

SCIENCE, REASON AND CONSCIENCE: A PHILOSOPHICAL JOURNEY FROM THE CHAIR TO THE CREATOR – 25

“The Universe’s First Breath: A Philosophical Journey from the Big Bang to the Creator’s Intervention”

When the final words of the debate faded into silence, it was as if the universe itself paused, holding its breath for a moment. The questions sparking in the minds of the audience seemed to part the curtains of an unseen stage, and the profound stillness behind the words hinted at the footsteps of an entirely different truth. The Believer’s emphasis on divine intervention and the Deist’s reliance on natural mechanisms flowed like rivers charting different courses, yet where these currents converged, another reality shimmered into view.

This reality transcended the confines of mere debate. It was a call, beckoning toward the beginning of existence itself, to that great moment of silence—the first spark of a thought, a being, or perhaps a breath. Those deep questions that humanity has pursued for millennia, questions that reason and conscience have ceaselessly grappled with, emerged once again. But this time, the pursuit felt stronger, clearer—a search imbued with new resolve.

The cosmos... an eternal poem, a timeless manuscript concealing a mystery within every verse. Its rhythm sways between the mathematical precision of order and the inevitable unraveling of entropy—a unique cadence that echoes through all things. And within this rhythm lies the reverberation of that primal moment: the first cry of the Big Bang, the awe-inspiring dance of energy transforming into matter, and the dazzling choreography of stars and galaxies unfurling into the cosmos.

Now, we prepare to turn the pages of this colossal story. We embark on a journey to the first spark of creation, to that delicate line where order and chaos intertwine in a breathtaking dance, to the profound moment when time and space were born.

This journey is more than a narrative—it is a discovery, a pursuit of truth. Like a seed cracking open to become a towering tree, we delve into the depths to uncover the universe’s first breath. And we know that this quest will illuminate not only the vastness outside but also the infinity within us.

For those who seek the truth, the next door is opening. The chapter begins.

Believer: To better understand the concept of “natural mechanisms” as expressed by our Deist friend, let us first clarify what this term signifies. Natural mechanisms are the physical, biological, and chemical processes that operate within the order and functioning of the cosmos. These mechanisms are intricately interwoven and critical for the continuity of life as we know it.

The term “natural mechanisms” encompasses a wide range of processes,¹ playing a pivotal role in the structure and operation of the universe (we’ve detailed some of these in the footnotes). At first glance, this may seem like a commonplace scientific term we use

to describe the workings of the cosmos. However, upon deeper reflection, we begin to see the profound and intricate order inherent within these mechanisms.

Deist thought views these mechanisms as akin to a clock set in motion by a Creator, left to function on their own. Yet, this perspective risks unintentionally leading to the notion that the cosmos is self-sustaining and autonomous, potentially overlooking the extraordinary harmony and precision inherent in these mechanisms.

When we examine the workings of natural mechanisms more closely, we observe their extraordinary coordination. Physical, chemical, biological, and even cosmological processes are interconnected, as though every corner of the universe contributes to this grand harmony. But how did this intricate system begin? Let us explore this process step by step through the lens of scientific narrative.

To grasp the infinite scope of the cosmos' story, I invite you on a journey that transcends time and space. Together, we will delve into the delicate and profound design embedded in the workings of natural mechanisms, exploring how they operate in harmony with the law of entropy. Let us venture to the origins of everything, to the universe's first breath, to that initial spark where it all began.

To understand the profound operation of natural mechanisms and the unique plan underpinning the creation of the cosmos, let us now travel back to the moment where all these processes commenced-the beginning of the universe's extraordinary journey:

1. The Big Bang: The Beginning

"LIKE THE FIRST CELL DIVIDING IN A MOTHER'S WOMB."

The initial stage that brought forth all existence in the universe was akin to the first step in which a single cell divides and begins forming an entire organism.

The creation of the universe began with the Big Bang. This was the moment when time and space emerged.² Before this event, there was neither time, nor space, nor matter.³ The Big Bang was also the moment energy came into existence, becoming the fundamental source of all matter and radiation in the cosmos.⁴

Time began to flow, and space started to expand. The universe was filled with an incredibly dense and hot form of energy. However, this energy did not immediately transform into anything tangible. Everything awaited its turn.⁵

This was the beginning of a deliberate and orderly creation, much like the first cell dividing in a mother's womb-a meticulous and purposeful unfolding of existence.

2. The Planck Era: The Foundation of Laws⁶

"THE CREATION OF A CELL'S GENETIC STRUCTURE."

This era is akin to the first week of a baby's development in the womb, when its genetic code (DNA) is written, containing the fundamental information that will shape its entire life. Everything is still minuscule, but the entire blueprint for future growth is contained within.

THE 10^{-43} SECOND OF CREATION: The very first moment of the universe, known as the Planck Era, occurred in an unimaginably brief fraction of time- 10^{-43} seconds (0.000000000000000000000000000000000001 seconds).⁷ At this time, the size of the universe was approximately 10^{-32} of a millimeter (0.000000000000000000000000000001 millimeters)-so small that even calling it "tiny" would not suffice. In fact, the universe was trillions of times smaller than a millimeter.⁸

During this era, the physical forces we recognize today-gravity, electromagnetism, and the strong and weak nuclear forces-were unified as a single force.⁹ The first foundations of the laws that govern the natural world were established in this brief moment. This included the emergence of "quantum gravity," which underpins the principles of quantum mechanics and general relativity.¹⁰

However, matter did not yet exist in this era. There was only energy-intense, concentrated, and meticulously ordered energy...¹¹

3. The Transition from Energy to Matter

"THE FORMATION OF THE FIRST ORGANS."

This phase resembles the period in which a baby's organs begin to take shape in the womb. Cells organize themselves with specific purposes, laying the groundwork for essential structures like the heart and brain.

THE 10^{-32} SECOND OF CREATION:¹² As time progressed, the universe expanded and cooled. By 10^{-32} seconds after the beginning, the previously unified "**physical forces**" began to separate. The first to break away was **gravity**, the force responsible for the formation of large cosmic structures such as galaxies and stars.¹³ This separation played a crucial role in shaping the universe's future organization.

Following gravity, as the universe cooled further, the **electromagnetic force** and the **weak nuclear force** also separated and acquired their unique characteristics. The last to separate was the **strong nuclear force**, which binds atomic nuclei together and governs nuclear reactions.¹⁴

All these separations occurred within unimaginably short intervals of time, triggering profound transformations in the universe. During this process, the universe underwent rapid expansion, a phenomenon known as **inflation**. Inflation ensured that the universe became **homogeneous** (uniform throughout) and **isotropic** (the same in every direction). Without this rapid expansion, the universe could have ended up vastly different in structure.¹⁵

THE 10^{-6} SECOND OF CREATION:¹⁶ By 10^{-6} seconds after the beginning, energy started transforming into matter. Fundamental particles such as **quarks** and **gluons** came into existence. Quarks combined to form more complex particles like **protons** and **neutrons**.

At the same time, **matter** and **antimatter** were created. However, matter held a slight advantage over antimatter, a critical asymmetry that laid the foundation for all the matter that exists in the universe today.¹⁷

4. The Dawn of Entropy

"THE INCREASE IN CELLULAR ACTIVITY."

This phase resembles the moment when the baby's cells begin consuming energy at a rapid pace, marking the first signs of its developing metabolism. The initial, orderly exchanges of energy-entropy-begin to manifest.

With the creation of matter from energy, the perfectly ordered state of energy started to break down. As energy was utilized, it underwent **entropy**, transforming into a less useful form. This process signifies an increase in disorder.¹⁸

However, at that time, the rise in entropy was minimal, and as the universe expanded, this increase spread over a much broader timeline, gradually shaping the universe's dynamics.¹⁹

5. The Creation of the First Atoms

"THE FORMATION OF BONES AND ESSENTIAL TISSUES."

This phase parallels the stage in a baby's development when its skeletal structures begin to form. Organs and tissues come together to shape the physical body of the baby.

THE THIRD MINUTE OF CREATION:²⁰ Shortly after the Big Bang, the universe was still extremely hot and dense. Under these conditions, protons and neutrons moved freely, colliding constantly. As the universe expanded and cooled, protons and neutrons began to combine, forming the nuclei of **deuterium** (a heavy isotope of hydrogen). These deuterium nuclei then fused to create **helium nuclei**, with trace amounts of **lithium** and **beryllium** forming as well.

This process, known as **Big Bang Nucleosynthesis**, concluded when the universe was approximately 3 minutes old. By this time, the temperature and density of the universe had dropped too low for nuclear fusion to continue. As a result, the proportions of elements formed during Big Bang Nucleosynthesis provide critical insights into the conditions of the early universe.

By the third minute, as the universe cooled further, protons and neutrons combined to create the first atomic nuclei. During this process:

- **75% Hydrogen,**
- **25% Helium,**
- And trace amounts of **Lithium** and other light elements were formed.

6. Cosmic Radiation and the Stability of Atoms

"THE FIRST MOVEMENTS AND COMMUNICATION SIGNALS."

This phase mirrors the moment when a baby begins to move for the first time. With the development of the nervous system in the womb, initial unconscious reflexes and neural activities emerge.

THE 380,000TH YEAR OF CREATION:²¹ Following the Big Bang, the universe remained extremely hot and dense. Under these conditions, electrons were unable to bind to atomic nuclei and

moved freely. As the universe expanded and cooled, the energy of these electrons decreased, eventually allowing them to bind to nuclei. This process is known as **recombination**.

Recombination marks a significant turning point in the history of the universe. Before this event, the universe was an opaque plasma for light. Free electrons scattered photons (light particles) constantly, preventing light from traveling long distances. After recombination, the universe became transparent to light, allowing photons to travel freely.

The photons released during the recombination era form the **cosmic microwave background radiation** we observe today. This radiation is considered a "fossil" light from the early universe, providing critical insights into the structure and evolution of the cosmos.

7. The Creation of Active Entities: Stars and Galaxies

"HEARING THE BABY'S HEARTBEAT."

This phase parallels the moment when a mother hears her baby's heartbeat for the first time during an ultrasound. The heart functions as a motor, pumping energy throughout the body and regulating the baby's life.

THE 200 MILLIONTH YEAR OF CREATION: Around 200 million years after the Big Bang, variations in density left by quantum fluctuations began to draw gas clouds together under the influence of gravity.²² These clouds, primarily composed of hydrogen and helium, collapsed to form the first stars. In the cores of these stars, **nuclear fusion** ignited, releasing energy in a steady and controlled manner, thereby slowing the increase of entropy.²³

The merging of stars led to the formation of galaxies, giving the universe a more structured and orderly configuration.²⁴

Without this crucial intervention-the creation of stars and galaxies-energy would have continued converting into matter, and entropy would have relentlessly increased, rendering all energy unusable. To counteract this, **active entities** such as stars and galaxies were created to slow the progression of entropy, maintaining a dynamic and organized universe.

8. The Role of Stars and the Proliferation of Elements

"THE DETAILED DEVELOPMENT AND FUNCTIONAL MATURATION OF ORGANS."

This phase corresponds to the stage when the baby's organs become fully functional, preparing to perform more complex tasks. During this process, each organ readies itself for its future role.

The first stars began producing heavier elements such as **carbon, oxygen, and iron** in their cores.²⁵ When massive stars reached the end of their life cycles, they exploded in spectacular **supernovae**. These explosions scattered heavy elements into space, providing the raw materials for the formation of new stars and planets.²⁶

In this way, the stars contributed to the continued slowing of the universe's increasing entropy (though it is important to recognize that entropy cannot be entirely halted). These processes allowed the cosmos to sustain its dynamic order while nurturing the materials necessary for further cosmic evolution.

9. The Creation of the Solar System and Earth

"THE FORMATION OF THE BABY'S ENVIRONMENT."

This phase parallels the development of the amniotic fluid and placenta around the baby, forming systems that nourish and protect it as it grows.

4.6 BILLION YEARS AFTER CREATION: Approximately 4.6 billion years after the beginning, the Sun was formed through the gravitational collapse of clouds of gas and dust.²⁷

During the first 100 million years of the Solar System's formation, planets began to take shape from the rotating disks surrounding the Sun. Earth was created during this period and was endowed with conditions suitable for the development of life.²⁸

This meticulously arranged environment ensured the necessary foundation for the complex processes of life to unfold.

THE CREATION OF THE SOLAR SYSTEM (*Roughly occurred in the following stages*): The Solar System began as a rotating cloud of gas and dust known as the **Solar Nebula**. Under the influence of gravity, the nebula began to collapse. As it collapsed, the nebula spun faster and flattened into a disk. At its center, matter condensed to form the **proto-Sun**, which continued to heat and compress until nuclear fusion ignited.²⁹

In the rotating disk surrounding the proto-Sun, particles of dust and gas coalesced to form **planetesimals**. Through collisions and gravitational attraction, these planetesimals grew larger, eventually forming the **planets**.³⁰

THE CREATION OF EARTH: Earth is a rocky planet that formed within the disk surrounding the Sun. In its early stages, Earth experienced intense **volcanic activity** and **meteor bombardment**. Over time, Earth cooled, and water vapor condensed to form **oceans**. During this period, Earth's **atmosphere** and **magnetic field** also began to take shape, creating conditions essential for sustaining life.³¹

10. The First Life: A Miracle on Earth

"BIRTH AND THE FIRST BREATH."

This phase mirrors the moment a baby enters the world and takes its first breath. It marks the visible signs of life and the beginning of a new chapter.

3.6 BILLION YEARS AFTER CREATION: Approximately 3.6 billion years later, the first **organic molecules** (such as RNA) began to form through chemical reactions on Earth. From these molecules, **microorganisms** emerged, initiating life.³²

Earth was endowed with a series of favorable conditions to support life:

- **Water:** Water is a fundamental solvent for life. Earth is the only planet known to have abundant liquid water on its surface.³³

- **Atmosphere:** Earth's atmosphere blocks harmful solar radiation and regulates temperature, creating a stable environment for life.³⁴
- **Magnetic Field:** Earth's magnetic field protects the planet from harmful solar winds, preserving its atmosphere and surface conditions.³⁵
- **Distance from the Sun:** Earth resides in the **habitable zone**, the ideal range from the Sun where temperatures allow water to remain in its liquid state.³⁶

These conditions, carefully aligned, enabled the miracle of life to take root and flourish, setting the stage for the extraordinary diversity of life forms that would follow.

As you can see, when we examine the creation and functioning of the universe, the presence and intervention of a Creator are evident at every moment. The Creator has continually performed miracles, crafting and maintaining a masterpiece within the cosmos. From its inception to its current state, the universe has been designed as an orderly, purposeful, and artistic creation, operating with precision and continuity.

In this process, the universe was initially created with a fixed amount of energy, which formed the foundation for all matter and processes. However, the existence of energy alone is insufficient. According to the law of entropy, energy gradually becomes more disordered over time, transitioning into a less usable form. If the universe had relied solely on the initial energy, life would have ceased far earlier.

Thus, the Creator's intervention goes beyond the initial planning; active entities such as stars and galaxies were created to sustain the functioning of the universe. These active entities regulate energy, slowing the effects of entropy. Yet, even these entities eventually deplete their energy and succumb to disorder. At this point, the Creator's intervention becomes evident once more: new stars and galaxies are formed, and the processes maintaining order are renewed.

This continuous renewal demonstrates that the universe is never left to its own devices. On the contrary, new creations and new orders emerge at every moment, showcasing the ongoing creative artistry of the Creator. The constant interventions in the cosmos reveal a dynamic, ever-renewing act of creation that prevents the universe from descending into chaos.

By studying the universe, it becomes clear that every moment carries its own unique act of creation. This incessant activity and functionality underscore that the Creator does not abandon the universe but continuously crafts "new creations" in every instance. The ongoing creation within the cosmos is evidence that the Creator remains actively engaged, and the universe's existence is never left to chance or randomness.

At the same time, both scientific and divine sources point to an inevitable conclusion: the ultimate end, or what is scientifically referred to as the **"heat death"** of the universe. This unavoidable finale marks the point at which all energy will reach a completely disordered state.

The grand narrative of the universe's creation showcases not only the magnificent plan established at the beginning but also how this plan is perpetuated through continuous acts of creation. This reality demonstrates that the Creator never abandons the universe but

instead actively manifests their creative power at all times. The creations evident in every corner and every moment of the universe are proof of the Creator's continuous involvement, ensuring that the cosmos does not operate randomly.

In conclusion, it is clear that what is often referred to as "nature" and attributed a kind of divinity is, in fact, a system that constantly depends on renewal and external intervention. The creation of active entities such as stars and galaxies facilitates this renewal. Despite these interventions, however, even the system we call nature cannot escape its ultimate fate-the "heat death" of the universe.

The perfection of the laws of nature is only possible because they are **constantly overseen by a Creator**.

If you believe that "nature" is responsible for all this order and functioning, then you are attributing to it characteristics such as "**power**," "**strength**," "**will**," "**knowledge**," "**intellect**," "**consciousness**," "**sovereignty**," and "**authority**" as if it were an independent entity. But if this is the case, one must ask: Where is its **power** and **strength**? Where are its **will**, **knowledge**, **intellect**, and **consciousness**? Where is its **sovereignty** and **control**?

How can a system that cannot even save itself, that is dragged toward disorder and an inevitable end, be seen as "divine"? What reasoning validates such a notion? Would not conscience reject it? Where is the scientific basis for such a claim? Is this not a moment where logic utterly fails?

This clearly demonstrates, once again, that the universe could not have come into existence on its own and that its order can only be sustained by a **supreme will**.

If there is a reason to deny this power, state it. But in the face of such evident order and continuity, turning a blind eye to this truth would be a denial of our obligation to acknowledge reality, would it not?

The Believer paused for a moment, clasped their hands on the table, and looked at everyone in the room one by one. The determination in their eyes and the clarity in their words conveyed a deep conviction and a foundation of knowledge.

See you in the next chapter, God willing...

¹ Examples of Mechanisms in Nature:

1. Physical Mechanisms

- **Gravity:** The fundamental force that attracts objects toward one another.
- **Heat Transfer:** Energy transfer through conduction, convection, and radiation.
- **Water Cycle:** Processes of evaporation, condensation, precipitation, and runoff.
- **Erosion:** The wearing down of landforms by wind, water, and glaciers.
- **Magnetic Fields:** Protective fields generated by Earth's core movements.

2. Chemical Mechanisms

- **Photosynthesis:** The process by which plants produce food and oxygen using sunlight.
- **Respiration:** Organisms use oxygen and glucose to produce energy.
- **Chemical Equilibrium:** The balance achieved in chemical reactions.

-
- **Dissolution:** The process of solids dissolving in liquids (e.g., salt dissolving in water).
- 3. Biological Mechanisms**
- **Adaptation:** The process by which organisms adjust to their environment.
 - **Circulatory System:** The transport of blood throughout the body.
 - **Nervous System:** The transmission of information and reflex actions.
 - **Genetic Mechanisms:** DNA replication, genetic mutations, and gene transfer.
- 4. Ecosystem Mechanisms**
- **Food Chain:** Energy flow through feeding relationships.
 - **Biogeochemical Cycles:** The movement of elements like carbon, nitrogen, and phosphorus in nature.
 - **Symbiotic Relationships:** Mutual benefits between species (e.g., bees and flowers).
- 5. Geological Mechanisms**
- **Tectonic Plate Movements:** Earthquakes, volcanic eruptions, and mountain formation.
 - **Mineral Cycles:** The movement and transformation of minerals on Earth.
 - **Groundwater Circulation:** The flow and emergence of underground water.
- 6. Climatological and Meteorological Mechanisms**
- **Wind Formation:** Air movement caused by pressure differences.
 - **Climate Cycles:** Phenomena like seasons, El Niño, and ice ages.
 - **Cloud Formation:** Water vapor condensing into clouds.
- 7. Cosmological Mechanisms**
- **Big Bang:** The foundational event of the universe's origin and expansion.
 - **Cosmic Microwave Background Radiation:** Low-energy radiation remaining from the Big Bang.
 - **Expansion of the Universe:** The movement of galaxies away from each other as space itself expands.
 - **Black Hole Mechanisms:** The gravitational pull of super-dense regions drawing in matter and emitting energy.
 - **Star Formation:** The collapse of gas and dust clouds into stars.
 - **Supernova Explosions:** Massive stars exploding at the end of their lifecycles, spreading elements into space.
 - **Dark Matter and Dark Energy:** Phenomena explaining galaxy motions and the accelerated expansion of the universe.
 - **Formation of Planets and Moons:** The creation of planetary bodies from protoplanetary disks.
- 8. Astrophysical Mechanisms**
- **Solar Energy Production (Nuclear Fusion):** Hydrogen atoms fuse into helium, releasing energy.
 - **Interstellar Dust and Gas Cycle:** The processing and redistribution of gas and dust by stars within galaxies.
 - **Magnetospheres:** Protective shields created by planetary magnetic fields interacting with solar wind.
 - **Gamma-Ray Bursts:** High-energy explosions from early universe events or massive star deaths.
- 9. Intergalactic Mechanisms**
- **Colliding Galaxies:** The merging of two galaxies into a new galaxy.
 - **Gravitational Lensing:** Massive celestial objects bending light through their gravitational pull.
 - **Clustering:** The formation of large-scale structures like galaxy clusters through gravitational attraction.

² Hawking, S. W., & Mlodinow, L. (2010). *The Grand Design*. Bantam Books.

³ Weinberg, S. (1977). *The First Three Minutes: A Modern View of the Origin of the Universe*. Basic Books.

⁴ Singh, S. (2004). *Big Bang: The Origin of the Universe*. Fourth Estate.

⁵ Krauss, L. M. (2012). *A Universe from Nothing: Why There Is Something Rather than Nothing*. Free Press.

⁶ Cahill, K. (2013). *New dates for the eras of the universe from the Planck data*. *arXiv preprint arXiv:1308.6001*.

Unnikrishnan, C. S., Gillies, G. T., & Ritter, R. C. (2001). *An origin of the Universe determined by quantum physics and relativistic gravity*. *arXiv preprint arXiv:gr-qc/0109089*.

⁷ Greene, B. (2011). *The Elegant Universe: Superstrings, Hidden Dimensions, and the Quest for the Ultimate Theory* (Trans. Murat Alev). TÜBİTAK Popular Science Books. (Original work published in 1999).

-
- ⁸ Hawking, S. W., & Mlodinow, L. (2010). *The Grand Design* (Trans. Nezihe Bahar). Alfa Publishing. (Original work published in 2010).
- ⁹ Kaku, M. (2006). *Parallel Worlds: The Science of Alternative Universes and Our Future in the Cosmos* (Trans. Murat Alev). ODTÜ Publishing. (Original work published in 2004).
- ¹⁰ Penrose, R. (2016). *Fashion, Faith, and Fantasy in the New Physics of the Universe* (Trans. Umur Daybelge). Alfa Publishing. (Original work published in 2016).
- ¹¹ Rees, M. (2001). *Before the Beginning: Our Universe and Others* (Trans. Gürol Koca). TÜBİTAK Popular Science Books. (Original work published in 1997).
- ¹² Liddle, A. R. (2015). *An Introduction to Modern Cosmology* (3rd ed.). Wiley.
- Baumann, D. (2022). *Cosmology*. Cambridge University Press.
- ¹³ Weinberg, S. (2015). *The First Three Minutes: A Modern View of the Origin of the Universe* (Trans. Zekeriya Aydın). Alfa Publishing. (Original work published in 1977).
- ¹⁴ Liddle, A. (2015). *The First Three Minutes of the Universe* (Trans. Barış Gönülşen). TÜBİTAK Popular Science Books. (Original work published in 2003).
- ¹⁵ Guth, A. H. (1997). *The Inflationary Universe: The Quest for a New Theory of Cosmic Origins*. Basic Books.
- ¹⁶ Rafelski, J., Birrell, J., Steinmetz, A., & Yang, C. T. (2023). *A Short Survey of Matter-Antimatter Evolution in the Primordial Universe*. arXiv preprint arXiv:2305.09055.
- Nayak, G. C. (2019). *Matter-Antimatter Asymmetry of the Universe and Baryon Formation from Non-Equilibrium Quarks and Gluons*. arXiv preprint arXiv:1909.05640.
- ¹⁷ Singh, S. (2010). *Big Bang: The Origin of the Universe* (Trans. Murat Alev). Doğan Publishing. (Original work published in 2004).
- ¹⁸ Penrose, R. (2016). *Fashion, Faith, and Fantasy in the New Physics of the Universe* (Trans. Umur Daybelge). Alfa Publishing. (Original work published in 2016).
- ¹⁹ Liddle, A. (2015). *The First Three Minutes of the Universe* (Trans. Barış Gönülşen). TÜBİTAK Popular Science Books. (Original work published in 2003).
- ²⁰ Weinberg, S. (2015). *The First Three Minutes: A Modern View of the Origin of the Universe* (Trans. Zekeriya Aydın). Alfa Publishing. (Original work published in 1977).
- Liddle, A. (2015).** *The First Three Minutes of the Universe* (Trans. Barış Gönülşen). TÜBİTAK Popular Science Books. (Original work published in 2003).
- Steigman, G. (2007). Primordial Nucleosynthesis in the Precision Cosmology Era. *Annual Review of Nuclear and Particle Science*, 57(1), 463–491. <https://doi.org/10.1146/annurev.nucl.56.080805.140437>
- ²¹ Planck Collaboration. (2016). Planck 2015 results. XIII. Cosmological parameters. *Astronomy & Astrophysics*, 594, A13. <https://doi.org/10.1051/0004-6361/201525830>
- Dodelson, S. (2003). *Modern cosmology*. Academic Press.
- ²² Planck Collaboration. (2016). Planck 2015 results. XIII. Cosmological parameters. *Astronomy & Astrophysics*, 594, A13. <https://doi.org/10.1051/0004-6361/201525830>
- ²³ Bromm, V., & Larson, R. B. (2004). The First Stars. *Annual Review of Astronomy and Astrophysics*, 42(1), 79–118. <https://doi.org/10.1146/annurev.astro.42.053102.134017>
- ²⁴ Mo, H., van den Bosch, F. C., & White, S. (2010). *Galaxy Formation and Evolution*. Cambridge University Press.
- ²⁵ Bromm, V., & Larson, R. B. (2004). The First Stars. *Annual Review of Astronomy and Astrophysics*, 42(1), 79–118. <https://doi.org/10.1146/annurev.astro.42.053102.134017>
- ²⁶ Hillebrandt, W., & Niemeyer, J. C. (2000). Type IA Supernova Explosion Models. *Annual Review¹ of Astronomy and Astrophysics*, 38(1), 191–230. <https://doi.org/10.1146/annurev.astro.38.1.191>
- ²⁷ Bouvier, A., & Wadhwa, M. (2010). The age of the solar system redefined by the oldest Pb-Pb age of a meteoritic inclusion. *Nature Geoscience*, 3(9), 637–641.
- R., Daverio, D., Durrer, R., & Kunz, M. (2013). General relativity and cosmic structure formation. *Nature Physics*, 9(5), 345–349. <https://doi.org/10.1038/nphys2605>
- ²⁸ Montmerle, T., Augereau, J.-C., Chaussidon, M., Gounelle, M., Marty, B., & Morbidelli, A. (2006). Solar System Formation and Early Evolution: The First 100 Million Years. *Earth, Moon, and Planets*, 98(1-4), 39–95. <https://doi.org/10.1007/s11038-006-9087-5>
- ²⁹ Armitage, P. J. (2010). *Astrophysics of Planet Formation*. Cambridge University Press.
- ³⁰ Raymond, S. N., Quinn, T., & Lunine, J. I. (2007). High-resolution simulations of the final assembly of Earth-like planets 2: Water delivery and planetary habitability. *Astrobiology*, 7(6), 66–84. <https://doi.org/10.1089/ast.2006.06-0126>

³¹ Canup, R. M., & Asphaug, E. (2001). Origin of the Moon in a giant impact near the end of the Earth's formation. *Nature*, 412(6848), 708–712. <https://doi.org/10.1038/35089010>

³² Nutman, A. P., Bennett, V. C., Friend, C. R. L., Van Kranendonk, M. J., & Chivas, A. R. (2016). Rapid emergence of life shown by discovery of 3,700-million-year-old microbial structures. *Nature*, 537(7621), 535–538. <https://doi.org/10.1038/nature19355>

Allwood, A. C., Walter, M. R., Kamber, B. S., Marshall, C. P., & Burch, I. W. (2006). Stromatolite reef from the Early Archaean era of Australia. *Nature*, 441(7094), 714–718. <https://doi.org/10.1038/nature04764>

³³ Kasting, J. F., Whitmire, D. P., & Reynolds, R. T. (1993). Habitable Zones around Main Sequence Stars. *Icarus*, 101(1), 108–128. <https://doi.org/10.1006/icar.1993.1010>

³⁴ Catling, D. C., & Kasting, J. F. (2017). *Atmospheric Evolution on Inhabited and Lifeless Worlds*. Cambridge University Press.

³⁵ Glatzmaier, G. A., & Roberts, P. H. (1995). A three-dimensional self-consistent computer simulation of a geomagnetic field reversal. *Nature*, 377(6546), 203–209. <https://doi.org/10.1038/377203a0>

³⁶ Kopparapu, R. K., Ramirez, R., Kasting, J. F., Eymet, V., Robinson, T. D., Mahadevan, S., ... & Terrien, R. C. (2013). Habitable Zones Around Main-Sequence Stars: New Estimates. *The Astrophysical Journal*, 765(2), 131. <https://doi.org/10.1088/0004-637X/765/2/131>

SALAHATTİN ALTUNDAĞ