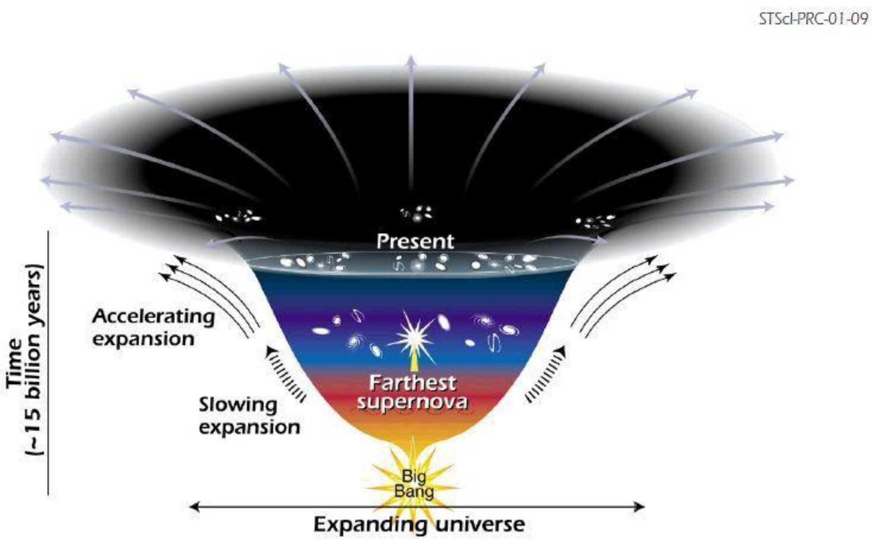


**Figure 23: Can life survive till the end of universe** [dccxii]

The uncertainty principle delivered a fatal blow to the idea of a strictly predetermined or programmed, clockwork universe. Because we cannot know the initial precise state of a quantum system, its future motion can only be described in terms of probabilities, not certainties. Even in classical, macroscopic systems, chaos theory demonstrates that complex systems are highly sensitive to initial conditions, making long-term predictions practically impossible, like with weather forecasting or earth quick early warning. Some modern physicists and philosophers, like Carlo Rovelli, explore the nature of time itself, challenging our common-sense notions of past and future as distinct entities, suggesting a complex relationship between cause, effect, and entropy. Ultimately, physics has transitioned from a search for absolute certainty to an embrace of the probabilistic nature of reality, acknowledging that the future is inherently uncertain and full of potential possibilities. Truly, in the world we actually inhabit dark laws abound, and they destroy predictive power by exacerbating errors and making measured quantities enthusiastically sensitive to unruly external factors.[dccxiii] In a dynamic world, there is no single answer under conditions of uncertainty. The mathematician A. F. M. Smith has summed it up well: '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.'[dccxiv] Physics is a fundamental discipline that not only deepens our understanding of the universe but also drives technological progress and societal change. From the discovery of fundamental laws to the development of technologies that have transformed modern life, physics has had a deep impact on human civilization. Moreover, it continues to inspire curiosity and exploration, addressing some of the most profound questions about existence, reality, and the nature of the universe. Quantum Theory and the General Theory of Relativity exploded the clockwork universe, proving beyond a shadow of a doubt that our knowledge was, at best, incomplete and would probably remain that way forever. There were places in the universe, such as black holes, from which no information at all could ever be obtained. Chaos Theory also demonstrated our inherent limits to knowing, forecasting, and controlling the world around us and showed the way that chaos can often be found at the heart of natural and social systems.

Although we may not always recognize it, this new world view has had a profound effect not only on science, but on art, literature, philosophy, and societal relations. Choosing among these rival scenarios as describe in this paper is done by 'weighing' the universe, for example, measuring the relative contributions of matter, radiation, dark matter, and dark energy to the critical density. More concretely, challenging scenarios are evaluated against data on galaxy clustering and distant supernovas, and on the anisotropies in the cosmic microwave background. The 21st century now begins with a humble acceptance of uncertainty. From Certainty to Uncertainty traces the rise and fall of the deterministic universe and shows the evolving influences that such disparate disciplines now have on one another. Michio Kaku's latest universe predictions focus on advanced AI, interstellar travel, Brain-Net or mind-internet, quantum computing and which revealing cosmic secrets. He foresees potential universe endings like the Big Crunch, and that emphasizing that future technology could solve big problems, and enable human expansion like Mars colonization, and even allow direct experience sharing via brain interfaces, though climate change remains an immediate threat.[dccxv] So, we may learn from history, and can speculate on how we will manage our lives into the future and predict the uncertainty. As we move forward, the study of physics will remain crucial in tackling the challenges of the future, from energy sustainability to space exploration and beyond. I hope that, in near future we will imagine better and will define clear picture of the fate of universe and our life on it.

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