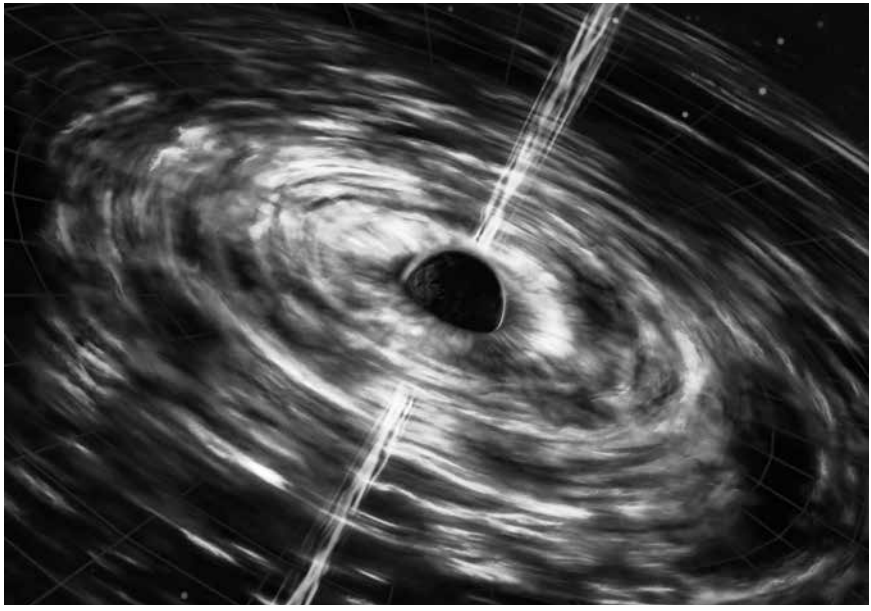
Beyond the Boundaries of Science

Exploring the Cosmic Story



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BEYOND THE BOUNDARIES OF SCIENCE
Exploring the Cosmic Story

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To my boys, Pradeep and Praveen whose love facilitated this work

Foreword

Humankind is excited to look at the Sun and the bright stars in the sky. From the ancient days, different theories have been put forth to explain the origin of celestial bodies and human life. Recently, there is a consensus among scientists that the Universe came into existence 13.7 billion years ago, from a glow and thereafter evolved into stars and galaxies. Our galaxy—the Milky Way—has many stars. One such star is the Sun, which has completed five billion years with planets including our earth. The earth has been the home to many living beings that can move or swim or crawl or fly including the superior creation, the human race, with an amazing brain and a powerful mind. Still, the most important issue before us is the evidence of the origin of human life. We are getting more and more data from telescopes, particle accelerators, deep space missions, and genome sequencers. Attempts are being considered to colonize Mars and to resettle humankind in the habitable planets beyond our solar system if they exist. Despite all our development of technology and ideas, despite all our discoveries and theories, there is much about our origins that remain mysterious. Therefore, there is a need for a comprehensive analysis of many of the cosmic puzzles that accompany our greatest scientific advances.

As a scientist for more than three decades, Dr. Latha Christie has carried out thorough research on this question of the origin and documented the evidence to make sense of the various mysteries and competing ideas, in this book—Beyond the Boundaries of Science. She has also analyzed what physicists are saying about the origin of the universe, and what biologists are saying about the origin of life, and has integrated various philosophical thoughts to make connections to human life.

Dr. Christie had tried to gather all available evidence meticulously to find out what happened before humanity even existed using the latest scientific findings in various fields like cosmology, archaeology, anthropology, biology, and geology. She has reviewed both the scientific data and theories and the various interpretations of the Bible's account of our origins. In this way, she has presented a compelling summary that points towards the conclusion that there is a supernatural Creator behind the cosmic events of the creation of the universe and the creation of life and suggests that harmonization of science and faith is possible.

This book is a scholarly, well-researched treatment of the origin of the universe and the origin of life, from the grandeur and beauty of the cosmos to the tiniest sub-atomic particles. I am sure that the evidence that she has gathered for this book will help curious readers to enhance their wisdom and understanding about the origin of the universe and human life. I commend this brilliant book for your reading.

Dr. A. Sivathanu Pillai, Dr. Kothari Chair professor,
Distinguished Scientist & Former Chief Controller (R&D), DRDO,
Former Distinguished Prof. ISRO, Founder BrahMos Aerospace,
Padmabhusan and Padmashree, Govt. of India.

PART 1
PROLOGUE

CHAPTER 1

EXAMINING THE QUESTION OF ORIGIN

"Two things inspire me to awe—the starry heavens above and the moral universe within.

Immanuel Kant

THE INTRIGUING QUESTION OF THE ORIGIN

There are certain events that get seared into the mind at an early age. You can never wipe out certain memories. A violent storm, a damaging fire, a lightning strike that brought tragedy or simply the starry sky on a dark night: all these, collectively, tell you that you are puny and helpless compared to these mighty forces, under the power of someone who runs the universe. When I look back to my childhood, I remember an occasion in 1969, when the whole world was celebrating the greatest moment in the history of space exploration—the moment Neil Armstrong took what is referred to a giant leap for mankind. He had just become the first person to walk on the moon. I was only four. With the awe and wonder of a child, I was listening to that story as my mother was feeding me. She also pointed to the sky and warned me that I should never tell a lie, as there is a God up there watching over me. Both God and the skies lit a spark of restless curiosity and a sense of mystery within me.

I grew up learning to spot the constellations and memorizing their names, along with my siblings, using the big books from my dad's library. Many of my memories are somehow linked to the skies. I often find myself gazing into the night sky, and I am amazed at the vastness of the universe. Just imagine this: There are more than 100

billion galaxies, each of which contains 100 billion stars! Grappling with the idea of billions of galaxies still amazes me. If you ever travel through the atmosphere as far as 100 kilometers (or 60 miles) above the surface of the earth, you will have found yourself in space. Why does space trigger so much curiosity? Probably because space doesn't seem to have an edge and it is the closest thing that we can associate with the infinite. It's no wonder we spend billions of dollars every year on space exploration. After the first walk on the moon, we sent the first space shuttle into space in the 1970s. That was followed by the first space station that sits in space, where it produces hundreds of kilowatts of power and two to four astronauts are in it at any one time. From Yuri Gagarin, in April 1961, until today, about 550 people have traveled into space.

On 14th February (Valentine's Day) 1990, the Voyager 1 spacecraft found itself 40 astronomical units (150 million kilometers) away from the sun, even beyond Neptune. From beyond our solar system, it looked back and provided images of our planet from further away than ever before. The earth looked like a "pale blue dot." This picture still inspires wonder in the viewer. Carl Sagan, a member of the Voyager imaging team, writes, "That's here. That's home. That's us. On it everyone you love, everyone you know, everyone you ever heard of, every human being who ever was, lived out their lives."[1] When we see how minute we are in contrast to the vastness of the entire universe, we cannot help but be humbled. Our thinking that we are the center of the universe becomes ludicrous.

When a group of astrophysicists attempted the impossible, to calculate the span of the universe, they discovered that the visible universe seems to stretch out at least 24 gigaparsecs in all directions. That's a radius of 78 billion light-years (1 parsec is a distance of 3.26 light-years). A beam of light can go around the earth seven times in one second. But, even though light travels so fast (186,000 miles per second), it takes about 100,000 years to traverse from one end of our Milky Way galaxy to the other. Now try to wrap your mind around how vast our universe is. This immensity explains why, on the way home on the Apollo 11, Neil Armstrong said, "It suddenly struck me

1 Sagan, *Pale Blue Dot*, 12.

that that tiny pea, pretty and blue, was the Earth. I put up my thumb and shut one eye, and my thumb blotted out the planet Earth. I didn't feel like a giant. I felt very, very small."[2]

The vastness of the universe fascinated me and instilled a feeling of transcendence—that there is more to the universe than meets the eye and drove me to physics and also to other branches of science, to explore the big and deep question about the nature of the universe and its origin: How did this whole universe come into being? Over time, I found that this question of origin has enchanted not only me but also many philosophers and scientists over many centuries. This is because a well-grounded understanding of this key question of origin—where did this entire universe come from? How did life emerge?—will help in exploring the other most profound and eternally significant issues: What is the meaning of life? And where do we go when we die?

THE HISTORY OF IDEAS ABOUT THE COSMOS

From ancient times, the skies were, for the longest time, regarded as the locus of divinity and were a source of fascination. The early travelers and sailors used the sun by day and the stars and moon by night to find their way. In today's postmodern culture of smartphones and GPS, knowledge of the constellations is rare, but in the ancient past, it was a necessity for survival. With the birth of philosophy around 600 BC, new lines of thought emerged in the Eastern Mediterranean, in the field of astronomy—a departure from the myths and whims of gods to various models of a starry spherical universe. This era saw extensive developments in mathematics (Euclid and Pythagoras), physics (Archimedes) and, mostly, the birth of universities to promote research and to investigate ideas (Socrates' and Plato's Academy). Through his electrifying writing, Plato powerfully explained his understanding of celestial matters by the *Allegory of the Cave*.[3] Speaking through Socrates, he says that we, like prisoners in a cave, can only see shadows of the appearances of real objects. To grasp the real fundamental nature of what is causing them, we need to free ourselves from our chains and leave the cave. While Plato considered events in the world to be just

2 McRae, "Neil Armstrong," *ASME*, July 2012.

3 Plato, *The Allegory of the Cave*, VII.

shadows cast by forms behind them, his famous student Aristotle appealed to observation or empiricism. Aristotle said that heavenly bodies were made of something different from the bodies which are on earth.[4] He believed in the geocentric universe, later described in more detail by Claudius Ptolemy, where the universe is spherical and finite, centered on circular earth—an idea which was still the most widely accepted during the early Middle Ages.

During the sixteenth century, a radical shift in the human perception of reality took place, and there was a departure from the existing geocentric model to a heliocentric model that depicted the sun as the center, with the earth and other planets revolving around it. Nicholas Copernicus, Tycho Brahe and Johannes Kepler were the three main men behind this shift in thinking, now known as "the Copernican Revolution." Copernicus, a priest, argued that the planets moved in concentric circles around the sun and that the earth, in addition to rotating about the sun, also rotated on its own axis and the apparent motion of the stars and planets was due to this combination. The publication of his book, *de revolutionibus orbium coelestium* (On the Revolutions of the Celestial Spheres), just before his death in 1543, triggered the Copernican Revolution and made a profound contribution to the development of science.

In 1609, Galileo built his first telescope and, from the mountains, made observations of the craters on the moon, of Jupiter's moons and of the stars, and these confirmed Copernicus' model of a heliocentric Solar System. In 1632, Galileo published his book Dialogue, in which he claimed that the Earth moves around the Sun. Because of the prevailing view of Geocentricity, he was put under house arrest. However, Heilbron in his book *The Sun in the Church* provides a magnificent correction to oversimplified accounts of the hostility between science and religion. He writes about the four Catholic churches that housed instruments which threw light on the disputed geometry of the solar system, serving as the best solar observatories in the world between 1650 and 1750.

This revolution started by Copernicus, Kepler, and Galileo, and

4 Aristotle, *On the Heavens*.

allowed us to understand why planets move as they do was finally completed by Sir Isaac Newton. As a pioneer in the development of calculus, he was one of the greatest mathematicians and one of the most influential scientists who ever lived. He offered ground-breaking, mathematical approaches and developed a mechanical view of the operations of nature in his *Principia Mathematica*. This describes the structure of the physical universe as operating according to particular, universal principles. The principles which describe the motion of objects on earth can also be shown to govern the movement of planets. The same gravitational force which attracted the apple to the earth could, in Newton's view, operate between the sun and the planets. His three laws of motion established the general principles relating to terrestrial motion, and they could be applied to celestial motion as well. A hundred years after Newton, Pierre-Simon Laplace, a French mathematician, derived from Newton's mechanics a closed, deterministic view of the world. This strict deterministic concept suggests that, if someone knew all the relevant facts about the state of a system at a particular time, the future of that system could be correctly predicted by intelligence, ruling out any possibility of external influence.

Beginning on the cusp of the twentieth century, the most profound shift in our understanding of the Cosmos occurred. On 15th November 1915, Albert Einstein used his imagination rather than mathematics to come up with his most famous and elegant equation that rules the universe, transforming our understanding of space and time—the general theory of relativity (GR). GR states that in space-time distortion of the geometry of the cosmos by massive objects produces the effect called gravity in the same way that a heavy sleeper distorts the geometry of a sagging mattress on which he sleeps. This makes all objects, from light beams (light gets bent around clusters of galaxies) to pebbles, to follow curved paths through space. Before this, Isaac Newton and other scientists thought that all matter strutted and paraded on the stage called space-time, but Einstein showed that it is no longer a static stage, that stage of space-time itself—dances folding and wrapping, stretching and growing or collapsing in response to the actors of energy and mass. "Spacetime grips mass, telling it how

to move; and mass grips spacetime, telling it how to curve."[5] It is mind-boggling to know that space-time wraps itself around a star and disappears into a black hole. Because Einstein unveiled such a theory, that transformed our understanding of the cosmos, he secured a place for himself as one of the topmost scientific minds—causing Dr. Thomas Harvey to run off with Einstein's brain after its autopsy, because he believed that it had unusual brain anatomy.

But where does this fabric of space-time come from? To address this question of the origin of space-time, we need another theory that could explain the microscopic world and this theory is called Quantum Theory. General Relativity explains the universe in terms of things that are large and heavy, by focusing on gravity. In contrast, Quantum Mechanics explains how things happen at small, sub-atomic scales, by focusing on the other fundamental forces. Although classical physics expected to calculate what actually happens, quantum theory can only calculate the relative probability of various things that might happen. The Heisenberg Uncertainty Principle states that probabilities are intrinsic to physics. This was a death knell to determinism and also to naturalism. The deterministic view posited by classical Newtonian science dissolved into sets of probability waves in Hilbert space entangled particles and multi-dimensional, curved space-time.

> *the primary qualities of the physical world are mysterious—reality is veiled*

The theories of relativity and quantum mechanics revealed that the primary qualities of the physical world are mysterious—reality is veiled and all we can know is how things appear when we observe them. Immanuel Kant calls this "transcendental idealism." Many of the phenomena at the quantum level, like quantum entanglement and the double slit experiment, are awe-inspiring, suggesting that we are very akin to Plato's prisoners in the cave and still require a much deeper insight into the underlying ultimate reality.

5 Wheeler, *A Journey into Gravity,* 275.

THE MYSTERIES OF THE UNIVERSE

In this age of cosmology, astronomers are probing the forces that shaped our universe with new generations of giant telescopes on land and specialized instruments in space, like the Hubble Space Telescope. Hubble has completed its 27 years in space and is still sending back beautiful and revealing images, bringing the beauty of the cosmos into our lives. Such telescopes are documenting the behavior of the cosmos on the largest of scales, going back to the first moments of its existence and charting its evolution hundreds of billions of years into the future.

In this way, many discoveries became possible, such as the accelerating expansion of the universe, the dark energy, extra-solar planets, and white dwarf stars. These discoveries point to the enduring mystery of science and the many cosmic puzzles that accompany our greatest scientific advances. What started the Big Bang? How did the inflation come to an end? What is the mystery behind the dark energy that we assume is the reason for speeding up the expansion of the universe? These mysteries still remain unsolved because, at present, there is no scientific theory to explain the beginning condition of the universe. All attempts to reconcile General Relativity, that explains the macro world, and Quantum Physics, that explains the micro world, have failed.

Another mysterious occurrence, that doesn't have an agreed explanation, is the design of the universe, which seems to be finely tuned. Cosmology is producing more and more evidence that our universe is based upon numerous parameters that must be extremely fine-tuned for life to exist. If the strength of any of the four fundamental forces had varied only slightly, the universe might have flown apart and dissipated moments after it was born. The position of our solar system, between the two spiral arms of Milky Way galaxy, the mass of the sun, and the mass and position of the earth are such that life can spawn on our planet. Was the basic layout of physical laws a coincidence? Why are the makeup of the universe and the laws that govern its working fine-tuned to an amazing degree? This fine-tuning of the initial conditions appears to conflict with the idea suggested by some scientists that the universe is not purposeful, but simply random.

There are several mysteries surrounding the origin and variety of life. Even after many decades of intense research, the origin of the first biological organism—the spontaneous generation of life—still remains a mystery. Even after unearthing so many fossils, the evidence is not enough to explain how different species arose. The beautiful complexity of DNA, the double helix structure which provides the blueprint of an individual, is another mystery. Our understanding of biology and genetics is not able to answer how a complex system like our eye might have come into existence. Also, the mystery shrouding the emergence of intelligence and morality in human beings appears unfathomable.

THE BOUNDARIES OF SCIENTIFIC TRUTH

The profound mysteries of life and cosmos still remain, despite great scientific progress in the disciplines of cosmology, archaeology, anthropology, biology, and geology, which helps us to probe deeply into the past. Although the rapid pace of scientific advancement provides a powerful way of searching for truth regarding the question of origin, it also brings many uncertainties. This is because scientific knowledge is only a collection of verified explanations about objective reality that are based on predicted and observed phenomena and so, as the quality of our observations increases with technological advances, our knowledge also changes. Thus, scientific ideas are constantly being revised and, in that process, what was previously considered scientific truths have sometimes turned out to be scientific half-truths or even falsehood. For example, according to Newton, the events and contents of the universe do not affect time, but, according to Einstein, velocity, gravity, and even location do affect time—a radically different picture. Though the laws of physics are the same from the beginning, with the advent of quantum physics—it looked as though we had discovered something novel. It was the limit of scientific knowledge that made us assume that nature was deterministic earlier and probabilistic now, shifting between two opposing and distinct classes of principles and beliefs. In this way, as scientific method tests evidence, some theories are disproved so that our understanding can be improved. Indeed, every theory or law will have conditions in which it is valid and outside of which it may not be. For example, Maxwell's electromagnetic theory is valid for macroscopic scales but fails when applied at subatomic scales.

Similarly, Ohm's law is valid for most materials, but not for semiconductors. For a particle physicist or an electromagnetic student, the evidence to prove that a subatomic particle or microwave exists generally has to be indirect. The evidence for belief in black holes or microwaves is not based on whether one can see or feel, but on the way, scientists have reached a consensus on these subjects, and the combined evidence in favor of them is strong.

Sharp controversy often exists among scientists over many of the fundamental ideas at the very core of the scientific method—one famous example being the Einstein-Bohr debate. Full confidence in the accuracy and completeness of a scientific theory is never possible. Far from providing a finished product, science is a work in progress. David Hume's work on empiricism led him to the understanding that scientific 'truth' is not absolute truth nor can it be proven by empirical observations.[6] Kurt Gödel's first incompleteness theorem says that even mathematical systems are incomplete and can contain contradictions and inconsistency, so it becomes difficult to validate the empirical observations of scientists using mathematics.[7]

"Based, then, on the work of both Hume and Godel, the conclusion is inescapable that absolute truth cannot be confined within the bounds of logical (inductive) or mathematical (probabilistic) systems. At best, all that can be done with induction or mathematics is to apprehend a part of the larger truth that is out there; the systems being used are simply not robust enough to capture the entirety of this truth."[8]

A scientist may claim and aim for objectivity in their collection and interpretation of data, but their approach and, therefore, its outcome is never completely free of the subjective influences on their thinking and philosophical orientation. This is very much true when trying to reconstruct the past. Astronomers, looking out into space, and biologists, looking back at the emergence of the first life, are very much like historians; they are trying to construct historical accounts of one-time events that happened in the past using the fragmentary evidence that

6 Hume, Treatise of Human nature.

7 Gödel, "Some mathematical results," 1930b, 1931, and 1931a.

8 Brush, *The Limitations of Scientific Truth*, 71.

is available in the present. When scientists attempt to describe the past, they are subject to cultural constraints and limitations in the same way as historians, who describe the past. Their reconstructions of the past may easily be distorted by the cultural biases, fears, and expectations of the present. Brush says, "Our senses are governed by our minds, and too often we see what we want to see, hear what we want to hear. Once again, facts do not speak for themselves; they must be interpreted!"[9]

Indeed, two scientists who are examining the same evidence can arrive at radically opposite conclusions. For example, Francis Collins, looking at DNA, says that it gives him a glimpse of God's mind, whereas Richard Dawkins calls it selfish. Both the scientists are looking at the same object and arriving at totally different conclusions. Science is certainly one approach to understanding our world, but what are its limits, and is it the only way?

"Francis Collins, looking at DNA, says that it gives him a glimpse of God's mind, whereas Richard Dawkins calls it selfish."

In February 2002, Donald Rumsfeld, the US defense secretary was awarded the Plain English Campaign's premier *Foot In Mouth* trophy by Britain's Plain English Campaign, for his most baffling comment: "as we know, there are known knowns; there are things we know we know. We also know there are known unknowns; that is to say, we know there are some things we do not know. But there are also unknown unknowns—the ones we don't know we don't know."[10] Some of the mysteries associated with our origin are so huge that our search may only end up identifying "known unknowns"—things that, due to our limitations, we do not know, but where we can tell that there is a gap in our knowledge. A "known unknown" might be something for which we have only certain clues so that we would need more information to see the whole picture. Alternatively, it might be something for which we have inexhaustible information, so much that its complexity is beyond our comprehension.

9 Brush, *The Limitations*, 248.

10 Remarks at a NATO press briefing, 2002.

Concerning the question of the origin of the universe and life, there can also be "unknown unknowns"—things we do not even realize that we do not know them. For example, there is a severe spatial limitation in the knowledge of the physical universe; scientific knowledge is confined only to a region of the universe that is observable. Beyond that radius, countless galaxies may reside, but they will be beyond our visible range as they are receding from us faster than the speed of light, towards the edge of the universe.

Most of the time, while describing a reality, certainty is replaced by uncertainty in quantum mechanics. Brush says that "Quantum theory takes away the certainty that scientists cannot hope to discover the "real" world in infinite detail, not because there is any limit to their intellectual ingenuity or technical expertise, nor even because there are laws of physics preventing the attainment of perfect knowledge. The basis of the quantum theory is more revolutionary yet: it asserts that perfect objective knowledge of the world cannot be had because there is no objective world."[11] Bernard d'Espagnat, the theoretical physicist who won the Templeton Prize in 2009, says that the world we perceive is merely a shadow of the ultimate reality because the reality revealed by science offers only a "veiled" view of an underlying reality that science cannot access.[12] He argues that underlying empirical reality is a mysterious, non-conceptualisable "ultimate reality," not embedded in space and (presumably) not in time either and such an objective reality is forever veiled from human knowledge.

THE INVESTIGATION: IN SEARCH OF TRUTH

If science ends up with many such "known unknowns" and also "unknown unknowns," how can we find a credible answer to the profound questions about origins such as: How did the universe come into existence? Was the basic layout of physical laws a coincidence? Is life a fluke or a lucky roll of cosmic dice? Are we a cosmic mistake? Is the Universe somehow fine-tuned to allow life to arise and flourish throughout the cosmos? Did time itself have a beginning, or was our beginning somewhere in the middle of an infinite quantity of time?

11 Brush, *The Limitations*, 48.

12 "Science Cannot Fully," *Science Magazine*, Mar. 2009.

How do you explain the rise of complex, intelligent life? What does it all add up to? Can we know the truth behind our origins through science alone? Is there a supernatural Designer behind all that exists? Does this imply that the universe is imbued with purpose? These questions have been intriguing me for years. Arthur L. Schawlow (Professor of Physics at Stanford University, 1981 Nobel Prize in physics): "It seems to me that when confronted with the marvels of life and the universe, one must ask why and not just how."[13] The why question became my major pursuit and encouraged me to investigate this question of origin.

> *Is life a fluke or a lucky roll of cosmic dice? Are we a cosmic mistake?*

In this pursuit, I found that there are many unsolved mysteries in the scientific understanding of our origin and this is not only because of the many "known unknowns" encountered in the search for truth but also due to the many "unknown unknowns" that might take us by surprise as we learn more. Can these mysteries ever be unlocked, or will they remain a mystery forever? Can science alone give a credible answer to my question of origin, or is there more, beyond the reach of science, such as a super intelligence responsible for this mystery? With this objective of an unrelenting quest for truth, I tried to gather all available evidence to find out what happened before humanity even existed.

I have been searching for answers, devouring articles on cosmology, geology, biology, archaeology and every other –ology that could give me information on this subject. I have been journeying along with astronomers and galaxy hunters, peering through their telescopes using my mind and imagination, to find the missing pieces of the cosmic puzzles, as I toured through the strange reaches of the galaxies. Like the stargazers, I spent time looking up and examining billions and billions of galaxies and was enthralled at the serene beauty of the star-studded skies. Like a curious child, I was immersed in a gauzy haze of adventure, and my mind often came to a standstill, as I stood in awe and wonder at the beauty of the cosmos. In this book, I aim to present

13 Margenau and Varghese, *Cosmos, Bios, Theos*, 105.

what I have discovered in an intellectually satisfying manner, though the complete truth cannot be grasped or presented exhaustively. I have aimed to avoid exaggerated claims or unfounded criticisms, but rather to sort out fact from fancy, as we grapple together in finding the right pieces of evidence.

One answer to the question "Where did we come from?" is based on the idea that there is a Divine Architect who has created a finely tuned universe that is imbued with purpose and functions in a consistent manner expressive of the character and the wisdom of its designer. The other answer to the question of origin, which is often assumed, is random chance. If random chance is the answer, and if life arose by random chance and natural processes, life could just as easily be extinguished in the same way. Chuck Colson says, "Our choices are shaped by what we believe is real and true, right and wrong, good and beautiful. Our choices are shaped by our worldview."[14] Since people can interpret the same evidence in diverse ways, it is vital to choose the right worldview, as our worldview colors the way we see almost everything around us.

Many intellectuals end up in the middle ground of open possibilities. If you are reading this book with such a stand, then please be sure that, though the possibilities are innumerable, the cumulative evidence presented in this book will help your ideas converge. Though one could spend a whole life gathering different ideas, enjoying the uncertainty and ambiguity and reveling in possibility, it is surely necessary at some point to narrow down those possibilities and confront reality. Mankind has for ages been seeking a credible answer to that one profound question of origin because it is on this that the meaning of this life and the possibility of eternal life depends.

While on the way to unlocking profound mysteries about our universe, I was caught in awe and wonder, on how little I know and on how much there remains to be learned. The dim haze of mystery shrouding the marvels of the natural world around me added enchantment to my pursuit of truth. I hope this book captures you with the same sense of wonder and awe.

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14 Colson and Pearcey, *How Now Shall We Live*, 13.