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## Parallel Universes

*Most sets of values would give rise to universes that, although they might be very beautiful, would contain no one able to wonder at that beauty.*

– Stephen Hawking (1996)

Perhaps one of the most exciting – and unsettling – concepts in modern cosmology is the theory that we inhabit a parallel universe. Although this idea is widely used in the popular science media, the idea is not just in the realm of fiction any more. However, the extent to which it has proliferated often makes it seem like science fiction.

The proponents of parallel universes believe that there are vibrations of different universes everywhere. Probably, we are missing that subtle message, as we're just not in tune with the vibrations. There are possibly other parallel universes in our own living rooms. "The many worlds represent reality," wrote Michio Kaku, professor of theoretical physics at New York University and author of *Parallel Worlds: A Journey through Creation, Higher Dimensions, and the Future of the Cosmos* (2005).

Physicists hypothesize several levels of parallel universes. Some even envision an infinite number of parallel universes. Could there be people with your own memories and appearance? If we accept the idea of infinite universes, then there must be an outcome of every possible choice that we can't even imagine.

The scientific history of parallel universes begins with a doctoral thesis by Hugh M. Everett (UCISpace @ the Libraries 1973). Everett started his graduate work with John Archibald Wheeler at Princeton University in New Jersey. Applying the ideas of quantum mechanics, Everett made an outlandish conclusion even for today's standards. In his paper "The Theory of the Universal Wave Function," Everett argued that the universe is describable, in theory, by an objectively existing universal wave function. According to him a new universe is created every time we make an observation, and the wave function corresponding to each event does not collapse but gives rise to each independent reality.



**Figure 2.1.** Parallel universes. Are they a figment of the imagination or just unknown physical structures? (Image Credit: Wikimedia Commons)

This reality that he described is not the reality we customarily think of, but is a reality composed of many worlds.

The consequences Everett's assertions were staggering. And many physicists remain uneasy with it even today. To accept the notion that *everything that is possible can happen* is not an easy pill to swallow. Some researchers suggested that the way to achieve reconciliation is to drop the single universe view and to relate the multiplicity of frame representations of physics and mathematics to the many different physical universes viewed in physics (Benioff 2009). As we know, such opinions are still debated without any definite conclusion.

Though Everett's many worlds interpretation gained some popularity later on, for various reasons it fell apart. Additionally, Everett did not continue his work in theoretical physics, as he wasn't excited about working in academia, rather choosing a new career with military work. He died in 1982 at the age of 51.

## PARALLEL UNIVERSES IN HINDU MYTHOLOGY

The concept of parallel universes may be novel and disconcerting to scientists, but it rests very comfortably within ancient Hindu cosmology. The *Puranas*,<sup>1</sup> Hindu religious texts thought to date back to between 500 and 1500 B.C., are replete with descriptions of many worlds whose inhabitants are ruled by kings in the human plane and Gods in a higher plane.

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<sup>1</sup> The Puranas are a class of literary texts all written in Sanskrit verses.

The many Gods, in turn, belong to many different worlds and planes of existence. At the highest level of the hierarchy is the trinity, namely, Brahma, Vishnu,<sup>2</sup> and Shiva,<sup>3</sup> ruling the divine kingdoms. Brahma is the creator, who dreams the universe into being, which is maintained by Vishnu. What humans perceive as reality is in fact the dream of Brahma, misled by matter. Brahman<sup>4</sup> (not to be confused with Brahma) is the base of all reality and existence. Brahman is uncreated, external, infinite, and all-embracing. It is the ultimate cause and goal of all that exists. All beings emanate from Brahman; all beings return back to the same source. Brahman is in all things, and it is the true self (atman<sup>5</sup>) of all beings.

Well, the above mentioned themes coupled with myriad stories and an array of metaphors seem to be nothing more than the mythological stories widespread across the different cultures of the world. Yet, the metaphysical connotation of this idea and the cosmic formation in Hindu philosophy warrants some attention here, though this is not intended to infer any scientific conclusions.

In Hindu philosophy, the physical universe is a dream and it has only the kind of reality that a dream has. It is in a state of unceasing evolution, where names and forms arise and die out, but the true self remains unchanged. These material worlds float around while the cycles of creation and destruction continue endlessly. The ultimate reality is the Absolute (*brahman*), which transcends and includes everything and has been sought about extensively by some well-known physicists such as Erwin Schrodinger, Werner Heisenberg, and Niels Bohr. However, such interest in Oriental wisdom on the part of physicists has often been taken as an indication that the world view derived from physics is somehow deeply connected with that of eastern religions (Duquette 2011).

We have to maintain a clear distinction between mysticism and modern science. Exploring the subtlety of the universe or knowing the unknown seems to be the central theme of such writings. It should be clearly stated here that most physicists, even those who expressed an interest in Vedanta thoughts, consider that it is inappropriate to establish any solid conclusions by equating the insights from physics with mystical and religious ideas. Still, many physicists share a general view that ultimate reality cannot be known through direct experience such as personal or laboratory measurements. In fact, many physicists, while dealing with an entirely new world opened up by quantum theory and relativity, were often stranded in their effort to explain the experiments and observations.

In his book *Quantum Questions: Mystical Writings of the World's Great Physicists*, Ken Wilber (2001) remarked it is “the radical failure of [the “new”] physics, and not its supposed similarities to mysticism, that paradoxically led so many physicists to a mystical view of the world”. Some even abandoned the pure scientific view to embrace the mysticism and philosophy, perhaps, as a last solace.

Among the many universes envisioned by physicists, one could exist in extra dimensions and might be physically very close to us. As creatures of a three-dimensional world,

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<sup>2</sup> Vishnu is the second God in the Hindu triumvirate (or *Trimurti*). The triumvirate consists of three Gods who are responsible for the creation, upkeep and destruction of the world. The other two Gods are [Brahma](#) and [Shiva](#).

<sup>3</sup> The role of Shiva is to destroy the universe in order to recreate it.

<sup>4</sup> In Hinduism Brahman is the ultimate reality, the power that makes the cosmos function.

<sup>5</sup> An individual soul or self. The ultimate goal in Hinduism is to achieve moksha through the realization that one's Atman and [Brahman](#) are the same thing.

we may not perceive it. But scientists hope that these universes might drop some clues to help us identify them, like ripples in a pond help us locate the actual disturbance. Modern scientific theories of creation and the world of particle physics help us develop a picture of our cosmos, which might be just one of many possible universes, provided the many-world interpretation will survive in coming years.

Since the mystical connotations have been of interest to many physicists, it's appropriate to discuss bit about the interest of Hindu Gods in Western culture.

## **WHY ARE HINDU GODS CELEBRATED IN THE WEST?**

One of my fellow faculty members has a Ganesha deity on his table, which he had collected from India during a trip several years ago. Ganesha sits there displaying a deep sense of tranquility close to a computer in all his majesty and mystery in an American office setting. Another of my colleagues, who is an expert in world mythology, named her lovely daughter Kali, after the fearful and ferocious Hindu Goddess. In both cases, they ended up telling me that they simply liked the object and the name and gracefully skipped the religious and philosophical implications one could attach to these. But that made me wonder why Hindu Gods and Goddesses are getting so much attention in Western culture, though many of them are still unaware of it. Is it simply the curiosity that drives such affinity?

We all know that planets are named after Greek or Roman Gods. This is explicable given the Greek connection to early astronomy and the European inheritance of the ancient knowledge gained by Greeks. But often the names simply deceive. For example, the planet Venus is named after the Goddess of beauty, though now we know that the so-called beautiful planet's atmosphere is full of carbon dioxide with a floating mist of sulfuric acid that can corrode any flesh. What a strange beauty!!! Of course, beauty can be deceiving and dangerous. Obviously, ancient notions about planets and stars were skewed, though they laid the foundation of modern astronomy.

Sanskrit and Indian philosophy always had a broad appeal to philosophers and scientists. From Niles Bohr to Robert Oppenheimer, many scientists had a deep interest in the Vedas and Upanishads. Oppenheimer's remark from the *Bhagavad Gita*, "Now, I am become Death, the destroyer of worlds," has been widely written about; it came to his mind after Oppenheimer observed the first experimental detonation of an atomic bomb in the New Mexico desert.

Furthermore, the Hindu Gods easily blend into the human psyche. Many of them engaged in activities that we are used to. They, like us, loved, hated, killed and procreated. They enlightened their followers with words and deeds and explained material success and failure to the devotees, making it easier for them to overcome the delusion of both.

Another reason is the association Hindu Gods have with deeper philosophical nuance and its linkage to science. Theoretical physicist Fritjof Capra's *The Tao of Physics* is an international bestseller that explores and relates the depiction of the Nataraja posture with the continuous creation and destruction of particles and their different manifestations in the universe.

The strongest symbolic acknowledgment of this work is reflected in the Nataraja statue outside CERN, the European Organization for Nuclear Research, which has built

the world's largest particle accelerator, the Large Hadron Collider (LHC), on the France-Switzerland border. The Indian government gifted a 6 ft Nataraja statue to CERN in 2004. It portrays Shiva's dance of creation and destruction, much like the dance of fundamental particles that generates and destroys matter and energy in the universe in various forms.

A plaque next to the Shiva statue captures the contemporary connotation of the metaphor of Shiva's cosmic dance from Capra's book: "Modern physics has shown that the rhythm of creation and destruction is not only manifest in the turn of the seasons and in the birth and death of all living creatures, but is also the very essence of inorganic matter and for the modern physicists. Then, Shiva's dance is the dance of subatomic matter. The metaphor of the cosmic dance thus unifies ancient mythology, religious art and modern physics."

It is ironic that, partly driven by capitalist market forces, the customer service representatives working for U. S. companies from their outsourced locations fake their name to better suit the English audiences, while many in the West find traditional Hindu names more and more attractive. There is little reason to resent this, as even Gods are subjected to the laws of nature for their survival.

Again, I learned that my colleague who is expecting soon will name her daughter Maya, the ultimate illusion. And, if anyone seeks a boy's name, a clear choice is Vishnu, another name that is vanishing from the Indian demographic landscape as virtual Bobs and Joes flourish and survive along with Pepsi and McDonald's. We cannot foresee how future generations will perceive the world. They might not be interested in any illusion, as in years from now they may have transformed into beings without any name and desire to know anything. Then the great Maya will dissolve in Brahman.

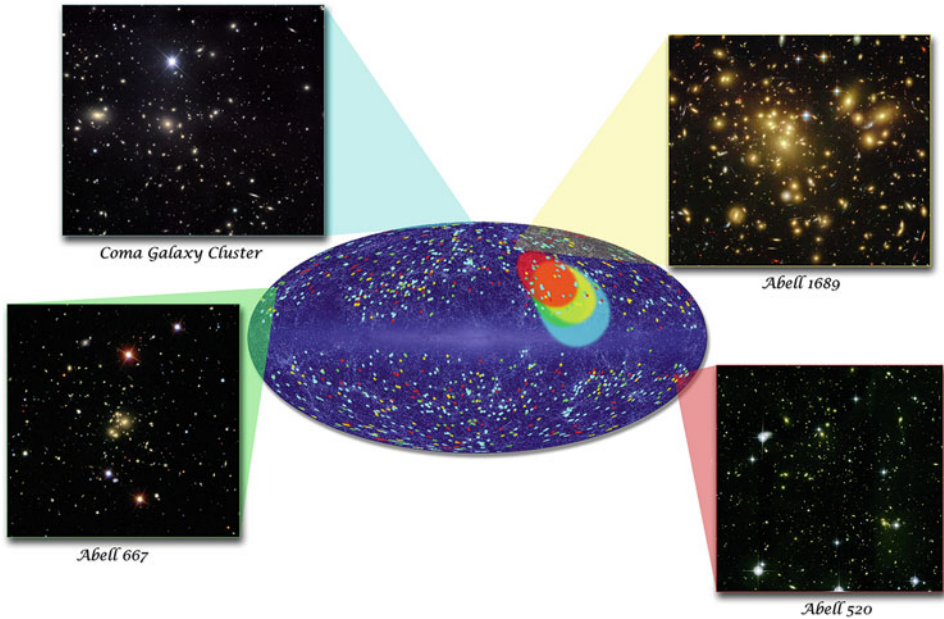
## OBSERVATIONAL EVIDENCE

The only observational evidence, purportedly, in support of parallel universes has come from the aforementioned NASA's Wilkinson Microwave Anisotropy Probe (WMAP). While analyzing the cosmic microwave background (CMB) radiation data, scientists discovered evidence of a huge void spanning almost 1 billion light-years (1 light-year<sup>6</sup> is approximately 10 trillion km). The void in the infant universe represents the absence of any material, which otherwise should have become stars and planets. None of the current cosmological theories can explain such huge voids in the data. Some physicists interpret this as the unmistakable imprint of another universe beyond the edge of our own. Physicist Mersini-Houghton proposed a model of entangled universes, under which they predict two huge voids, not just one (Frankel 2011). One of them has been found by WMAP data, and new data is expected to reveal a second similar void. The recently launched Planck satellite by the European Space Agency, whose exceedingly sensitive detectors measure CMB radiation and which captured its first image recently, may be able to ascertain this second void.

Even if everyone agrees these features are caused by shadow universes, we still could not deduce anything about them aside from their ghostly thumbprint.

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<sup>6</sup> A light-year is a unit of distance. It is the distance that light can travel in one year. Light moves at a velocity of about 300,000 kilometers (km) each second. So in one year, it can travel about 10 trillion km. More precisely, one light-year is equal to 9,500,000,000,000 km.



**Figure 2.2.** The effect of multiverse. The colored dots are clusters within one of four distance ranges, with *redder colors* indicating greater distance. Colored ellipses show the direction of bulk motion for the clusters of the corresponding color. Images of representative galaxy clusters in each distance slice are also shown (Image credit: NASA/Goddard/A. Kashlinsky et al.).

## COSMIC PARALLELS?

Whether Vedic cosmology, as some suggest, has scores of other eerie parallels with some of the most cutting-edge recent cosmological theories of multiverse, oscillating universe, and the Big Bang, so it should come as no surprise that some of the greatest minds in science have turned to these 3,500-year-old cosmological ideas for inspiration and questions about our enigmatic universe. Some physicists have shown deep interest in philosophical aspects of Upanishads.<sup>7</sup>

Striking as these similarities are, it does not mean that modern science has vindicated Vedic cosmology. For one, these modern cosmological theories may themselves be disproved and, besides, many physicists remain skeptical of these theories. Some cosmologists, for instance, question the whole notion of multiverse. According to them, if the universe encompasses everything we know or ever want to know, it rules out any room for parallel universes. Some other models suggest that universes are finite in number and restricted by mathematical formulations.

<sup>7</sup>The latest of the writings to be considered part of the Vedic period, written between the eighth and third centuries BCE. These are collections of stories, discussions, and instructions addressing issues of the relationship between the human and the ultimate realms.

Even so, the idea that all structures that exist mathematically also exist physically is the foundation of the parallel universe concept. This hypothesis, known as the ultimate ensemble, predicts the existence of all universes that can be defined by mathematical equations. But many physicists disagree on the grounds that not all mathematical structures are well defined.

Nevertheless, the concept of many worlds or parallel universes, which would have invited the ridicule of mainstream physicists, as it did when it was first proposed more than half a century ago (1957) by American physicist Hugh Everett, is currently one of the hottest trends in theoretical physics. The multiverse theory is the inevitable result of quantum mechanics, which represents a set of multiple probable states for a particle. When an observation is made, the particle chooses one of the multiple states measured by the observer, and the other states collapse. This is the most basic principle behind the existence of many universes, or multiverses.

Quantum physics, the study of the minutest particles that make up matter, has been remarkably successful, but it reveals a picture of a quantum reality so strange that our minds are unable to grasp it. For instance, quantum mechanical experiments have proved that objective reality is unlikely to have a separate existence. The nature of the ultimate reality is intertwined with our actions, and uncertainty rules when we observe it. This is contrary to our common sense view that reality has an existence independent of the observer. In the realm of the smallest particles, however, objective reality is not an absolute entity that can definitely be measured, as is true in classical physics.

Erwin Schrodinger, a leading theorist in quantum mechanics, who had a lifelong interest in philosophy, wrote (2012): “From all we have learnt about the structure of living matter, we must be prepared to find it working in a manner that cannot be reduced to the ordinary laws of physics. And that not on the ground that there is any ‘new force’ or what not, directing the behavior of the single atoms within a living organism, but because the construction is different from anything we have yet tested in the physical laboratory.”

This is not very far removed from the concept of Brahman – the self-existent, immanent, and transcendent supreme and ultimate reality. Brahman is the fundamental divine cause of everything in and beyond the universe. The nature of Brahman is explained as personal and impersonal, and it is the source of the creation of the universe and Gods. The universe and all the objects in it are the manifestation of a fundamental reality, which we don’t know yet. We understand the universe as an exchange of matter and energy, and scientists often disagree about the fundamental building blocks of these phenomena.

The absence of objective reality implies that the material world could be an illusion – or, what Hindu sages called Maya. In Hinduism, Maya<sup>8</sup> is the natural illusion that the material world is the only reality. It is a skewed perception, albeit commonly held, to believe that the material world is the fundamental reality. Maya, which has its roots in the Upanishads, denotes the power of God to make human beings believe in an illusion. The material world is the manifestation of Brahman, the infinite and immortal reality that is responsible for matter, energy, space, time, and every being. The scriptures and philosophies seek to unveil the illusion to learn the ultimate truth. However, such descriptions are

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<sup>8</sup> Maya is the illusion or the skewed perspective with which we experience the universe.

purely philosophical in nature, definitely interesting, and our rational thought demands a transparent and logical procedure to know the ultimate truth.

Science employs its own methods and procedures toward that goal. Our universe and its subjects are creatures of spirit coated with matter that conceals the spirit from the light. Science can demonstrate its processes, is based on rationality and logic, and can be comprehended, but that is somewhat lost in the scheme of the ancient wisdom. Consider, for example, this Upanishad expression, “That which permeates all, which nothing transcends and which, like the universal space around us, fills everything completely from within and without, that Supreme non-dual Brahman –That Thou Art.”

Our interpretations of the evolution of the cosmos, once based on myths and legends, have advanced markedly in the last century. We live in a universe that is beaming with billions of galaxies that are continuously expanding. We now know that this expansion is accelerating, and we will never know what is beyond our cosmic horizon, as no light will ever reach us from the expanding universe. It is ironic that we need many universes for the existence of our own universe!

The scientific approach always assumes that fundamental reality is different from us, and we are independent observers seeking truth. But many researchers now believe that we must rethink this assumption. Our observation impacts the observed reality, because we are part of it. This essentially is the Advaita<sup>9</sup> philosophy, a cornerstone of Hinduism, which asserts that Brahman (ultimate reality) and Atman (self) are the same. Such a non-dualistic approach is advocated by many modern researchers who argue that the effect of observation either changes reality or creates new realities.

Human eyes operate using the visible light of the electromagnetic spectrum, allowing us to view only objects that emit light, which comprise only a small fraction of the universe. In modern times, telescopes augmented the unaided eye in the hunt for the unknown. Operating from ground and space, these telescopes scan the cosmos to draw pictures of material objects. Even with telescopes, we exploit the electromagnetic radiation to weave images of the cosmos. Whether it is gamma rays, X-rays, microwaves, or visible light, throughout human history we have been dependent upon different forms of light to learn of cosmic events that document our own history.

Here, let us discuss the most popular telescope of our time – the Hubble Telescope, known as the mirror on the universe.

## **THE MIRROR ON THE UNIVERSE, NOW TWENTY-TWO YEARS OLD**

While supporting Galileo in the backdrop of his conflict with the Catholic Church, a cardinal once remarked, “Bible teaches how to go to heaven, not how the heavens go.” Now, 400 years after Galileo attempted to know the heavens using his “spy glasses,” our machines can narrate the story of the heavens in much more detail.

The heavens narrate their stories in a distinct manner and allow humans to discern the mystery of creation and evolution. Up to now, humans could accomplish this only through

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<sup>9</sup> Advaita means non-dual and is a prominent school of thought in Hindu philosophy. This doctrine identifies the self (atman) with the ultimate reality (Brahman) and negates any real distinction between the individual and the entire universe.

the decoding of light. This is because light is a messenger that can convey the untold chronicles of the cosmos, which has been a great source of myths and legends ever since the beginning of humankind. For the ancients, the heavens were the citadel of Gods who visited them for various reasons and often punished them with fiery objects. The naked eye had been the only means to investigate the elements of the cosmos, and it changed forever in 1609. Galileo, the father of modern astronomy, developed a new scientific world when he used the power of the telescope to explore the heavens. He narrated the accounts of his observation in *The Starry Messenger* published in 1610.

Telescopes are often referred to as time machines, as they escort us back in time. When we peep at a star or any other object a few million light years away, we are in fact seeing that object as it existed a few million years ago. Since Galileo's first use of the telescope, scientists have been improving the power of telescopes to gaze at the unfathomable universe. Now, 400 years after the Galilean adventure, modern astronomers are on the verge of investigating the frontiers of the known universe. A variety of telescopes, operating from ground and space, aid them in this process. If the Galilean 'spy glasses' were able to reach just the backyard of our galactic neighborhood, the modern era telescopes take us closer to the moments of creation known as the Big Bang.

Among these machines is the world's most famous telescope, the Hubble Space Telescope, which turned 22 on April 24, 2012. During the last two decades of operation, it saw the birth and death of stars and captured many turbulent cosmic collisions. It granted us an exotic vision to enjoy the wonders that lie in the tempestuous cosmic ocean. Some call it "The Mirror on the Universe," while others describe it as "The Eye on the Sky." It continues to beam hundreds of images back to Earth every week.



**Figure 2.3.** There are many descriptions for the Hubble telescope, including the eye on the sky or the mirror on the universe (Image credit: NASA).

As mentioned in Chapter 1, named after the American astronomer Edwin Hubble, whose observations in the 1920s supported the theory of an expanding universe, Hubble has been in continuous action for the last two decades. Since its launch in 1990, most of its original instruments have been upgraded or replaced by service missions. Hubble, located at about 565 km above Earth's surface, approximately the size of a school bus, completes one full orbit around Earth in 97 min.

In addition to many startling discoveries, the Hubble images have become the artwork of the cosmos. The Hubble Ultra Deep Field (HUDF), completed in 2004, is an image of a small region of space created using Hubble data accumulated over a period of 4 months. In fact, some of these objects date back to the baby universe, approximately 13 billion years ago, when the galaxies were just forming from the seeds of the Big Bang. This particular image contains an estimated 10,000 galaxies in different shapes and sizes. Each of them might contain billions of stars and many possible planetary systems. Scientists were perplexed at the mere existence of such a large number of galaxies, and some even dubbed them as "Kingdoms of Heaven."

The mystery surrounding the creation and existence of the universe reaches out to us in the form of light energy. Hubble has done more than any other modern telescope to garner that energy and to paint a picture of the history of the universe for coming generations. Edwin Hubble observed and measured the departure of galaxies using a technique known as the redshift in physics. Now we know that the galaxies not only depart from each other, but their exodus is accelerated by the inexplicable dark energy.

The latest and last Hubble repair mission was conducted in May 2009, extending the life span of the telescope for another 5 years. The instruments on the telescope can observe the edges of the universe in visible light, ultraviolet and infrared ranges of the electromagnetic spectrum. HST is located at about 565 km above Earth's surface with an approximate size of a school bus. The website devoted to HST (<http://hubblesite.org>) provides every detail and discoveries of the telescope, and enable the public to track every moment of its voyage.

If our current notion of the universe is true, in the far future our own Milky Way Galaxy will be left alone in the galactic playground, with other galaxies having receded to unknown parts of the cosmos. The finite speed of light will not overcome the unlimited space that would be created among the galaxies due to the accelerating nature of their retreat. This could lead future generations to assume that their galaxy is the same as the universe. If preserved, the Hubble images will enlighten our descendants with the chronicle of that ultimate isolation.

## **HOW FAR BACK CAN WE SEE?**

We believe what we see, but astronomy has long taught us that our eyes deceive. What we see today might be the drama of the cosmos unfolded long ago. Past, present, and future lose their meaning in the vastness of the universe.

Recently, researchers and telescopes detected the most distant object in the visible universe. While we celebrate the discovery, the fact is that this particular object likely no



**Figure 2.4.** As far as NASA's Hubble space telescope can see. This view of nearly 10,000 galaxies is the deepest visible-light image of the cosmos. Called the Hubble Ultra Deep Field, this galaxy-studded view represents a "deep" core sample of the universe, cutting across billions of light-years (Courtesy of NASAimages.org-Galaxies, Galaxies everywhere).

longer exists. So, even as we wonder how far we can see to the edge of the universe, it also invites the fundamental question: Can we trust what we see?

Four hundred years after Galileo peeped into the heavens using the first telescope, human civilization set its sights on the edge of the visible universe. The gamma ray burst (GRB) named GRB 090423 (Tanvir et al. 2009) is the most remote object we have ever seen in the cosmos. There are no magic machines in the foreseeable future to lead us further.

This GRB, estimated to be 13.1 billion light-years away, is one of the brightest stellar explosions recorded. NASA's space telescope SWIFT spotted the event first in April 2009 and then scores of ground-based telescopes took over.

Astronomers use redshift as a tool for determining distances in the universe. The redshift is the wavelength or frequency shift of light as it travels. This is similar to the changes in the frequency of an ambulance siren as it passes by. We perceive the declining frequency or lower pitch of sound as it travels, even though the ambulance is producing it at the same frequency. Analysis of light from cosmic events, such as a GRB enables researchers to measure the distance and origin of such events. Light is a messenger that carries the details of its journey in its wavelength spectrum. It also means that if light does not reach us, there is no way of knowing what is out there in the farthest corners of the universe.

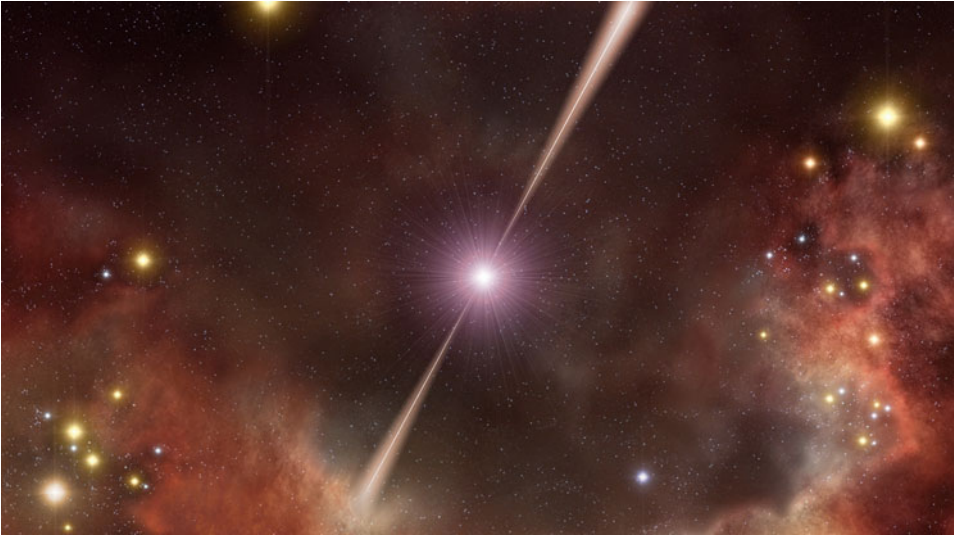
GRB 090423 is the aftermath of the explosion from one of the early stars in the universe. Since this event occurred 13.1 billion years ago and the universe is considered to be 13.7 billion years old, this first-generation star had a life span of about 630 million years – a young star by cosmic standards. It is usual for massive stars to end their life at younger ages compared to less dense stars, which survive billions of years.

When mid-sized stars, such as our Sun, finish their main sequence life, they end up as “white dwarfs,” a relatively quiet event. However, massive stars send out the message of their demise as waves after a violent death in the form of supernovae. During this process, the core of the star transforms into a highly dense neutron star, sending the outer layer of stellar masses to form a nebula.

A nebula serves as the feeding grounds for the next generation of stars. Nebulae teach us that death and birth are cyclic in the universe rather than absolute transformations. Our Solar System was once a part of a nebula created from the death of a star caused by a supernova explosion. In nature, creation-preservation-destruction are continuous cycles, without beginning or end.

A supernova explosion (more details about supernova will be discussed in Chap. 6) in the past created a nebula that in turn became the birthplace of our star, the Sun, and its planets. Scientists believe our Sun is a third-generation star. Millions of years later, organic molecules formed in one of the planets and evolved to become intelligent beings – humans. In essence, all the heavier elements, such as carbon, oxygen, and nitrogen that make up our body came from supernova explosions. The elements heavier than hydrogen were created in the interiors of stars and then expelled into space, to be integrated into later stars. As the astronomer Carl Sagan once noted, we are made of “star stuff.”

If we want to see our cosmic ancestry, nebulae are the best to place to look at. The Eagle Nebula, which is 7,000 light-years from Earth, is one of the most admired nebulae, thanks to the Hubble Telescope, which captured this nebula in all its majesty. The Eagle Nebula shows huge columns of gas and dust, light-years across, known as the Pillars of Creation. Please remember that the final illustration is not the actual color, but is closer to



**Figure 2.5.** Gamma ray bursts are so intense despite happening halfway across the universe, they sometimes can be seen briefly with the unaided eye (Image credit: ESO).

what we would see if we could see all the wavelengths of color. The picture is a combination of different images taken through different filters, and has been processed to eliminate cosmic radiation and other distractions. The pictures show that new stars are born in this stellar nursery. Astronomical calculations reveal that these pillars vanished 6,000 years ago due to a nearby supernova explosion. Yet, we will continue to see the intact pillars for another 1,000 years as the message of that destruction in the form of light that has yet to reach us. The pillars are truly an impression of the past, and they tell us that time is an illusion in which we live, along with space, and is created by the movement of objects and perceptions. In some sense, time exists because we are bound to things through our senses.

The stellar nursery, aptly named, pillars of creation with its majestic appearance teaches us not only about our cosmic history, it reveals the grand illusion unfolding in huge scales in front of our own eyes. The gravitational forces churn the cosmic material to prepare for celestial births. It is not hard to imagine that a few billion years ago, our own star, sun had a similar origin in the shadows of a nebula we could call solar nebula.

Supernova explosions are illustrious events among astrophysicists because they provide a rare opportunity for researchers to study distant parts of the cosmos. Even our most sophisticated telescopes are unable to spot a star at those distances, but a supernova outshines even its mother galaxy, providing an exceptional chance to look at it.

The stellar explosions more powerful than supernovas are known as hypernovae. These are events capable of sterilizing life in their cosmic neighborhoods. In a galaxy such as our own, the Milky Way, these events occur only rarely – once every 100,000 years. Given the billions of galaxies spanning the universe, however, it is a common event in the universe. If the supernova explosion leads to neutron stars and black holes, scientists think that hypernovae might create something more than just black holes. In the case of hypernova, the core of the star turns into a black hole, but the outer material falls back into the

core, resulting in gamma-ray bursts (GRB). The GRBs are said to be the “birth cry” of black holes from the farthest corners of the universe.

When we look at the Sun, in fact we are seeing the Sun as it existed 8 min ago – the time light takes (at a speed of 186,000 miles per second) to travel the 93 million miles between the Sun and Earth. Even if the Sun disappears in a cosmic event, we will continue to see the non-existent Sun for 8 min! We perceive the past of the Sun as our present Sun. By the same reasoning, what we are seeing of the GRB is an event that took place 13.1 billion years ago. This GRB and the resulting nebula must be long gone, but earthlings see it now as the “messenger light” from that occurrence, as it has just reached us in this corner of the Milky Way Galaxy. We are looking at this GRB today and seeing yesterday!

Under the Big Bang theory, cosmologists believe the universe has been expanding since its birth 13.7 billion years ago. When the waves originating from this hypernovae began their journey, the universe was much smaller than its current size. As the waves propagated throughout the universe, they had to travel greater distances as the departing galaxies created new space between them. The gamma rays encountered this new space as extra distance on their voyage. Thus, the successor of this event, if it exists, must be much farther than 13.1 billion light-years. Probably, we will never know about it as its distance to our galaxy has increased so much that the light or any electromagnetic radiation it emits will never reach us.

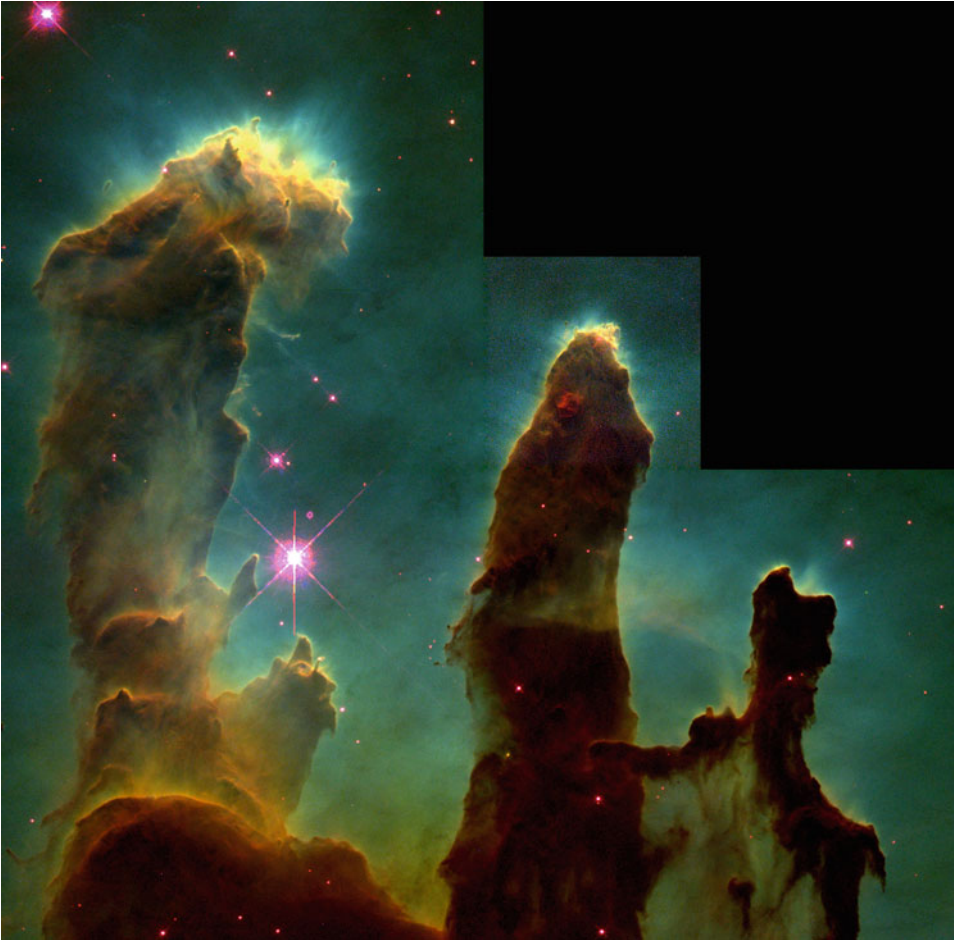
The visible universe represents the space we can conceive in the sense that radiation from there will reach us. There must be much more to explore beyond the visible universe, but we have no means of knowing. As the universe continues its expansion, eventually our Milky Way Galaxy will be left alone in the universe with all the others departed to farther reaches. In the absence of any information from other galaxies, the mortals on this galaxy might assume that their universe is their own galaxy.

So how far can we see? The puzzling answer is around 13 billion light-years. Our best telescopes can see a few million years after the origin of the universe. But we cannot see anything before the point when light did not emerge out of the baby universe. Asking the question, “How far can we see?” is actually the same as inquiring, “How far back in time can we see?” The expanding universe imposes a limit on our view, and so we will not see anything beyond 13 billion light-years ago. And when we see it, unfortunately it will not be there anymore!

The early universe was not transparent to light, which implies that we can write the history of our cosmos only up to the point when the first light began its journey, long after the creation of the universe. Additionally, the interaction of light with matter distorts the details of the information it carries. However, unlike light, gravitational waves propagate through the cosmos without reflection or refraction. That could potentially allow us to create a purer picture of the cosmos beyond the levels light allows us.

Nevertheless, it would be an incredible proposition to gather the evidence for parallel universes. We haven’t been able to know the edges of our own universe, and it may not be possible to do so as the expanding universe rewrites its own boundaries. Yet, the concept of multiverses would remain as powerful as our own universe. Carl Sagan once remarked (1980), “The universe is not required to be in perfect harmony with human ambition. The universe seems neither benign nor hostile, merely indifferent.”

As the creatures of this universe, our dreams and imaginations will pursue not just the copies of our planet but also the replicas of our own universe.



**Figure 2.6.** The pillars of creation. Stars are born (Image credit: NASA).

## REFERENCES

- Ananthaswamy, A. (2007). *Mystery of a giant void in space*. <http://www.newscientist.com/article/mg19626355.300>. Accessed 12 July 2011.
- Ashtekar, A. (1999). *Quantum mechanics of geometry*. <http://arxiv.org/abs/gr-qc/9901023>. Accessed July 2011
- BBC – Religions – Hinduism: Vishnu. (2009). BBC – Homepage. <http://www.bbc.co.uk/religion/religions/hinduism/deities/vishnu.shtml>. Accessed 7 Oct 2010.
- Benioff, P. (2009). A possible approach to inclusion of space and time in frame fields of quantum representations of real and complex numbers. *Advances in Mathematical Physics*, 2009, article id 452738, 22 pages, 2009. doi:[10.1155/2009/452738](https://doi.org/10.1155/2009/452738).
- Bohm, D. (1951). *Quantum theory*. New York: Prentice-Hall.
- Davies, P. C. W. (2004). Multiverse cosmological models. *Modern Physics Letters A*, 19(10), 727–743.
- Davies, P. (2006). *The goldilocks enigma*. New York: Mifflin.

- Dorman, E. R. (2011). Hinduism and science: The state of the south Asian science and religion discourse. *Zygon: Journal of Religion & Science*, 46(3), 593–619. Academic Search Premier, EBSCOhost, viewed June 2, 2012.
- Duquette, J. (2011). Quantum physics and vedanta': A perspective from bernard d'espagnat's scientific realism. *Zygon: Journal of Religion & Science*, 46(3), 620–638. Academic Search Premier, EBSCOhost, viewed May 19, 2013.
- Everett III, H. (1957). "Relative state" formulation of quantum mechanics. *Reviews of Modern Physics*, 29, 454–462. <http://www.scientificamerican.com/article.cfm?id=hugh-everett-biography>
- Frankel, M. (2011). Time and the multiverse | plus.maths.org. 2012. Time and the multiverse | plus.maths.org. [ONLINE] Available at <http://plus.maths.org/content/time-and-multiverse>. Accessed 14 Mar 2012.
- Galileo and Theology (Cosmology: Ideas). (2013). Galileo and theology (cosmology: ideas). [ONLINE]. <http://www.aip.org/history/cosmology/ideas/galileo.htm>. Accessed 14 Mar 2013.
- Gross, D., Henneaux, M., & Sevrin, A. (Eds.). (2005). *The quantum structure of space and time: proceedings of the 23rd Solvay conference, Brussels, Belgium, December 2005*. New Jersey: World Scientific Press.
- Hawking, S. W. (1996). *The Illustrated Brief History of Time* (Updated and expanded edition, updsted sub edition). New York: Bantam.
- Horowitz, G. T. (2005). Spacetime in string theory. *New Journal of Physics*, 7, article 201.
- Hugh, E. (1957). *Reviews of Modern Physics* 29, 454–462. Bibcode 1957RvMP...29..454E.
- Jack Ng, Y. (2007). Holographic foam, dark energy and infinite statistics. *Physics Letters B*, 657 (1–3), 10–14.
- Kaku, M. (2005). *Parallel worlds: A journey through creation, higher dimensions, and the future of the cosmos*. New York: Anchor Books.
- Kaku, M. (2008). *Physics of the impossible: A scientific exploration into the world of phasers, force fields, teleportation, and time travel*. New York: Doubleday.
- Madore, J. *Noncommutative geometry for pedestrians*. <http://arxiv.org/abs/gr-qc/9906059>
- Raffa, F. A., & Rasetti, M. (2009). Natural numbers and quantum states in fock space. *International Journal of Quantum Information*, 7(Supplement), 221–228.
- Sagan, C. (1980). *Cosmos*. New York: Random House.
- Sagan, C. (1994). *Pale blue dot: A vision of the human future in space*. New York: Random House.
- Sagan, C. (2000). *Carl Sagan's cosmic connection: An extraterrestrial perspective*. Cambridge: Cambridge University Press.
- Schrodinger, E. (2012). *What is life? With mind and matter and autobiographical sketches* (Canto classics Reprintth ed.). Cambridge/New York: Cambridge University Press.
- Tanvir, N. R., et al. (2009). A gamma-ray burst at a redshift of  $z=8.2$ . *Nature*, 461(7268), 1254–1257.
- Tegmark, M. (2003). Parallel universes. *Scientific American*. April 14, 282, 41–51.
- Tegmark, M. (2008). The mathematical universe. *Foundations of Physics*, 38(2), 101–150.
- UCISpace @ the Libraries – "The Theory of the Universal Wave Function," long thesis as published, 1973. 2013. UCISpace @ the Libraries – "The Theory of the Universal Wave Function," long thesis as published, 1973. Available at <http://ucispace.lib.uci.edu/handle/10575/1302>. Accessed 10 July 2011.
- Wheeler, J. A. (1957). Assessment of Everett's 'Relative State' formulation of quantum theory. *Reviews of Modern Physics*, 29(3), 463–465.
- Wilber, K. (2001). *Quantum questions: Mystical writings of the world's great physicists* (Revisedth ed.). Boston: Shambhala.
- Wolfram, S. (2002). *A new kind of science*. Champaign: Wolfram Media.
- Zukav, G. (1979). *The dancing Wu Li masters: An overview of the new physics*. New York: Morrow and Co., 1979, Many worlds theory. pp. 106–110, 319, 321. Described by [162].

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