Theophysics and Related Issues in Cosmology
Twenty-one Wikipedia Articles
Contents

Articles

Theophysics
Physical cosmology
Cosmology (metaphysics)
Cosmology in medieval Islam
Religious cosmology
Natural theology
Henry More
Cambridge Platonists
Richard Popkin
Emanuel Swedenborg
Raimon Panikkar
Omega Point
Frank J. Tipler
Anthropic principle
Fine-tuned Universe
Multiverse
Ultimate fate of the universe
Zygon: Journal of Religion & Science
Teleological argument
Anne Conway, Viscountess Conway
Pierre Teilhard de Chardin

References

Article Sources and Contributors
Image Sources, Licenses and Contributors

Article Licenses

License
Theophysics

Theophysics is a term used occasionally in philosophy for an approach to cosmology that attempts to reconcile physical cosmology and religious cosmology. It is related to the term physicotheology, the difference between them being that the aim of physicotheology is to derive theology from physics, whereas that of theophysics is to derive physics from theology.

Usage

Paul Richard Blum (2002) uses the term in a critique of physicotheology, i.e. the view that arguments for the existence of God can be derived from the existence of the physical world (e.g. the "argument from design"). Theophysics would be the opposite approach, i.e. an approach to the material world informed by the knowledge that it was created by God.[1]

Richard H. Popkin (1990) applies the term to the "spiritual physics" of Cambridge Platonist Henry More and his pupil and collaborator Lady Anne Conway,[2] who enthusiastically accepted the new science, but rejected the various forms of materialist mechanism proposed by Descartes, Hobbes and Spinoza to buttress it,[3] as these, More and Conway argued, were incapable of explaining productive causality.[4] Instead, More and Conway offered what Popkin calls "a genuine important alternative to modern mechanistic thought",[3] "a thoroughly scientific view with a metaphysics of spirits to make everything operate". Materialist mechanism triumphed, however, and today their spiritual cosmology, as Popkin notes, "looks very odd indeed".[4]

The term has been applied by some philosophers to the system of Emanuel Swedenborg. William Denovan (1889) wrote in Mind: "The highest stage of his revelation might be denominated Theophysics, or the science of Divine purpose in creation."[5] R. M. Wenley (1910) referred to Swedenborg as "the Swedish theophysicist".[6]

Pierre Laberge (1972) observes that Kant's famous critique of physicotheology in the Critique of Pure Reason (1781; second edition 1787) has tended to obscure the fact that in his early work, General History of Nature and Theory of the Heavens (1755), Kant defended a physicotheology that at the time was startlingly original, but that succeeded only to the extent that it concealed what Laberge terms a theophysics ("ce que nous appellerons une théophysique").[7]

Theophysics is a fundamental concept in the thought of Raimon Panikkar, who wrote in Ontonomía de la ciencia (1961) that he was looking for "a theological vision of Science that is not a Metaphysics, but a Theophysics.... It is not a matter of a Physics 'of God', but rather of the 'God of the Physical'; of God the creator of the world... not the world as autonomous being, independent and disconnected from God, but rather ontonically linked to Him". As a vision of "Science as theology", it became central to Panikkar's "cosmotheandric" view of reality.[8]

Author Lawrence Poole adopted the term in 1980, establishing principles and a mathematical formula that purports to link the human soul and God.

Frank J. Tipler's Omega Point theory (1994), which identifies concepts from physical cosmology with theistic concepts, is sometimes referred to by the term,[9] although not by Tipler himself. Tipler was an atheist when he wrote The Anthropic Cosmological Principle (1986, co-authored with John D. Barrow, whose many popular books seldom mention theology) and The Physics of Immortality (1994),[10] but a Christian when he wrote The Physics of Christianity (2007). In 1989, Wolfhart Pannenberg, a liberal theologian in the continental Protestant tradition, welcomed Tipler's work on cosmology as raising "the prospect of a rapprochement between physics and theology in the area of eschatology".[11] In subsequent essays, while not concurring with all the details of Tipler's discussion, Pannenberg has defended the theology of the Omega Point.[9]

The term is also occasionally used as a nonce word in parodies or humorous contexts, as by Aldous Huxley in Antic Hay (1923).[12]
References


Further reading

Physical cosmology

Physical cosmology, as a branch of astronomy, is the study of the largest-scale structures and dynamics of the universe and is concerned with fundamental questions about its formation and evolution. For most of human history, it was a branch of metaphysics and religion. Cosmology as a science originated with the Copernican principle, which implies that celestial bodies obey identical physical laws to those on Earth, and Newtonian mechanics, which first allowed us to understand those laws.

Physical cosmology, as it is now understood, began with the twentieth century development of Albert Einstein's general theory of relativity and better astronomical observations of extremely distant objects. These advances made it possible to speculate about the origin of the universe, and allowed scientists to establish the Big Bang Theory as the leading cosmological model. Some researchers still advocate a handful of alternative cosmologies; however, cosmologists generally agree that the Big Bang theory best explains observations.

Cosmology draws heavily on the work of many disparate areas of research in physics. Areas relevant to cosmology include particle physics experiments and theory, including astrophysics, general relativity, and plasma physics. Thus, cosmology unites the physics of the largest structures in the universe with the physics of the smallest structures in the universe.

History of physical cosmology

Modern cosmology developed along tandem tracks of theory and observation. In 1916, Albert Einstein published his theory of general relativity, which provided a unified description of gravity as a geometric property of space and time. At the time, Einstein believed in a static universe, but found that his original formulation of the theory did not permit it. This is because masses distributed throughout the universe gravitationally attract, and move toward each other over time. However, he realized that his equations permitted the introduction of a constant term which could counteract the attractive force of gravity on the cosmic scale. Einstein published his first paper on relativistic cosmology in 1917, in which he added this cosmological constant to his field equations in order to force them to model a static universe. This so-called Einstein model is, however, unstable to small perturbations—it will eventually start expanding or contracting. The universe described by the Einstein model is static; space is finite and unbounded (analogous to the surface of a sphere, which has a finite area but no edges). It was later realized that Einstein's model was just one of a larger set of possibilities, all of which were consistent with general relativity and the cosmological principle. The cosmological solutions of general relativity were found by Alexander Friedmann in the early 1920s. His equations describe the Friedmann-Lemaître-Robertson-Walker universe, which may expand or contract, and whose geometry may be open, flat, or closed.
In the 1910s, Vesto Slipher (and later Carl Wilhelm Wirtz) interpreted the red shift of spiral nebulae as a Doppler shift that indicated they were receding from Earth. However, it is difficult to determine the distance to astronomical objects. One way is to compare the physical size of an object to its angular size, but a physical size must be assumed to do this. Another method is to measure the brightness of an object and assume an intrinsic luminosity, from which the distance may be determined using the inverse square law. Due to the difficulty of using these methods, they did not realize that the nebulae were actually galaxies outside our own Milky Way, nor did they speculate about the cosmological implications. In 1927, the Belgian Roman Catholic priest Georges Lemaître independently derived the Friedmann-Lemaître-Robertson-Walker equations and proposed, on the basis of the recession of spiral nebulae, that the universe began with the "explosion" of a "primeval atom"—which was later called the Big Bang. In 1929, Edwin Hubble provided an observational basis for Lemaître's theory. Hubble showed that the spiral nebulae were galaxies by determining their distances using measurements of the brightness of Cepheid variable stars. He discovered a relationship between the redshift of a galaxy and its distance. He interpreted this as evidence that the galaxies are receding from Earth in every direction at speeds directly proportional to their distance. This fact is now known as Hubble's law, though the numerical factor Hubble found relating recessional velocity and distance was off by a factor of ten, due to not knowing at the time about different types of Cepheid variables.

Given the cosmological principle, Hubble's law suggested that the universe was expanding. There were two primary explanations put forth for the expansion of the universe. One was Lemaître's Big Bang theory, advocated and developed by George Gamow. The other possibility was Fred Hoyle's steady state model in which new matter would be created as the galaxies moved away from each other. In this model, the universe is roughly the same at any point in time.

For a number of years the support for these theories was evenly divided. However, the observational evidence began to support the idea that the universe evolved from a hot dense state. The discovery of the cosmic microwave background in 1965 lent strong support to the Big Bang model, and since the precise measurements of the cosmic microwave background by the Cosmic Background Explorer in the early 1990s, few cosmologists have seriously proposed other theories of the origin and evolution of the cosmos. One consequence of this is that in standard general relativity, the universe began with a singularity, as demonstrated by Stephen Hawking and Roger Penrose in the 1960s.

**Energy of the cosmos**

Light elements, primarily hydrogen and helium, were created in the Big Bang. These light elements were spread too fast and too thinly in the Big Bang process (see nucleosynthesis) to form the most stable medium-sized atomic nuclei, like iron and nickel. This fact allowed for later energy release, as such intermediate-sized elements are formed in our era. The formation of such atoms powers the steady energy-releasing reactions in stars, and also contributes to sudden energy releases, such as in novae. Gravitational collapse of matter into black holes is also thought to power the most energetic processes, generally seen at the centers of galaxies (see quasars and in general active galaxies).

Cosmologists are still unable to explain all cosmological phenomena purely on the basis of known conventional forms of energy such as those related to the accelerating expansion of the universe. Cosmologists therefore invoke a yet unexplored form of energy called dark energy\(^{[8]}\) to account for certain cosmological observations. One hypothesis is that dark energy is the energy of virtual particles (which mathematically must exist in vacuum due to the uncertainty principle).

There is no unambiguous way to define the total energy of the universe in the current best theory of gravity, general relativity. As a result it remains controversial whether one can meaningfully say that total energy is conserved in an expanding universe. For instance, each photon that travels through intergalactic space loses energy due to the redshift effect. This energy is not obviously transferred to any other system, so seems to be permanently lost. Nevertheless some cosmologists insist that energy is conserved in some sense; this would preserve the law of
conservation of energy.\[^9\]

Thermodynamics of the universe is a field of study to explore which form of energy dominates the cosmos - relativistic particles which are referred to as radiation, or non-relativistic particles which are referred to as matter. The former are particles whose rest mass is zero or negligible compared to their energy, and therefore move at the speed of light or very close to it; the latter are particles whose kinetic energy is much lower than their rest mass and therefore move much slower than the speed of light.

As the universe expands, both matter and radiation in it become diluted. However, the universe also cools down, meaning that the average energy per particle is getting smaller with time. Therefore the radiation becomes weaker, and dilutes faster than matter. Thus with the expansion of the universe, radiation becomes less dominant than matter. In the very early universe, radiation dictated the rate of deceleration of the universe's expansion, and the universe is said to have been 'radiation dominated'. Later, as the average energy per photon becomes roughly 10 eV and lower, matter dictates the rate of deceleration and the universe is said to be 'matter dominated'. The intermediate case is not treated well analytically. As the expansion of the universe continues, matter dilutes even further and the cosmological constant becomes dominant, leading to an acceleration in the universe's expansion.

**History of the universe**

The history of the universe is a central issue in cosmology. The history of the universe is divided into different periods called epochs, according to the dominant forces and processes in each period. The standard cosmological model is known as the ΛCDM model.

**Equations of motion**

The equations of motion governing the universe as a whole are derived from general relativity with a small, positive cosmological constant\[^10\]. The solution is an expanding universe; due to this expansion the radiation and matter in the universe are cooled down and become diluted. At first, the expansion is slowed down by gravitation due to the radiation and matter content of the universe. However, as these become diluted, the cosmological constant becomes more dominant and the expansion of the universe starts to accelerate rather than decelerate. In our universe this has already happened, billions of years ago.

**Particle physics in cosmology**

Particle physics is important to the behavior of the early universe, since the early universe was so hot that the average energy density was very high. Because of this, scattering processes and decay of unstable particles are important in cosmology.

As a rule of thumb, a scattering or a decay process is cosmologically important in a certain cosmological epoch if the time scale describing that process is smaller or comparable to the time scale of the expansion of the universe, which is \(1/H\) with \(H\) being the Hubble constant at that time. This is roughly equal to the age of the universe at that time.

**Timeline of the Big Bang**

Observations suggest that the universe began around 13.7 billion years ago. Since then, the evolution of the universe has passed through three phases. The very early universe, which is still poorly understood, was the split second in which the universe was so hot that particles had energies higher than those currently accessible in particle accelerators on Earth. Therefore, while the basic features of this epoch have been worked out in the Big Bang theory, the details are largely based on educated guesses. Following this, in the early universe, the evolution of the universe proceeded according to known high energy physics. This is when the first protons, electrons and neutrons formed, then nuclei and finally atoms. With the formation of neutral hydrogen, the cosmic microwave background was emitted. Finally, the epoch of structure formation began, when matter started to aggregate into the first stars and
quasars, and ultimately galaxies, clusters of galaxies and superclusters formed. The future of the universe is not yet firmly known, but according to the $\Lambda$CDM model it will continue expanding forever.

Areas of study

Below, some of the most active areas of inquiry in cosmology are described, in roughly chronological order. This does not include all of the Big Bang cosmology, which is presented in Timeline of the Big Bang.

The very early universe

While the early, hot universe appears to be well explained by the Big Bang from roughly $10^{-33}$ seconds onwards, there are several problems. One is that there is no compelling reason, using current particle physics, to expect the universe to be flat, homogeneous and isotropic (see the cosmological principle). Moreover, grand unified theories of particle physics suggest that there should be magnetic monopoles in the universe, which have not been found. These problems are resolved by a brief period of cosmic inflation, which drives the universe to flatness, smooths out anisotropies and inhomogeneities to the observed level, and exponentially dilutes the monopoles. The physical model behind cosmic inflation is extremely simple, however it has not yet been confirmed by particle physics, and there are difficult problems reconciling inflation and quantum field theory. Some cosmologists think that string theory and brane cosmology will provide an alternative to inflation.

Another major problem in cosmology is what caused the universe to contain more particles than antiparticles. Cosmologists can observationally deduce that the universe is not split into regions of matter and antimatter. If it were, there would be X-rays and gamma rays produced as a result of annihilation, but this is not observed. This problem is called the baryon asymmetry, and the theory to describe the resolution is called baryogenesis. The theory of baryogenesis was worked out by Andrei Sakharov in 1967, and requires a violation of the particle physics symmetry, called CP-symmetry, between matter and antimatter. Particle accelerators, however, measure too small a violation of CP-symmetry to account for the baryon asymmetry. Cosmologists and particle physicists are trying to find additional violations of the CP-symmetry in the early universe that might account for the baryon asymmetry.

Both the problems of baryogenesis and cosmic inflation are very closely related to particle physics, and their resolution might come from high energy theory and experiment, rather than through observations of the universe.

Big bang nucleosynthesis

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

The cosmic microwave background is radiation left over from decoupling after the epoch of recombination when neutral atoms first formed. At this point, radiation produced in the Big Bang stopped Thomson scattering from charged ions. The radiation, first observed in 1965 by Arno Penzias and Robert Woodrow Wilson, has a perfect thermal black-body spectrum. It has a temperature of 2.7 kelvins today and is isotropic to one part in $10^5$. Cosmological perturbation theory, which describes the evolution of slight inhomogeneities in the early universe, has allowed cosmologists to precisely calculate the angular power spectrum of the radiation, and it has been measured by the recent satellite experiments (COBE and WMAP) and many ground and balloon-based experiments (such as Degree Angular Scale Interferometer, Cosmic Background Imager, and Boomerang). One of the goals of these efforts is to measure the basic parameters of the Lambda-CDM model with increasing accuracy, as well as to test the predictions of the Big Bang model and look for new physics. The recent measurements made by WMAP, for example, have placed limits on the neutrino masses.

Newer experiments, such as QUIET and the Atacama Cosmology Telescope, are trying to measure the polarization of the cosmic microwave background. These measurements are expected to provide further confirmation of the theory as well as information about cosmic inflation, and the so-called secondary anisotropies, such as the Sunyaev-Zel'dovich effect and Sachs-Wolfe effect, which are caused by interaction between galaxies and clusters with the cosmic microwave background.

**Formation and evolution of large-scale structure**

Understanding the formation and evolution of the largest and earliest structures (i.e., quasars, galaxies, clusters and superclusters) is one of the largest efforts in cosmology. Cosmologists study a model of hierarchical structure formation in which structures form from the bottom up, with smaller objects forming first, while the largest objects, such as superclusters, are still assembling. One way to study structure in the universe is to survey the visible galaxies, in order to construct a three-dimensional picture of the galaxies in the universe and measure the matter power spectrum. This is the approach of the Sloan Digital Sky Survey and the 2dF Galaxy Redshift Survey.

Another tool for understanding structure formation is simulations, which cosmologists use to study the gravitational aggregation of matter in the universe, as it clusters into filaments, superclusters and voids. Most simulations contain only non-baryonic cold dark matter, which should suffice to understand the universe on the largest scales, as there is much more dark matter in the universe than visible, baryonic matter. More advanced simulations are starting to include baryons and study the formation of individual galaxies. Cosmologists study these simulations to see if they agree with the galaxy surveys, and to understand any discrepancy.

Other, complementary observations to measure the distribution of matter in the distant universe and to probe reionization include:

- The Lyman alpha forest, which allows cosmologists to measure the distribution of neutral atomic hydrogen gas in the early universe, by measuring the absorption of light from distant quasars by the gas.
- The 21 centimeter absorption line of neutral atomic hydrogen also provides a sensitive test of cosmology
- Weak lensing, the distortion of a distant image by gravitational lensing due to dark matter.

These will help cosmologists settle the question of when and how structure formed in the universe.

**Dark matter**

Evidence from Big Bang nucleosynthesis, the cosmic microwave background and structure formation suggests that about 23% of the mass of the universe consists of non-baryonic dark matter, whereas only 4% consists of visible, baryonic matter. The gravitational effects of dark matter are well understood, as it behaves like a cold, non-radiative fluid that forms haloes around galaxies. Dark matter has never been detected in the laboratory, and the particle physics nature of dark matter remains completely unknown. Without observational constraints, there are a number of
candidates, such as a stable supersymmetric particle, a weakly interacting massive particle, an axion, and a massive compact halo object. Alternatives to the dark matter hypothesis include a modification of gravity at small accelerations (MOND) or an effect from brane cosmology.

**Dark energy**

If the universe is flat, there must be an additional component making up 73% (in addition to the 23% dark matter and 4% baryons) of the energy density of the universe. This is called dark energy. In order not to interfere with Big Bang nucleosynthesis and the cosmic microwave background, it must not cluster in haloes like baryons and dark matter. There is strong observational evidence for dark energy, as the total energy density of the universe is known through constraints on the flatness of the universe, but the amount of clustering matter is tightly measured, and is much less than this. The case for dark energy was strengthened in 1999, when measurements demonstrated that the expansion of the universe has begun to gradually accelerate.

Apart from its density and its clustering properties, nothing is known about dark energy. Quantum field theory predicts a cosmological constant much like dark energy, but 120 orders of magnitude larger than that observed. Steven Weinberg and a number of string theorists (see string landscape) have used this as evidence for the anthropic principle, which suggests that the cosmological constant is so small because life (and thus physicists, to make observations) cannot exist in a universe with a large cosmological constant, but many people find this an unsatisfying explanation. Other possible explanations for dark energy include quintessence or a modification of gravity on the largest scales. The effect on cosmology of the dark energy that these models describe is given by the dark energy's equation of state, which varies depending upon the theory. The nature of dark energy is one of the most challenging problems in cosmology.

A better understanding of dark energy is likely to solve the problem of the ultimate fate of the universe. In the current cosmological epoch, the accelerated expansion due to dark energy is preventing structures larger than superclusters from forming. It is not known whether the acceleration will continue indefinitely, perhaps even increasing until a big rip, or whether it will eventually reverse.

**Other areas of inquiry**

Cosmologists also study:

- whether primordial black holes were formed in our universe, and what happened to them.
- the GZK cutoff for high-energy cosmic rays, and whether it signals a failure of special relativity at high energies
- the equivalence principle, whether or not Einstein's general theory of relativity is the correct theory of gravitation, and if the fundamental laws of physics are the same everywhere in the universe.

**References**


Physical cosmology


Further reading

Popular


Textbooks


**External links**

**From groups**

• Cambridge Cosmology (http://www.damtp.cam.ac.uk/user/gr/public/cos_home.html) - from Cambridge University (public home page)

• Cosmology 101 (http://map.gsfc.nasa.gov/m_uni.html) - from the NASA WMAP group

• Center for Cosmological Physics (http://cfcp.uchicago.edu/). University of Chicago, Chicago, Illinois.

• Origins, Nova Online (http://www.pbs.org/wgbh/nova/origins/) - Provided by PBS.

**From individuals**


• Madore, Barry F., "Level 5 (http://nedwww.ipac.caltech.edu/level5/) : A Knowledgebase for Extragalactic Astronomy and Cosmology". Caltech and Carnegie. Pasadena, California, USA.

• Tyler, Pat, and Phil Newman "Beyond Einstein (http://universe.gsfc.nasa.gov/)". Laboratory for High Energy Astrophysics (LHEA) NASA Goddard Space Flight Center.

• Wright, Ned. "Cosmology tutorial and FAQ (http://www.astro.ucla.edu/~wright/cosmolog.htm)". Division of Astronomy & Astrophysics, UCLA.


• Cliff Burgess; Fernando Quevedo (November 2007). "The Great Cosmic Roller-Coaster Ride" (print). *Scientific American* (Scientific American): pp. 52–59. "(subtitle) Could cosmic inflation be a sign that our universe is embedded in a far vaster realm?"
Cosmology (metaphysics)

Cosmology in metaphysics is the reflection on the totality of all phenomena. It contrasts with physical cosmology, the study of the origin of the universe in scientific terms after the Copernican Revolution.

Metaphysical naturalism is the belief that the physical universe is all that exists. Materialism and energeticism are two naturalistic cosmologies.

Theistic cosmologies

Theism is the belief that a God or gods exists as a supernatural entity that created the universe and governs its outcome. Types of theism include monotheism and polytheism. The Abrahamic religions are theisms.

Pantheism is the belief that God and the universe have a one-to-one correspondence or the universe is a manifestation of God. The philosopher Spinoza was a pantheist. Panentheism or emanationism is the belief that the entire universe is part of God, but God is greater than the universe. The Neo-Platonic philosopher Plotinus was an emanationist.

Deism is the belief that God or gods created the universe, set everything in motion, and then had nothing more to do with it. God remains completely transcendent to the creation after creating it.

Other cosmologies

Cosmological dualism (as opposed to body-mind dualism) is the belief that there are two gods or metaphysical forces and the universe is a product of these gods or forces. The Persian religion Zoroastrianism is cosmologically dualistic.

This cosmology can also often be found in works of fantasy, often in the form of a benevolent creator and a malicious evil anti-deity, as this provides a clearly defined line between good and evil. A notable example of this is Robert Jordan's *The Wheel of Time* series (the Creator and the Dark One).

Idealism is the belief that only consciousness exists. The various features of the world may be thought of as "ideas in the mind of God." Various forms of idealism can be compatible with either theism or atheism. The British philosopher George Berkeley was an idealist, as was the German philosopher Hegel. See: Hindu idealism, Buddhist idealism, Platonic idealism, German idealism, British Idealism, Panpsychism.

Acosmism is the belief that neither the self nor the universe has ever existed. This is held by some forms of strict Advaita Vedanta, a Hindu philosophy. The Buddhist philosopher Nagarjuna, whose beliefs are called voidism, or nihilism (in the Eastern, rather than the Western sense), believed that the world neither exists, nor does it not exist.

Metaphysics and the Single Intelligible Object

Cosmology was a subject of metaphysics before the Copernican Revolution. Especially since Einstein's theories, cosmology has been primarily concerned with physics (see physical cosmology). But the Great Ideas of the Western World[1] defines metaphysical cosmology as "holding the universe in your hand as if it was a single intelligible object," to which it must be added, "for the purpose of defining Man's place in the universe," not to mention the place of the person "holding" the universe. Physics takes the world apart piece by ever smaller piece, trying to figure out the puzzle of existence. Metaphysical cosmology puts the universe into one comprehensible object so that it may be examined as the whole. From this method, the "first science" of metaphysics can generate theories, but not science.

According to the PBS program *Faith & Reason*,[2] cosmology is a "branch of study concerned with the origins and nature of the universe." But this describes physical cosmology as well. The difference between them is that physical cosmology takes a dim view of "theoretical" metaphysics; what cannot be proved by science has little account in physics. However, the epistemological principle of discovering "cosmos" from "chaos" has traditionally been to
accept the findings of either the metaphysics or the science of cosmology, then "develop the consequences."[^3]

Metaphysical cosmology did not give way easily to physics. Copernicus developed the "heliocentric" theory of the universe, and when Galileo backed him up, the cosmology of the Roman Church, cosmology built on the solid foundation of Aristotle's metaphysics as introduced into the Church by Thomas Aquinas, received a shock heard throughout the Western World: the Earth was not the center of the universe. Galileo was put on trial for contradicting the Church, but his case won, with the resultant phenomenon of the "Copernican Revolution," so called ever since.

**References**

[^1]: The Great Ideas are the "Syntopicon" of the Great Books of the Western World, constituting Volumes II and III of 54 volumes.
[^3]: *Dictionary of Philosophy*; Dagobert D. Runes, Editor; 1968

**External links**

- Cosmology (http://www.newadvent.org/cathen/04413a.htm) and Cosmogony (http://www.newadvent.org/cathen/04405c.htm) at the Catholic Encyclopedia.

---

**Cosmology in medieval Islam**

Islamic cosmology refers to cosmology in Islamic societies. It is mainly derived from the Qur'an, Hadith, Sunnah, and current Islamic as well as other pre-Islamic sources. The Qur'an itself mentions seven heavens[^1] and a vast universe sustained by Allah.

**Metaphysical principles**

**Duality**

Islamic thought categorizes the entire cosmos into two domains: the Unseen Universe (Arabic عالم الغيب, Aalam-ul-Ghaib), which is imperceptible to mankind in general, has properties unknown to us, and includes Allah (metaphorically), angels, Paradise, Hell, seven heavens, and Al-Arsh (the Divine Throne)[^2]; and the Observable Universe (Arabic عالم الشهود, Alam-ul-Shahood), perceptible through the five senses (possibly enhanced by means of instruments). The Qur'an says: "Allah is He, Who is the only God, the knower of the Unseen and the Observed."[^3]

**Teleology**

In the light of a detailed description of the creation of the Universe drawn from the Qur'an and Sunnah, the purpose of existence is for God to become known, to be discovered by human beings. Before the creation, Allah was known only to himself, because nothing existed but he. It was part of his grand design that through created beings the Attributes of Allah were to be fulfilled.

Allah may be known in two ways: through revelation and by means of reasoning. In the former case, he has conveyed his presence to humankind by sending messengers. Individuals also may become aware of Allah's existence through personal revelations, much as a schoolchild learns from teachers and books. Reasoning may lead to awareness of God's existence through formal logic, rational arguments, or deductions from the results of scientific or historical research, according to the individual's interests, education, and aptitudes. Those who choose to study the Qur'an and Hadith may obtain further understanding of Allah, his rights, and his judgement of the beings in both the unseen and observable universes.
Sufi cosmology

Sufi cosmology (Arabic: ﺍﻟﻜﻮﺯﻣﻮﻟﻮﺟﻴﺔ ﺍﻟﺼﻮﻓﻴﺔ) is a general term for cosmological doctrines associated with the mysticism of Sufism. These may differ from place to place, order to order and time to time, but overall show the influence of several different cosmographies:

• The Quran's testament concerning God and immaterial beings, the soul and the afterlife, the beginning and end of things, the seven heavens etc.
• The Neoplatonic views cherished by Islamic philosophers like Avicenna and Ibn Arabi.
• The Hermetic-Ptolemaic spherical geocentric world.
• The Ishraqi visionary universe as expounded by Suhrawardi Maqtul.

Quranic interpretations

There are several verses in the Qur'an (610-632) which some medieval and modern writers have interpreted as foreshadowing modern cosmological theories. An early example of this can be seen in the work of the Islamic theologian Fakhr al-Din al-Razi (1149–1209), in dealing with his conception of physics and the physical world in his Matalib. He discusses Islamic cosmology, criticizes the idea of the Earth's centrality within the universe, and explores "the notion of the existence of a multiverse in the context of his commentary" on the Qur'anic verse, "All praise belongs to God, Lord of the Worlds." He raises the question of whether the term "worlds" in this verse refers to "multiple worlds within this single universe or cosmos, or to many other universes or a multiverse beyond this known universe." He rejects the Aristotelian view of a single world or universe in favour of the existence of multiple worlds and universes, a view that he believed to be supported by the Qur'an and by the Ash'ari theory of atomism.

Cosmology in the medieval Islamic world

Cosmology was studied extensively in the Muslim world during what is known as the Islamic Golden Age from the 7th to 15th centuries.

There are exactly seven verses in the Quran that specify that there are seven heavens. One verse says that each heaven or sky has its own order, possibly meaning laws of nature. Another verse says after mentioning the seven heavens "and similar earths".

In 850, al-Farghani wrote Kitab fi Jawani ("A compendium of the science of stars"). The book primarily gave a summary of Ptolemaic cosmography. However, it also corrected Ptolemy's Almagest based on findings of earlier Iranian astronomers. Al-Farghani gave revised values for the obliquity of the ecliptic, the precessional movement of the apogees of the sun and the moon, and the circumference of the earth. The books were widely circulated through the Muslim world, and even translated into Latin.

Cosmography

ʿAjāʾib al-makhlūqāt wa gharāʾib al-mawjūdāt (Arabic: ﻋﺠﺎﺋﺐ ﺍﻟﻤﺨﻠﻮﻗﺎﺕ ﻭ ﻏﺮﺍﺋﺐ ﺍﻟﻤﻮﺟﻮﺩﺍﺕ, meaning Marvels of creatures and Strange things existing) is an important work of cosmography by Zakariya ibn Muhammad ibn Mahmud Abu Yahya al-Qazwini who was born in Qazwin year 600 (AH (1203 AD).

Temporal finitism

In contrast to ancient Greek philosophers who believed that the universe had an infinite past with no beginning, medieval philosophers and theologians developed the concept of the universe having a finite past with a beginning (see Temporal finitism). This view was inspired by the creation myth shared by the three Abrahamic religions: Judaism, Christianity and Islam. The Christian philosopher, John Philoponus, presented the first such argument against the ancient Greek notion of an infinite past. His arguments were adopted by many most notably; early Muslim philosopher, Al-Kindi (Alkindus); the Jewish philosopher, Saadia Gaon (Saadia ben Joseph); and the
Muslim theologian, Al-Ghazali (Algazel). They used two "logical" arguments against an infinite past, the first being the "argument from the impossibility of the existence of an actual infinite", which states:[⁷]

"An actual infinite cannot exist."

"An infinite temporal regress of events is an actual infinite."

"∴ An infinite temporal regress of events cannot exist."

The second argument, the "argument from the impossibility of completing an actual infinite by successive addition", states:[⁷]

"An actual infinite cannot be completed by successive addition."

"The temporal series of past events has been completed by successive addition."

"∴ The temporal series of past events cannot be an actual infinite."

Both arguments were adopted by later Christian philosophers and theologians, and the second argument in particular became more famous after it was adopted by Immanuel Kant in his thesis of the first antimony concerning time.[⁷]

**Galaxy observation**

The Persian astronomer Alhazen (965–1037) made the first attempt at observing and measuring the Milky Way's parallax,[⁸] and he thus 'determined that because the Milky Way had no parallax, it was very remote from the earth and did not belong to the atmosphere.'[⁹] The Persian astronomer Abū Rayhān al-Bīrūnī (973–1048) proposed the Milky Way galaxy to be "a collection of countless fragments of the nature of nebulous stars."[¹⁰] The Andalusian astronomer Ibn Bajjah ("Avempace", d. 1138) proposed that the Milky Way was made up of many stars which almost touched one another and appeared to be a continuous image due to the effect of refraction from sublunary material, citing his observation of the conjunction of Jupiter and Mars on 500 AH (1106/1107 AD) as evidence.[¹¹][¹²] Ibn Qayyim Al-Jawziyya (1292–1350) proposed the Milky Way galaxy to be "a myriad of tiny stars packed together in the sphere of the fixed stars".[¹³]

In the 10th century, the Persian astronomer Abd al-Rahman al-Sufi (known in the West as Azophi) made the earliest recorded observation of the Andromeda Galaxy, describing it as a "small cloud".[¹⁴] Al-Sufi also identified the Large Magellanic Cloud, which is visible from Yemen, though not from Isfahan; it was not seen by Europeans until Magellan's voyage in the 16th century.[¹⁵][¹⁶] These were the first galaxies other than the Milky Way to be observed from Earth. Al-Sufi published his findings in his *Book of Fixed Stars* in 964.

**Possible worlds**

Al-Ghazali, in *The Incoherence of the Philosophers*, defends the Ash'ari doctrine of a created universe that is temporally finite, against the Aristotelian doctrine of an eternal universe. In doing so, he proposed the modal theory of possible worlds, arguing that their actual world is the best of all possible worlds from among all the alternate timelines and world histories that God could have possibly created. His theory parallels that of Duns Scotus in the 14th century. While it is uncertain whether Al-Ghazali had any influence on Scotus, they both may have derived their theory from their readings of Avicenna's *Metaphysics*.[¹⁷]
Multiversal cosmology

Fakhr al-Din al-Razi (1149–1209), in dealing with his conception of physics and the physical world in his *Matalib al-'Aliya*, criticizes the idea of the Earth's centrality within the universe and "explores the notion of the existence of a multiverse in the context of his commentary" on the Qur'anic verse, "All praise belongs to God, Lord of the Worlds." He raises the question of whether the term "worlds" in this verse refers to "multiple worlds within this single universe or cosmos, or to many other universes or a multiverse beyond this known universe." In volume 4 of the *Matalib*, Al-Razi states:[5]

It is established by evidence that there exists beyond the world a void without a terminal limit (*khala' la nihayata laha*), and it is established as well by evidence that God Most High has power over all contingent beings (*al-mumkinat*). Therefore He the Most High has the power (*qadir*) to create a thousand thousand worlds (*alfa alfi 'awalim*) beyond this world such that each one of those worlds be bigger and more massive than this world as well as having the like of what this world has of the throne (*al-arsh*), the chair (*al-kursiyy*), the heavens (*al-samawat*) and the earth (*al-ard*), the sun (*al-shams*) and the moon (*al-qamar*). The arguments of the philosophers (*dala'il al-falasifah*) for establishing that the world is one are weak, flimsy arguments founded upon feeble premises.

Al-Razi rejected the Aristotelian and Avicennian notions of a single universe revolving around a single world. He describes the main arguments against the existence of multiple worlds or universes, pointing out their weaknesses and refuting them. This rejection arose from his affirmation of atomism, as advocated by the Ash'ari school of Islamic theology, which entails the existence of vacant space in which the atoms move, combine and separate. He discussed in greater detail the void, the empty space between stars and constellations in the Universe, in volume 5 of the *Matalib.*[5] He argued that there exists an infinite outer space beyond the known world,[18] and that God has the power to fill the vacuum with an infinite number of universes.[19]

Refutations of astrology

The study of astrology was refuted by several Muslim writers at the time, including al-Farabi, Ibn al-Haytham, Avicenna, Biruni and Averroes. Their reasons for refuting astrology were often due to both scientific (the methods used by astrologers being conjectural rather than empirical) and religious (conflicts with orthodox Islamic scholars) reasons.[20]

Ibn Qayyim Al-Jawziyya (1292–1350), in his *Miftah Dar al-SaCadah*, used empirical arguments in astronomy in order to refute the practice of astrology and divination.[21] He recognized that the stars are much larger than the planets, and thus argued:[13]

"And if you astrologers answer that it is precisely because of this distance and smallness that their influences are negligible, then why is it that you claim a great influence for the smallest heavenly body, Mercury? Why is it that you have given an influence to al-Ra's and al-Dhanab, which are two imaginary points [ascending and descending nodes]?"
Al-Jawziyya also recognized the Milky Way galaxy as "a myriad of tiny stars packed together in the sphere of the fixed stars" and thus argued that "it is certainly impossible to have knowledge of their influences."[13]

**Early heliocentric models**

The Babylonian astronomer, Seleucus of Seleucia, who advocated a heliocentric model in the 2nd century BC, wrote a work that was later translated into Arabic. A fragment of his work has survived only in Arabic translation, which was later referred to by the Persian philosopher Muhammad ibn Zakariya al-Razi (865-925).[22]

In the late ninth century, Ja'far ibn Muhammad Abu Ma'shar al-Balkhi (Albumasar) developed a planetary model which some have interpreted as a heliocentric model. This is due to his orbital revolutions of the planets being given as heliocentric revolutions rather than geocentric revolutions, and the only known planetary theory in which this occurs is in the heliocentric theory. His work on planetary theory has not survived, but his astronomical data was later recorded by al-Hashimi, Abū Rayhān al-Bīrūnī and al-Sijzi.[23]

In the early eleventh century, al-Biruni had met several Indian scholars who believed in a heliocentric system. In his *Indica*, he discusses the theories on the Earth's rotation supported by Brahmagupta and other Indian astronomers, while in his *Canon Masudicus*, al-Biruni writes that Aryabhata's followers assigned the first movement from east to west to the Earth and a second movement from west to east to the fixed stars. Al-Biruni also wrote that al-Sijzi also believed the Earth was moving and invented an astrolabe called the "Zuraqi" based on this idea:[24]

"I have seen the astrolabe called Zuraqi invented by Abu Sa'id Sijzi. I liked it very much and praised him a great deal, as it is based on the idea entertained by some to the effect that the motion we see is due to the Earth's movement and not to that of the sky. By my life, it is a problem difficult of solution and refutation. [...] For it is the same whether you take it that the Earth is in motion or the sky. For, in both cases, it does not affect the Astronomical Science. It is just for the physicist to see if it is possible to refute it."

In his *Indica*, al-Biruni briefly refers to his work on the refutation of heliocentrism, the *Key of Astronomy*, which is now lost:[24]

"The most prominent of both modern and ancient astronomers have deeply studied the question of the moving earth, and tried to refute it. We, too, have composed a book on the subject called *Miftah 'ilm al-hai'ah* (*Key of Astronomy*), in which we think we have surpassed our predecessors, if not in the words, at all events in the matter."
Early Hay’a program

During this period, a distinctive Islamic system of astronomy flourished. It was Greek tradition to separate mathematical astronomy (as typified by Ptolemy) from philosophical cosmology (as typified by Aristotle). Muslim scholars developed a program of seeking a physically real configuration (hay’a) of the universe, that would be consistent with both mathematical and physical principles. Within the context of this hay’a tradition, Muslim astronomers began questioning technical details of the Ptolemaic system of astronomy.\[25\]

Some Muslim astronomers, however, most notably Abû Rayhân al-Bîrûnî and Nasîr al-Dîn al-Tûsî, discussed whether the Earth moved and considered how this might be consistent with astronomical computations and physical systems.\[26\] Several other Muslim astronomers, most notably those following the Maragha school of astronomy, developed non-Ptolemaic planetary models within a geocentric context that were later adapted by the Copernican model in a heliocentric context.

Between 1025 and 1028, Ibn al-Haytham (Latinized as Alhazen), began the hay’a tradition of Islamic astronomy with his Al-Shuku ala Batlamyus (Doubts on Ptolemy). While maintaining the physical reality of the geocentric model, he was the first to criticize Ptolemy’s astronomical system, which he criticized on empirical, observational and experimental grounds,\[27\] and for relating actual physical motions to imaginary mathematical points, lines and circles.\[28\] Ibn al-Haytham developed a physical structure of the Ptolemaic system in his Treatise on the configuration of the World, or Maqâlah fî hay'at al-âlam, which became an influential work in the hay’a tradition.\[29\] In his Epitome of Astronomy, he insisted that the heavenly bodies "were accountable to the laws of physics."\[30\]

In 1038, Ibn al-Haytham described the first non-Ptolemaic configuration in The Model of the Motions. His reform was not concerned with cosmology, as he developed a systematic study of celestial kinematics that was completely geometric. This in turn led to innovative developments in infinitesimal geometry.\[31\] His reformed model was the first to reject the equant\[32\] and eccentrics,\[33\] separate natural philosophy from astronomy, free celestial kinematics from cosmology, and reduce physical entities to geometrical entities. The model also propounded the Earth's rotation about its axis,\[34\] and the centres of motion were geometrical points without any physical significance, like Johannes Kepler's model centuries later.\[35\] Ibn al-Haytham also describes an early version of Occam's razor, where he employs only minimal hypotheses regarding the properties that characterize astronomical motions, as he attempts to eliminate from his planetary model the cosmological hypotheses that cannot be observed from Earth.\[36\]

In 1030, Abû al-Rayhân al-Bîrûnî discussed the Indian planetary theories of Aryabhata, Brahmagupta and Varahamihira in his Ta'rikh al-Hind (Latinized as Indica). Biruni stated that Brahmagupta and others consider that the earth rotates on its axis and Biruni noted that this does not create any mathematical problems.\[37\] Abu Said al-Sijzi, a contemporary of al-Biruni, suggested the possible heliocentric movement of the Earth around the Sun, which al-Biruni did not reject.\[38\] Al-Biruni agreed with the Earth's rotation about its own axis, and while he was initially neutral regarding the heliocentric and geocentric models,\[39\] he considered heliocentrism to be a philosophical problem.\[40\] He remarked that if the Earth rotates on its axis and moves around the Sun, it would remain consistent with his astronomical parameters.\[41][42][43]

"Rotation of the earth would in no way invalidate astronomical calculations, for all the astronomical data are as explicable in terms of the one theory as of the other. The problem is thus difficult of solution."
Andalusian Revolt

In the 11th-12th centuries, astronomers in al-Andalus took up the challenge earlier posed by Ibn al-Haytham, namely to develop an alternate non-Ptolemaic configuration that evaded the errors found in the Ptolemaic model.[44] Like Ibn al-Haytham's critique, the anonymous Andalusian work, *al-Istidrak ala Batlamyus (Recapitulation regarding Ptolemy)*, included a list of objections to Ptolemaic astronomy. This marked the beginning of the Andalusian school's revolt against Ptolemaic astronomy, otherwise known as the "Andalusian Revolt".[45]

In the 12th century, Averroes rejected the eccentric deferents introduced by Ptolemy. He rejected the Ptolemaic model and instead argued for a strictly concentric model of the universe. He wrote the following criticism on the Ptolemaic model of planetary motion:[46]

"To assert the existence of an eccentric sphere or an epicyclic sphere is contrary to nature. [...] The astronomy of our time offers no truth, but only agrees with the calculations and not with what exists."

Averroes' contemporary, Maimonides, wrote the following on the planetary model proposed by Ibn Bajjah (Avempace):

"I have heard that Abu Bakr [Ibn Bajja] discovered a system in which no epicycles occur, but eccentric spheres are not excluded by him. I have not heard it from his pupils; and even if it be correct that he discovered such a system, he has not gained much by it, for eccentricity is likewise contrary to the principles laid down by Aristotle.... I have explained to you that these difficulties do not concern the astronomer, for he does not profess to tell us the existing properties of the spheres, but to suggest, whether correctly or not, a theory in which the motion of the stars and planets is uniform and circular, and in agreement with observation."[47]

Ibn Bajjah also proposed the Milky Way galaxy to be made up of many stars but that it appears to be a continuous image due to the effect of refraction in the Earth's atmosphere.[11] Later in the 12th century, his successors Ibn Tufail and Nur Ed-Din Al Betrugi (Alpetragius) were the first to propose planetary models without any equant, epicycles or eccentrics. Their configurations, however, were not accepted due to the numerical predictions of the planetary positions in their models being less accurate than that of the Ptolemaic model,[48] mainly because they followed Aristotle's notion of perfectly uniform circular motion.

Maragha Revolution

The "Maragha Revolution" refers to the Maragheh school's revolution against Ptolemaic astronomy. The "Maragha school" was an astronomical tradition beginning in the Maragheh observatory and continuing with astronomers from Damascus and Samarkand. Like their Andalusian predecessors, the Maragha astronomers attempted to solve the equant problem and produce alternative configurations to the Ptolemaic model. They were more successful than their Andalusian predecessors in producing non-Ptolemaic configurations which eliminated the equant and eccentrics, were more accurate than the Ptolemaic model in numerically predicting planetary positions, and were in better agreement with empirical observations.[40] The most important of the Maragha astronomers included Mo'ayyeduddin Urði (d. 1266), Nasr al-Dīn al-Tūṣī (1201–1274), Najm al-Dīn al-Qazwīnī al-Kātibī (d. 1277), Qutb al-Dīn al-Shirazi (1236–1311), Sadr al-Sharia al-Bukhari (c. 1347), Ibn al-Shatir (1304–1375), Ali Qushji (c. 1474), al-Birjandi (d. 1525) and Shams al-Dīn al-Khafri (d. 1550).[49]
Nasīr al-Dīn al-Tūsī resolved significant problems in the Ptolemaic system with the Tusi-couple, which later played an important role in the Copernican model.

Some have described their achievements in the 13th and 14th centuries as a "Maragha Revolution", "Maragha School Revolution", or "Scientific Revolution before the Renaissance". An important aspect of this revolution included the realization that astronomy should aim to describe the behavior of physical bodies in mathematical language, and should not remain a mathematical hypothesis, which would only save the phenomena. The Maragha astronomers also realized that the Aristotelian view of motion in the universe being only circular or linear was not true, as the Tusi-couple showed that linear motion could also be produced by applying circular motions only.[50]

Unlike the ancient Greek and Hellenistic astronomers who were not concerned with the coherence between the mathematical and physical principles of a planetary theory, Islamic astronomers insisted on the need to match the mathematics with the real world surrounding them, which gradually evolved from a reality based on Aristotelian physics to one based on an empirical and mathematical physics after the work of Ibn al-Shatir. The Maragha Revolution was thus characterized by a shift away from the philosophical foundations of Aristotelian cosmology and Ptolemaic astronomy and towards a greater emphasis on the empirical observation and mathematization of astronomy and of nature in general, as exemplified in the works of Ibn al-Shatir, Qushji, al-Birjandi and al-Khafri.[52][53][54]

Other achievements of the Maragha school include the first empirical observational evidence for the Earth's rotation on its axis by al-Tusi and Qushji,[55] the separation of natural philosophy from astronomy by Ibn al-Shatir and Qushji,[56] the rejection of the Ptolemaic model on empirical rather than philosophical grounds by Ibn al-Shatir,[40] and the development of a non-Ptolemaic model by Ibn al-Shatir that was mathematically identical to the heliocentric Copernican model.[57]

Mo'ayyeduddin Urdi (d. 1266) was the first of the Maragheh astronomers to develop a non-Ptolemaic model, and he proposed a new theorem, the "Urdi lemma".[58] Nasīr al-Dīn al-Tūsī (1201–1274) resolved significant problems in the Ptolemaic system by developing the Tusi-couple as an alternative to the physically problematic equant introduced by Ptolemy.[59] Tusi's student Qutb al-Din al-Shirazi (1236–1311), in his The Limit of Accomplishment concerning Knowledge of the Heavens, discussed the possibility of heliocentrism.

Al-Qazwīnī al-Kātibī, who also worked at the Maragheh observatory, in his Hikmat al-'Ain, wrote an argument for a heliocentric model, though he later abandoned the idea.[38]
Ibn al-Shatir (1304–1375) of Damascus, in *A Final Inquiry Concerning the Rectification of Planetary Theory*, incorporated the Urdi lemma, and eliminated the need for an equant by introducing an extra epicycle (the Tusi-couple), departing from the Ptolemaic system in a way that was mathematically identical to what Nicolaus Copernicus did in the 16th century. Unlike previous astronomers before him, Ibn al-Shatir was not concerned with adhering to the theoretical principles of natural philosophy or Aristotelian cosmology, but rather to produce a model that was more consistent with empirical observations. For example, it was Ibn al-Shatir's concern for observational accuracy which led him to eliminate the epicycle in the Ptolemaic solar model and all the eccentrics, epicycles and equant in the Ptolemaic lunar model. His model was thus in better agreement with empirical observations than any previous model, and was also the first that permitted empirical testing. His work thus marked a turning point in astronomy, which may be considered a "Scientific Revolution before the Renaissance." His rectified model was later adapted into a heliocentric model by Copernicus, which was mathematically achieved by reversing the direction of the last vector connecting the Earth to the Sun. In the published version of his masterwork, *De revolutionibus orbium coelestium*, Copernicus also cites the theories of al-Battani, Arzachel and Averroes as influences, while the works of Ibn al-Haytham and al-Biruni were also known in Europe at the time.

An area of active discussion in the Maragheh school, and later the Samarkand and Istanbul observatories, was the possibility of the Earth's rotation. Supporters of this theory included Naṣīr al-Dīn al-Tūsī, Nizam al-Dīn al-Nisaburi (c. 1311), al-Sayyid al-Sharif al-Jurjani (1339–1413), Ali Qushji (d. 1474), and Abd al-Ali al-Birjandi (d. 1525). Al-Tusi was the first to present empirical observational evidence of the Earth's rotation, using the location of comets relevant to the Earth as evidence, which Qushji elaborated on with further empirical observations while rejecting Aristotelian natural philosophy altogether. Both of their arguments were similar to the arguments later used by Nicolaus Copernicus in 1543 to explain the Earth's rotation (see Astronomical physics and Earth's motion section below).

**Experimental astrophysics and celestial mechanics**

In the 9th century, the eldest Banū Mūsā brother, Ja'far Muhammad ibn Mūsā ibn Shākir, made significant contributions to Islamic astrophysics and celestial mechanics. He was the first to hypothesize that the heavenly bodies and celestial spheres are subject to the same laws of physics as Earth, unlike the ancients who believed that the celestial spheres followed their own set of physical laws different from that of Earth. In his *Astral Motion* and *The Force of Attraction*, Muhammad ibn Musa also proposed that there is a force of attraction between heavenly bodies, foreshadowing Newton's law of universal gravitation.

In the early 11th century, Ibn al-Haytham (Alhazen) wrote the *Maqala fi daw al-qamar* (*On the Light of the Moon*) some time before 1021. This was the first attempt successful at combining mathematical astronomy with physics and the earliest attempt at applying the experimental method to astronomy and astrophysics. He disproved the universally held opinion that the moon reflects sunlight like a mirror and correctly concluded that it "emits light from those portions of its surface which the sun's light strikes." In order to prove that "light is emitted from every point of the moon's illuminated surface," he built an "ingenious experimental device." Ibn al-Haytham had "formulated a clear conception of the relationship between an ideal mathematical model and the complex of observable phenomena; in particular, he was the first to make a systematic use of the method of varying the experimental conditions in a
constant and uniform manner, in an experiment showing that the intensity of the light-spot formed by the projection of the moonlight through two small apertures onto a screen diminishes constantly as one of the apertures is gradually blocked up.\[65\]

Ibn al-Haytham, in his *Book of Optics* (1021), was also the first to discover that the celestial spheres do not consist of solid matter, and he also discovered that the heavens are less dense than the air. These views were later repeated by Witelo and had a significant influence on the Copernican and Tychonic systems of astronomy.\[66\]

In the 12th century, Fakhr al-Din al-Razi participated in the debate among Islamic scholars over whether the celestial spheres or orbits (*falak*) are "to be considered as real, concrete physical bodies" or "merely the abstract circles in the heavens traced out year in and year out by the various stars and planets." He points out that many astronomers prefer to see them as solid spheres "on which the stars turn," while others, such as the Islamic scholar Dahhak, view the celestial sphere as "not a body but merely the abstract orbit traced by the stars." Al-Razi himself remains "undecided as to which celestial models, concrete or abstract, most conform with external reality," and notes that "there is no way to ascertain the characteristics of the heavens," whether by "observable" evidence or by authority (*al-khabar*) of "divine revelation or prophetic traditions." He concludes that "astronomical models, whatever their utility or lack thereof for ordering the heavens, are not founded on sound rational proofs, and so no intellectual commitment can be made to them insofar as description and explanation of celestial realities are concerned.\[5\]

The theologian Adud al-Din al-Iji (1281–1355), under the influence of the Ash'ari doctrine of occasionalism, which maintained that all physical effects were caused directly by God's will rather than by natural causes, rejected the Aristotelian principle of an innate principle of circular motion in the heavenly bodies,\[67\] and maintained that the celestial spheres were "imaginary things" and "more tenuous than a spider's web".\[56\]

**Astronomical physics and Earth's motion**

The work of Ali Qushji (d. 1474), who worked at Samarkand and then Istanbul, is seen as a late example of innovation in Islamic theoretical astronomy and it is believed he may have possibly had some influence on Nicolaus Copernicus due to similar arguments concerning the Earth's rotation. Before Qushji, the only astronomer to present empirical evidence for the Earth's rotation was Nasīr al-Dīn al-Tūsī (d. 1274), who used the phenomena of comets to refute Ptolemy's claim that a stationary Earth can be determined through observation. Al-Tusi, however, eventually accepted that the Earth was stationary on the basis of Aristotelian cosmology and natural philosophy. By the 15th century, the influence of Aristotelian physics and natural philosophy was declining due to religious opposition from Islamic theologians such as Al-Ghazali who opposed to the interference of Aristotelianism in astronomy, opening up possibilities for an astronomy unrestrained by philosophy. Under this influence, Qushji, in his *Concerning the Supposed Dependence of Astronomy upon Philosophy*, rejected Aristotelian physics and completely separated natural philosophy from astronomy, allowing astronomy to become a purely empirical and mathematical science. This allowed him to explore alternatives to the Aristotelian notion of a stationary Earth, as he explored the idea of a moving Earth. He also observed comets and elaborated on al-Tusi's argument. He took it a step further and concluded, on the basis of empirical evidence rather than speculative philosophy, that the moving Earth theory is just
as likely to be true as the stationary Earth theory and that it is not possible to empirically deduce which theory is true.[55][56][68] His work was an important step away from Aristotelian physics and towards an independent astronomical physics.[69]

Despite the similarity in their discussions regarding the Earth's motion, there is uncertainty over whether Qushji had any influence on Copernicus. However, it is likely that they both may have arrived at similar conclusions due to using the earlier work of al-Tusi as a basis. This is more of a possibility considering "the remarkable coincidence between a passage in De revolutionibus (1.8) and one in Ṭūsī's Tadhkira (II.1[6]) in which Copernicus follows Ṭūsī's objection to Ptolemy's "proofs" of the Earth's immobility." This can be considered as evidence that not only was Copernicus influenced by the mathematical models of Islamic astronomers, but may have also been influenced by the astronomical physics they began developing and their views on the Earth's motion.[70]

In the 16th century, the debate on the Earth's motion was continued by al-Birjandi (d. 1528), who in his analysis of what might occur if the Earth were moving, develops a hypothesis similar to Galileo Galilei's notion of "circular inertia",[71] which he described in the following observational test (as a response to one of Qutb al-Din al-Shirazi's arguments):

"The small or large rock will fall to the Earth along the path of a line that is perpendicular to the plane (sath) of the horizon; this is witnessed by experience (tajriba). And this perpendicular is away from the tangent point of the Earth's sphere and the plane of the perceived (hissi) horizon. This point moves with the motion of the Earth and thus there will be no difference in place of fall of the two rocks."[72]

### Notes

1. [Qur'an 2:29](http://qurancomplex.org/Quran/Targama/Targama.asp?L=eng&Page=2)
5. Adi Setia (2004), "Fakhr Al-Din Al-Razi on Physics and the Nature of the Physical World: A Preliminary Survey" (http://findarticles.com/p/articles/mi_q0QYQ/is_2_2/ai_n9532826/), *Islam & Science 2*, retrieved 2010-03-02
20. (Saliba 1994b, pp. 60 & 67–69)


[24] (Nasr 1993, pp. 135–136)


[26] (Ragep, Teresi & Hart 2002)

[27] (Sabra 1998, p. 300)


[29] (Langermann 1990, pp. 25–34)

[30] (Duhem 1969, p. 28)

[31] (Rashed 2007)

[32] (Rashed 2007, pp. 20 & 53)

[33] (Rashed 2007, pp. 33–4)

[34] (Rashed 2007, pp. 20 & 32–33)

[35] (Rashed 2007, pp. 51–2)

[36] (Rashed 2007, pp. 35–6)

[37] (Nasr 1993, p. 135, n. 13)

[38] (Baker & Chapter 2002)

[39] (Marmura 1965)

[40] (Saliba 1994b, pp. 233–234 & 240)


[42] (Saliba 1980, p. 249)


[44] (Saliba 1981, p. 219)


[49] (Dallal 1999, p. 171)

[50] (Saliba 1994b, pp. 245, 250, 256–257)


[52] (Saliba 1994b, pp. 42 & 80)


[54] (Huff 2003, pp. 217–8)

[55] (Ragep 2001a)

[56] (Ragep 2001b)

[57] (Saliba 1994b, pp. 254 & 256–257)

[58] (Saliba 1979)

[59] (Gill 2005)


[62] (Saliba 1994a, p. 116)


[64] (Briffault 1938, p. 191)


[66] (Rosen 1985, pp. 19–20 & 21)
References

• Briffault, Robert (1938), *The Making of Humanity*
• Daryabadi, Abdul Majid (1941), *The Holy Qur'an, English Translation*, 57, Lahore
• Saliba, George (1994a), "Early Arabic Critique of Ptolemaic Cosmology: A Ninth-Century Text on the Motion of the Celestial Spheres", *Journal for the History of Astronomy* 25: 115–141

**External links**

• The Quran and Cosmology (http://www.alislam.org/library/books/revelation/part_4_section_5.html)
• Dr Israr Ahmed (http://islam.islamabad.net/)

**Religious cosmology**

A *Religious cosmology* (also *mythological cosmology*) is a way of explaining the origin, the history and the evolution of the cosmos or universe based on the religious mythology of a specific tradition. Religious cosmologies usually include an act or process of creation by a creator deity or a larger pantheon.

**Buddhism**

In Buddhism, the universe comes into existence dependent upon the actions (karma) of its inhabitants. Buddhists posit neither an ultimate beginning or final end to the universe, but see the universe as something in flux, passing in and out of existence, parallel to an infinite number of other universes doing the same thing.

The Buddhist universe consists of a large number of worlds which correspond to different mental states, including passive states of trance, passionless states of purity, and lower states of desire, anger, and fear. The beings in these worlds are all coming into existence or being born, and passing out of existence into other states, or dying. A world comes into existence when the first being in it is born, and ceases to exist, as such, when the last being in it dies. The universe of these worlds also is born and dies, with the death of the last being preceding a universal conflagration that destroys the physical structure of the worlds; then, after an interval, beings begin to be born again and the universe is once again built up. Other universes, however, also exist, and there are higher planes of existence which are never destroyed, though beings that live in them also come into and pass out of existence.

As well as a model of universal origins and destruction, Buddhist cosmology also functions as a model of the mind, with its thoughts coming into existence based on preceding thoughts, and being transformed into other thoughts and other states.
Hebrew Bible

Further information: Biblical cosmology and Genesis creation myth

The main Judeo-Christian religious text, the Bible, opens with a story of creation. The first two chapters of the Book of Genesis describe the creation of heaven and earth by God (called both Elohim and Yhvh) in six successive days.

• First day: God creates light ("Let there be light!")[^1][Gen 1:3]—the first divine command. The light is divided from the darkness, and "day" and "night" are named.
• Second day: God creates a firmament ("Let a firmament be...!")[^2][Gen 1:6–7]—the second command—to divide the waters above from the waters below. The firmament is named "heaven" (shamayim).
• Third day: God commands the waters below to be gathered together in one place, and dry land to appear (the third command).[^3][Gen 1:9–10] "earth" and "sea" are named. God commands the earth to bring forth grass, plants, and fruit-bearing trees (the fourth command).
• Fourth day: God creates lights in the firmament (the fifth command)[^4][Gen 1:14–15] to separate light from darkness and to mark days, seasons and years. Two great lights are made and the stars.
• Fifth day: God commands the sea to "teem with living creatures", and birds to fly across the heavens (sixth command).[^5][Gen 1:20–21] He creates birds and sea creatures, and commands them to be fruitful and multiply.
• Sixth day: God commands the land to bring forth living creatures (seventh command); He makes wild beasts, livestock and "every thing that creepeth upon the earth".[^6][Gen 1:24–25] He then creates humanity in His "image" and "likeness" (eighth command).[^7][Gen 1:26–28] They are told to "be fruitful, and multiply, and fill the earth, and subdue it." The totality of creation is described by God as "very good."
• Seventh day: God, having completed the heavens and the earth, rests from His work, and blesses and sanctifies the seventh day.[^8][Gen 2:2]

Christianity

It is a tenet of Christian faith (Roman Catholic, Orthodox and Protestant) that God is the creator of all things from nothing, and has made human beings in the Image of God, who by direct inference is also the source of the human soul. In Chalcedonian Christology, Jesus is the Word of God, which was in the beginning and, thus, is uncreated, and hence is God, and consequently identical with the Creator of the world ex nihilo.

The New Testament claims that God created everything by the eternal Word, Jesus Christ his beloved Son. In him:

> "all things were created, in heaven and on earth... all things were created through him and for him. He is before all things, and in him all things hold together.[^1]

Mormon

Mormon cosmology draws from Biblical cosmology, but has many unique elements provided by Latter Day Saint movement founder Joseph Smith, Jr.

According to Mormon cosmology, there was a pre-existence, better described as a pre-mortal life, in which human spirits were literal children of heavenly parents.[^2] Though their spirits were created, the essential "intelligence" of these spirits is considered eternal, and without beginning. During this pre-existence, two plans were said to have been presented, one championed by Lucifer (Satan) that would have involved loss of moral agency, and another championed by God the Father. When his plan was not accepted, Lucifer is said to have rebelled and taken a third of the hosts of heaven with him to the earth to serve as tempters. According to a plan of salvation as described by God the Father, Jesus would create the earth, under the direction of God the Father, as a place where humanity would be tested. After the resurrection all men and women except spirits that followed Lucifer and the sons of perdition would be assigned one of three degrees of glory. Within the highest degree, the Celestial Kingdom, there are three divisions, and those in the highest of these divisions would become gods and goddesses through a process called exaltation or "eternal progression". This would involve having spirit children and populating new worlds.
The Earth's creation, according to Mormon scripture, was not *ex nihilo*, but organized from existing matter. The faith teaches that this earth is just one of many inhabited worlds, and that there are many governing heavenly bodies, including a planet or star Kolob which is said to be nearest the throne of God. According to some Mormon sources, God the Father himself was once like a human, and lived on a planet with his own higher god.

**Hinduism**

The Hindu cosmology and timeline is the closest to modern scientific timelines and even more which might indicate that the Big Bang is not the beginning of everything but just the start of the present cycle preceded by an infinite number of universes and to be followed by another infinite number of universes. It also includes an infinite number of universes at one given time.

The Rig Veda questions the origin of the cosmos in: "Neither being (sat) nor non-being was as yet. What was concealed? And where? And in whose protection?...Who really knows? Who can declare it? Whence was it born, and whence came this creation? The devas (demigods) were born later than this world's creation, so who knows from where it came into existence? None can know from where creation has arisen, and whether he has or has not produced it. He who surveys it in the highest heavens, he alone knows—or perhaps does not know." (Rig Veda 10. 129)

The Rig Veda's view of the cosmos also sees one true divine principle self-projecting as the divine word, *Vaak*, 'birthing' the cosmos that we know, from the monistic *Hiranyagarbha* or Golden Womb. The *Hiranyagarbha* is alternatively viewed as Brahma, the creator who was in turn created by God, or as God (Brahman) himself. The universe is considered to constantly expand since creation and disappear into a thin haze after billions of years. An alternate view is that the universe begins to contract after reaching its maximum expansion limits until it disappears into a fraction of a millimeter. The creation begins anew after billions of years (Solar years) of non-existence.

The puranic view asserts that the universe is created, destroyed, and re-created in an eternally repetitive series of cycles. In Hindu cosmology, a universe endures for about 4,320,000,000 years (one day of Brahma, the creator or *kalpa*) and is then destroyed by fire or water elements. At this
point, Brahma rests for one night, just as long as the day. This process, named *pralaya* (*Cataclysm*), repeats for 100 Brahma years (311 Trillion, 40 Billion Human Years) that represents Brahma's lifespan. Similarly at a given time there are an infinite number of Brahma's performing the creation of each of these universes that are infinite in number. It must be noted that Brahma is the creator but not necessarily regarded as God in Hinduism. He is mostly regarded as a creation of God / Brahman.

We are currently believed to be in the 51st year of the present Brahma and so about 156 trillion years have elapsed since He was born as Brahma. After Brahma's "death", it is necessary that another 100 Brahma years (311 Trillion, 40 Billion Years) pass until a new Brahma is born and the whole creation begins anew. This process is repeated again and again, forever.

Brahma's day is divided in one thousand cycles (*Maha Yuga*, or the Great Year). *Maha Yuga*, during which life, including the human race appears and then disappears, has 71 divisions, each made of 14 *Manvantara* (1000) years. Each *Maha Yuga* lasts for 4,320,000 years. *Manvantara* is Manu's cycle, the one who gives birth and governs the human race.

Each *Maha Yuga* consists of a series of four shorter *yugas*, or ages. The *yugas* get progressively worse from a moral point of view as one proceeds from one *yuga* to another. As a result, each *yuga* is of shorter duration than the age that preceded it. The current *Kali Yuga* (Iron Age) began at midnight 17 February / 18 February in 3102 BC in the proleptic Julian calendar.

Space and time are considered to be *maya* (illusion). What looks like 100 years in the cosmos of Brahma could be thousands of years in other worlds, millions of years in some other worlds and 311 trillion and 40 billion years for our solar system and earth.

---

**Islam**

Islam preaches that God, or *Allah*, created the universe, including Earth's physical environment and human beings. The highest goal is to visualize the cosmos as a book of symbols for meditation and contemplation for spiritual upliftment or as a prison from which the human soul must escape to attain true freedom in the spiritual journey to God. Islam elaborates on cosmology in many instances. A modern English translation of the Quran describes the creation of the universe as follows: "We have built the heaven with might, and We are Steadily Expanding it." 51:47

*Earlier English translations like for example Ahmed Ali, The Noble Qur'an, Pickthal, Shakir and Yusuf Ali never specify the expansion as a process that is still going on so it seems to be an addition after the expansion of the universe became a generally accepted scientific fact.*

Below here there are some other citations from the Quran on cosmology.

"Do not the Unbelievers see that the heavens and the earth were joined together (as one unit of creation), before we clove them asunder? We made from water every living thing. Will they not then believe?" 21:30 Yusuf Ali translation
"The Day that We roll up the heavens like a scroll rolled up for books (completed),- even as We produced the first creation, so shall We produce a new one: a promise We have undertaken: truly shall We fulfil it." 21:104 Yusuf Ali translation

**Jainism**

Jain cosmology considers the loka, or universe, as an uncreated entity, existing since infinity, having no beginning or an end.[4] Jain texts describe the shape of the universe as similar to a man standing with legs apart and arm resting on his waist. This Universe, according to Jainism, is narrow at the top, broad at the middle and once again becomes broad at the bottom.[5]

Mahāpurāṇa of Ācārya Jinasena is famous for this quote: "Some foolish men declare that a creator made the world. The doctrine that the world was created is ill advised and should be rejected. If God created the world, where was he before the creation? If you say he was transcendent then and needed no support, where is he now? How could God have made this world without any raw material? If you say that he made this first, and then the world, you are faced with an endless regression."

**Taoism**

The cosmology of Taoism beliefs is a complex mixture of different beliefs. There is a "primordial universe" Wuji (philosophy), and Hongjun Laozu, water or qi.[6][7] It transformed into Taiji and multiplied into everything.[8][9] The Pangu legend tells a formless chaos coalesced into a cosmic egg. Pangu emerged (or woke up) and separated Yin from Yang with a swing of his giant axe, creating the Earth (murky Yin) and the Sky (clear Yang). To keep them separated, Pangu stood between them and pushed up the Sky. After Pangu died, he became everything.

**References**

[2] LDS Church (1995) ("Each [human] is a beloved spirit son or daughter of heavenly parents."); LDS Church (1997, p. 11) ("Man, as a spirit, was begotten and born of heavenly parents, and reared to maturity in the eternal mansions of the Father.").
[4] "This universe is not created nor sustained by anyone: It is self sustaining, without any base or support" "Nishpaadito Na Kenaapi Na Dhritah Kenachichch Sah Swayamsiddho Niradhaaro Gagane Kimtvavasthitah" [Yogaśāstra of Ācārya Hemacandra 4.106] Tr by Dr. A. S. Gopani
[5] See Hemacandras description of universe in Yogaśāstra "…Think of this loka as similar to man standing akimbo…"4.103-6
[8] 太一與三一 (http://www.riccibase.com/docfile/rel-tab06.htm)
Natural theology

Natural theology is a branch of theology based on reason and ordinary experience. Thus it is distinguished from revealed theology (or revealed religion) which is based on scripture and religious experiences of various kinds; and also from transcendental theology, theology from a priori reasoning.

Marcus Terentius Varro (116–27 BC) in his (lost) Antiquitates rerum humanarum et divinarum established a distinction of three kinds of theology: civil (political) (theologia civilis), natural (physical) (theologia naturalis) and mythical (theologia mythica). The theologians of civil theology are "the people", asking how the gods relate to daily life and the state (imperial cult). The theologians of natural theology are the philosophers, asking for the nature of the gods, and the theologians of mythical theology are the poets, crafting mythology. The terminology entered Stoic tradition and is used by Augustine of Hippo.

Natural theology, thus, is that part of the philosophy of religion dealing with describing the nature of the gods, or, in monotheism, arguing for or against attributes or non-attributes of God, and especially the existence of God, purely philosophically, that is, without recourse to any special or supposedly supernatural revelation. Physico-theology is the term for a theology based on the constitution of the natural world, especially derived from perceived elements of "design", which gave rise to the argument from design for the existence of God, beginning with the "fifth way" of the Summa Theologica by Thomas Aquinas (d. 1274).

Key proponents

Besides Zarathushtra's Gathas, Plato gives the earliest surviving account of a "natural theology", around 360 BC, in his dialogue "Timaeus" he states "Now the whole Heaven, or Cosmos, ...we must first investigate concerning it that primary question which has to be investigated at the outset in every case,—namely, whether it has existed always, having no beginning of generation, or whether it has come into existence, having begun from some beginning". He continues in his Laws establishing the existence of the gods by rational argument, stating "...which lead to faith in the gods? ...One is our dogma about the soul...the other is our dogma concerning the ordering of the motion of the stars". Aristotle in his Metaphysics argues for the existence of an "unmoved mover", an argument taken up in medieval scholastics.

From the 8th century, the Mutazilite school of Islam, compelled to defend their principles against the orthodox Islam of their day, looked for support in philosophy, and are among the first to pursue a rational Islamic theology, called Ilm-al-Kalam (scholastic theology). The teleological argument was presented by the early Islamic philosophers, Alkindus and Averroes (founder of Averroism), while Avicenna (founder of the Avicennism school of Islamic philosophy) presented both the cosmological argument and ontological argument in The Book of Healing (1027).

Thomas Aquinas (c.1225–1274), wrote Summa Theologica and Summa Contra Gentiles which both present various versions of the Cosmological argument and Teleological argument, respectively. The Ontological argument is also presented, but rejected in favor of proofs dealing with cause and effect alone.

Thomas Barlow, Bishop of Lincoln wrote Exceiritationes aliquot metaphysicae de Deo (1637) and spoke often of natural theology during the reign of Charles II.

John Ray (1627–1705) also known as John Wray, was an English naturalist, sometimes referred to as the father of English natural history. He published important works on plants, animals, and natural theology.

William Derham (1657–1735), was a friend and disciple of John Ray. He continued Ray's tradition of natural theology in two of his own works, The Physico-Theology, published in 1713, and the Astro-Theology, 1714. These would later help influence the work of William Paley (see below).

In An Essay on the Principle of Population, the first edition published in 1798, Thomas Malthus ended with two chapters on natural theology and population. Malthus—a devout Christian—argued that revelation would "damp the soaring wings of intellect", and thus never let "the difficulties and doubts of parts of the scripture" interfere with his
work.

William Paley gave a well-known rendition of the teleological argument for God. In 1802 he published *Natural Theology, or Evidences of the Existence and Attributes of the Deity collected from the Appearances of Nature*. In this he described the Watchmaker analogy, for which he is probably best known. Searing criticisms of arguments like Paley's are found in David Hume's posthumous *Dialogues Concerning Natural Religion*.\[^3\]

Thomas Paine wrote the definitive book on the natural religion of Deism, *The Age of Reason* (1794–1807). In it he uses reason to establish a belief in Nature's Designer who man calls God. He also establishes the many instances that Christianity and Judaism require us to give up our God-given reason in order to accept their claims to revelation.

American education reformer and abolitionist, Horace Mann (1796–1859) taught political economy, intellectual and moral philosophy, and natural theology.

Professor of chemistry and natural history, Edward Hitchcock also studied and wrote on natural theology. He attempted to unify and reconcile science and religion, focusing on geology. His major work in this area was *The Religion of Geology and its Connected Sciences* (1851).\[^4\]

The Gifford Lectures are lectures established by the will of Adam Lord Gifford. They were established to "promote and diffuse the study of Natural Theology in the widest sense of the term—in other words, the knowledge of God."

The term natural theology as used by Gifford means theology supported by science and not dependent on the miraculous.\[^5\]

### The Bridgewater Treatises

Debates over the applicability of teleology to scientific questions came to a head in the nineteenth century, as Paley's argument about design came into conflict with radical new theories on the transmutation of species. In order to support the canonical scientific views at the time, which explored the natural world within Paley's framework of a divine designer, The Earl of Bridgewater, a gentleman naturalist, commissioned eight *Bridgewater Treatises* upon his deathbed to explore "the Power, Wisdom, and Goodness of God, as manifested in the Creation."\[^6\] They first appeared during the years 1833 to 1840, and afterwards in Bohn's Scientific Library. The treatises are:

3. *Astronomy and General Physics considered with reference to Natural Theology*, by William Whewell, D. D.
5. *Animal and Vegetable Physiology considered with reference to Natural Theology*, by Peter Mark Roget.
8. *Chemistry, Meteorology, and the Function of Digestion, considered with reference to Natural Theology*, by William Prout, M.D.

In response to the claim in Whewell's treatise that "We may thus, with the greatest propriety, deny to the mechanical philosophers and mathematicians of recent times any authority with regard to their views of the administration of the universe", Charles Babbage published what he called *The Ninth Bridgewater Treatise, A Fragment*.\[^7\] As his preface states, this volume was not part of that series, but rather his own reflections on the subject. He draws on his own work on calculating engines to consider God as a divine programmer setting complex laws underlying what we think of as miracles, rather than miraculously producing new species on a Creative whim. There was also a fragmentary supplement to this, posthumously published by Thomas Hill.\[^8\]

The works are of unequal merit; several of them took a high rank in apologetic literature, but they attracted considerable criticism. One notable critic of the Bridgewater Treatises was Edgar Allan Poe, who wrote *Criticism*.\[^9\]

Robert Knox, an Edinburgh surgeon and leading advocate of radical morphology, referred to them as the "Bilgewater Treatises", to mock the "ultra-teleological school". Though memorable, this phrase overemphasises the influence of
teleology in the series, at the expense of the idealism of the likes of Kirby and Roget.\[10\]

References

[1] Plato, Timaeus (http://www.perseus.tufts.edu/cgi-bin/ptext?doc=Perseus:text:1999.01.0180;query=section=#400;layout=loc;Tim.28a)

Further reading

• Bascom, John, Natural Theology (1880)
• Hauerwas, Stanley, With the Grain of the Universe: The Church's Witness and Natural Theology ISBN 1-58743-016-9
• Kirby, W., On the Power Wisdom and Goodness of God. As Manifested in the Creation of Animals and in Their History, Habits and Instincts; Bridgewater Treatises, W. Pickering, 1835 (reissued by Cambridge University Press, 2009; ISBN 9781108000734)
• Prout, W., Chemistry, Meteorology, and the Function of Digestion Considered with Reference to Natural Theology; Bridgewater Treatises, W. Pickering, 1834 (reissued by Cambridge University Press, 2009; ISBN 978110800666)
• Roget, P.M., Animal and Vegetable Physiology. Considered with Natural Theology; Bridgewater Treatises, W. Pickering, 1834 (reissued by Cambridge University Press, 2009; ISBN 978110800086)

**External links**

• Apollos.ws (http://www.apollos.ws/philosophy-of-religion-article) A Christian site surveying arguments for the existence of God and responses to common arguments against.

• Catholic Encyclopedia article Bridgewater Treatises (http://www.newadvent.org/cathen/02783b.htm)

• Dialogues Concerning Natural Religion (http://www.anselm.edu/homepage/dbanach/dnr.htm) by David Hume


**The Bridgewater Treatises**


5. Animal and Vegetable Physiology, Considered with Reference to Natural Theology *Animal and Vegetable Physiology considered with reference to Natural Theology* (http://www.google.ca/books?id=EfwLAADAIAAJ&dq=Animal+and+Vegetable+Physiology+considered+with+reference+to+Natural+Theology), by Peter Mark Roget.


Henry More

Henry More FRS (October 12, 1614 – September 1, 1687) was an English philosopher of the Cambridge Platonist school.

Biography

Henry was born at Grantham and was schooled at The King's School, Grantham and at Eton College. Both his parents were Calvinists but he himself "could never swallow that hard doctrine." In 1631 he entered Christ's College, Cambridge, at about the time John Milton was leaving it. He took his BA in 1635, his MA in 1639, and immediately afterwards became a fellow of his college, turning down all other positions that were offered. He would not accept the mastership of his college, to which, it is understood, he would have been preferred in 1654, when Ralph Cudworth was appointed. In 1675, he finally accepted a prebend in Gloucester Cathedral, but only to resign it in favour of his friend Dr. Edward Fowler, afterwards bishop of Gloucester.

More taught many notable pupils, including Anne Finch, sister of Heneage Finch, subsequently Earl of Nottingham. She later became Lady Conway, and at her country seat at Ragley in Warwickshire, More would spend "a considerable part of his time." She and her husband both appreciated him, and amidst the woods of this retreat he wrote several of his books. The spiritual enthusiasm of Lady Conway was a considerable factor in some of More's speculations, even though she at length joined the Quakers. She became the friend not only of More and William Penn, but of Franciscus Mercurius van Helmont (1614–1699) and Valentine Gatreakes, mystical thaumaturgists of the 17th century. Ragley became a centre of devotion and spiritualism.

Views

More (1712) rejected Cartesian dualism on the following grounds: "It would be easier for me to attribute matter and extension to the soul, than to attribute to an immaterial thing the capacity to move and be moved by the body." His difficulties with Cartesian Dualism arose, not from an inability to understand how material and immaterial substances could interact, but from an unwillingness to accept any unextended entity as any kind of real entity. More continues "...it is plain that if a thing be at all it must be extended." So for More 'spirit' too must be extended. This led him to the idea of a 'fourth dimension" in which the spirit is extended, to which he gave the curious name of "essential spissitude." For further comments on this idea see Burtt (1932) and Smythies (1994). References. Burtt, E.A. The Metaphysical Foundations of Science. London. Routledge & Kegan Paul. 1932 More, H. The Immortality of the Soul. London (4th edition). 1712. Smythies, J. The Walls of Plato's Cave. Aldershot, Avebury. 1994
Works

He was a prolific writer of verse and prose. The *Divine Dialogues* (1688), a treatise which condenses his general view of philosophy and religion. Like many others he began as a poet and ended as a prose writer. His first work, published in 1642, but written two years earlier, was entitled *Psychodaia Platonica*; or, a *Platonicall Song of the Soul, consisting of foure several Poems*. This was followed in 1647 by his full collection of *Philosophicall Poems*, which includes *The Song of the Soul*, 'much enlarged, and is dedicated ' to his dear father.' A second edition was published in the same year, and it was included by A. B. Grosart in his Chertsey Worthies Library (1878).[2]

His prose works are:

- *Observations upon Anthroposophia Theomagica and Anima Magica Abscondita by Alazonomastix Philalethes*, 1650; in answer to Thomas Vaughan, who replied in *The Man-mouse taken in a Trape*.
- *The Second Lash of Alazonomastix*, a rejoinder to Vaughan, 1651.
- *An Antidote against Atheism, or an Appeal to the Naturall Faculties of the Minde of Man, whether there be not a God*, 1653 : 2nd edit. 'corrected and enlarged: With an Appendix thereunto annexed,' 1655.
- *Conjectura Cabbalistica ... or a Conjectural Essay of Interpreting the Minde of Moses, according to a Threefold Cabbala: viz. Literal, Philosophical, Mystical, or Divinely Moral*, 1653; dedicated to Ralph Culworth.
- *Enthusiasmus Triumphatus, or a Discourse of the Nature, Causes, Kinds, and Cure of Enthusiasme; written by Philophilus Parrasiastes, and prefixed to Alazonomastix his Observations and Reply, &c.*, 1656.
- *The Immortality of the Soul, so farre forth as it is demonstrable from the Knowledge of Nature and the Light of Reason*, 1659; dedicated to Viscount Conway.
- *An Explanation of the Grand Mystery of Godliness; or a True and Faithful Representation of the Everlasting Gospel of our Lord and Saviour Jesus Christ*, 1660.
- *A Modest Enquiry into the Mystery of Iniquity, and an Apologie, &c.*, 1664.
- *Divine Dialogues, containing sundry Disquisitions and Instructions concerning the Attributes of God and His Providence in the World*, 1668. The most authentic edition appeared in 1713.
- *An Exposition of the Seven Epistles to the Seven Churches; Together with a Brief Discourse of Idolatry, with application to the Church of Rome. The title of the latter in the volume itself is An Antidote against Idolatry, and it elicited from More in reply to attacks A brief Reply to a late Answer to Dr. Henry More his antidote against Idolatry, 1672, and An Appendix to the late Antidote against Idolatry, 1673.*
- *Enchiridion Metaphysicum: sive, de rebus incorporeis succincta et luculenta dissertati; pars prima*, 1671, an attack on Cartesian philosophy, which he had in earlier life admired.
- *Remarks upon two late ingenious Discourses [by Matthew Hale]; the one, an Essay, touching the Gravitation and non-Gravitation of Fluid Bodies; the other, touching the Torricellian Experiment, so far forth as they may concern any passages in his "Enchiridion Metaphysicum,"* 1676.
- *Apocalypsis Apocalypses; or the Revelation of St. John the Divine unveiled: an exposition from chapter to chapter and from verse to verse of the whole Book of the Apocalypse*, 1680.
- *A Plain and continued Exposition of the several Prophecies or Divine Visions of the Prophet Daniel, which have or may concern the People of God, whether Jew or Christian, &c.*, 1681.
- *A Brief Discourse of the Real Presence of the Body and Blood of Christ in the Celebration of the Holy Eucharist; wherein the Witty Artifices of the Bishop of Meaux [Bossuet] and of Monsieur Maimbourg are obviated, whereby they would draw in the Protestants to imbrace the doctrine of Transubstantiation*, 1681.[2]

More is also believed to have written *Philosophiae Teutonicae Censura*, 1670, a criticism of the theosophy of Jacob Boehme; and to have edited Joseph Glanvill's *Saducismus Triumphatus*, 1681. He certainly contributed largely to the volume, and also wrote many of the annotations to Glanvill's *Lux Orientalis,* 1682. More agreed with Glanvill on belief in witchcraft and apparitions. Several letters from More to John Worthington are printed in Worthington's
Diary, and some Letters Philosophical and Moral between John Norris and Henry More are added to Norris's Theory and Regulation of Love, 1688. A Collection of several Philosophical Writings of Dr. Henry More includes his Antidote against Atheism, with the Appendix, Enthusiasmus Triumphatus, Letters to Des Cartes, &c., Immortality of the Soul, and Conjectura Cabbalistica. A fourth edition, 'corrected and much enlarged,' was put forth in 1712, and was 'enriched with all the Scholia or Notes that he added afterwards in his Latin edition of these works.'

More issued complete editions of his works, his Opera theologica in 1675, and his Opera philosophica in 1678. Between 1672 and 1675 More was principally engaged in translating his English works into Latin. In 1675 appeared Henrici Mori Cantabrigiensis Opera Theologica, Anglice quidem primitius scripta, mine vero per autorem Latinae redditia. Hisce novus praefixus est De Synchronismis Apocalypticis Tractatus. This was followed in 1679 by a larger work in two volumes, Henrici Mori Cantabrigiensis Opera Omnia, tum quae Latine tum quae Anglice scripta sunt; nunc vero Latinitate donata instigatu et impensis generosisissimi juvenis Johannis Cockshutt nobilissim Angli. Mr. Cockshutt of the Inner Temple had left a legacy of £300 to More to have three of his principal pieces translated into Latin, and More complied with the terms of the legacy by translating into Latin many more of his English works. In 1692 were published Discourses on Several Texts of Scripture, with a preface signed 'John Worthington; ' and in 1694 Letters on Several Subjects, published by Edmund Elys. Abridgments of and extracts from the works of More were numerous; and in 1708 a volume was published for charitable libraries, The Theological Works of the most Pious and Learned Henry More. The work is in English, but 'according to the author's Improvements in his Latin edition.'

The chief authorities for his life are Richard Ward's Life (1710); the prefatio generalissima prefixed to his Opera omnia (1679); and also a general account of the manner and scope of his writings in an Apology published in 1664. The collection of his Philosophical Poems (1647), in which he has "compared his chief speculations and experiences," should also be consulted. An elaborate analysis of his life and works is given in John Tulloch's Rational Theology, vol. ii. (1874); see also R Zimmermann, Henry More und die vierte Dimension des Raums (Vienna, 1881); Henry More: Tercentenary Studies, ed. by Sarah Hutton (Dordrecht, 1990).

**Influence**

A quotation from More is used as the epigraph of Ralph Waldo Emerson's "The Over-soul."

**Notes**


**References**


**Attribution**

- This article incorporates text from a publication now in the public domain: Chisholm, Hugh, ed. (1911). *Encyclopædia Britannica* (11th ed.). Cambridge University Press.
Cambridge Platonists

The Cambridge Platonists were a group of philosophers at Cambridge University in the middle of the 17th century (between 1633 and 1688).

Programme

The Cambridge Platonists were reacting to two pressures. On the one hand, the dogmatism of the Puritan divines, with their anti-rationalist demands, were, they felt, immoral and incorrect. They also felt that the Puritan/Calvinist insistence upon individual revelation left God uninvolved with the majority of mankind. At the same time, they were reacting against the reductive materialist writings of Thomas Hobbes. They felt that the latter, while properly rationalist, were denying the idealistic part of the universe. To the Cambridge Platonists, religion and reason were in harmony, and reality was known not by physical sensation alone, but by intuition of the "intelligible forms" that exist behind the material world of everyday perception. Universal, ideal forms (à la Plato) inform matter, and the physical senses are unreliable guides to their reality.

As divines and in matters of polity, the Cambridge Platonists argued for moderation. They believed that reason is the proper judge of all disagreements, and so they advocated dialogue between the Puritans and the High Churchmen. They had a mystical understanding of reason, believing that reason is not merely the sense-making facility of the mind, but, instead, "the candle of the Lord" - an echo of the divine within the human soul and an imprint of God within man. Thus, they believed that reason could lead beyond the sensory, because it is semi-divine. Reason was, for them, of God, and thus capable of nearing God. Therefore, they believed that reason could allow for judging the private revelations of Puritan theology and the proper investigation of the rituals and liturgy of the Established Church. For this reason, they were called latitudinarians.

Representatives

- Anne Conway, Viscountess Conway (1631-1679)
- Anthony Ashley Cooper, 3rd Earl of Shaftesbury (1671-1713)
- Ralph Cudworth (1617–1688)
- Nathaniel Culverwel (1619–1651)
- Joseph Glanvill (1636-1680)
- Damaris Cudworth Masham (1659-1708)
- Henry More (1614–1687)
- John Norris (1657-1711)
- George Rust (d.1670)
- John Smith (1618–1652)
• Peter Sterry (1613–1672)
• Benjamin Whichcote (1609–1683)
• John Worthington (1618-1671)

**Major Works of the Cambridge Platonists**

• Conway's only surviving treatise, *The Principles of the Most Ancient and Modern Philosophy* (1692) presents an ontology of spirit in opposition to More, Descartes, Hobbes and Spinoza and utilizes a concept of a monad derived from Kabbala and which anticipates Leibniz who may have plagiarized the idea from her.

• Cudworth's chief philosophical work was *The True Intellectual System of the Universe* (1678) and the *Treatise concerning Eternal and Immutable Morality*, which appeared posthumously in 1731.

• Culverwel's chief work was *Light of Nature* (1652). Culverwel died young (probably at the age of 32). He had intended to write a multi-part work reconciling the Gospel with philosophical reason.

• Henry More (1614–1687) wrote many works. As a Platonist, his important works were *Manual of Ethics* (1666), the *Divine Dialogues* (1668), and the *Manual of Metaphysics* (1671). While all of More's works enjoyed popularity, the *Divine Dialogues* were perhaps most influential.

• John Smith, a student of Benjamin Whichcote, is best remembered today for the elegance of his style and the depth of his learning in the posthumously published *Select Discourses* (1660).

• Peter Sterry is remembered for his *A Discourse of the Freedom of the Will* (1675) among other works.

• Benjamin Whichcote (1609–1683) was one of the leaders of the movement, but he was also an active pastor and academic who did not publish in his lifetime. His sermons were notable and caused controversies, and Whichcote wrote a great deal without publishing. In 1685, *Some Select Notions of B. Whichcote* was published due to demand. After that was *Select Sermons* (1689) (with a preface by Shaftesbury) and *Several Discourses* (1701). Finally, a collection of his sayings appeared as *Moral and Religious Aphorisms* in 1703.

**Further reading**


**External links**

• The Cambridge Platonists entry by Sarah Hutton in the Stanford Encyclopedia of Philosophy

• Cambridge Platonism a new site dedicated to providing resources for the study of the philosophical and theological movement.

**References**


Richard Popkin

<table>
<thead>
<tr>
<th>Full name</th>
<th>Richard Popkin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Born</td>
<td>December 27, 1923</td>
</tr>
<tr>
<td>Died</td>
<td>April 14, 2005</td>
</tr>
<tr>
<td>Era</td>
<td>20th-century philosophy</td>
</tr>
<tr>
<td>Region</td>
<td>Western Philosophy</td>
</tr>
<tr>
<td>School</td>
<td>Scepticism, Pyrrhonian skepticism</td>
</tr>
<tr>
<td>Main interests</td>
<td>History of philosophy, Seventeenth century, Eighteenth century, Jewish philosophers, Jewish philosophy, millenarianism and messianism</td>
</tr>
<tr>
<td>Notable ideas</td>
<td>Influence of pyrrhonian skepticism on Western thought</td>
</tr>
</tbody>
</table>

Richard H. Popkin (December 27, 1923—April 14, 2005) was an academic philosopher who specialized in the history of enlightenment philosophy and early modern anti-dogmatism. His 1960 work The History of Scepticism from Erasmus to Descartes introduced previously unrecognized influence on Western thought in the seventeenth century, the Pyrrhonian Scepticism of Sextus Empiricus. Popkin also was an internationally acclaimed scholar on Jewish and Christian millenarianism and messianism.

**Life**

Richard Popkin was born in Manhattan to Louis and author Zelda Popkin, who jointly ran a small public relations firm. He earned his Bachelor's degree and, in 1950, his Ph.D. from Columbia University. He taught at American universities, including the University of Connecticut, The University of Iowa, the University of California San Diego, Washington University in St. Louis, and the University of California Los Angeles. He was visiting professor at University of California Berkeley, Brandeis University, Duke University, Emory University, Tel Aviv University, and was Distinguished Professor at the City University of New York. Popkin was the founding director of the International Archives of the History of Ideas and the first editor of the *Journal of the History of Philosophy*.

Among his honors, Popkin was awarded the Nicholas Murray Butler Medal by Columbia University and was a fellow of the American Academy of Arts and Sciences. He was president emeritus and founding editor of the *Journal of the History of Philosophy*.

Richard Popkin spent his later years living in Pacific Palisades, California. He died of emphysema in Los Angeles in April 2005. His papers have been archived at the William Andrews Clark Memorial Library at UCLA.
Family
Professor Popkin is survived by Juliet (née Greenstone), whom he married in 1944, and two of their three children, Jeremy Popkin (b. 1948) and his younger daughter, Susan Popkin (b. 1961). Margaret Popkin (1950–2005) was a prominent civil rights lawyer and activist, known particularly for her work in El Salvador during the civil war of the 1980s.

Works
Richard H. Popkin published many textbooks on philosophy, some with Avrum Stroll. He was editor and translator of selections from Pierre Bayle’s Historical and Critical Dictionary (1965). His last book, Disputing Christianity (2007) was completed posthumously by his son.

A Festschrift volume of essays in his honor, The Legacies of Richard H. Popkin, also edited by his son Jeremy Popkin, was published in 2009 (Springer, New York).

Beyond his philosophical works, he is noted for writing The Second Oswald (1966), questioning the Warren Report lone gunman explanation of the John F. Kennedy assassination.

Selected bibliography

- The High Road to Pyrrhonism, 1980.
  - Incl.: Hume's Racism Reconsidered, pp. 64 –75.
  - Spinoza (Oneworld Philosophers), 2004. ISBN 1851683399

References

[1] Later editions are enlarged and so have slightly different titles


External links

- The Reformed Librarie-Keeper (1650) (http://www.gutenberg.org/etext/15199) at Project Gutenberg, with an introduction by Richard H. Popkin

Swedenborg had a prolific career as an inventor and scientist. In 1741, at the age of fifty-three, he entered into a spiritual phase[5] in which he eventually began to experience dreams and visions beginning on Easter weekend April 6, 1744. This culminated in a spiritual awakening, whereupon he claimed he was appointed by the Lord to write a heavenly doctrine to reform Christianity. He claimed that the Lord had opened his spiritual eyes, so that from then on he could freely visit heaven and hell, and talk with angels, demons and other spirits.

<table>
<thead>
<tr>
<th>Era</th>
<th>18th-century</th>
</tr>
</thead>
<tbody>
<tr>
<td>Region</td>
<td>Europe</td>
</tr>
<tr>
<td>Born</td>
<td>January 29, 1688 Stockholm, Sweden</td>
</tr>
<tr>
<td>Died</td>
<td>March 29, 1772 (aged 84) London, England</td>
</tr>
<tr>
<td>Occupation</td>
<td>mining engineer, nobleman, author</td>
</tr>
<tr>
<td>Language</td>
<td>Swedish, Neo-Latin, English</td>
</tr>
<tr>
<td>Tradition or movement</td>
<td>Lutheran Christianity</td>
</tr>
<tr>
<td>Main interests</td>
<td>theology, science, philosophy</td>
</tr>
<tr>
<td>Notable ideas</td>
<td>Last Judgment and Second Coming of Christ occurred</td>
</tr>
<tr>
<td>Notable works</td>
<td><em>True Christian Religion</em>, <em>Heaven and Hell</em></td>
</tr>
<tr>
<td>Influences</td>
<td>Plato, Aristotle, Plotinus, Augustine, Descartes, Leibniz</td>
</tr>
</tbody>
</table>
He said that the Last Judgement had already occurred, in 1757, although only visible in the spiritual world, where he had witnessed it.\(^6\) That Judgement was followed by the Second Coming of Jesus Christ, which occurred, not by Christ in person, but by a revelation from Him through the inner, spiritual sense of the Word\(^7\) to Swedenborg.\(^8\) In fact, Swedenborg said, it is the presence of that spiritual sense that makes the Word Divine.\(^9\)

For the remaining 28 years of his life, he wrote and published 18 theological works, of which the best known was *Heaven and Hell* (1758),\(^10\)\(^11\) and several unpublished theological works. Some followers of Swedenborg believe that, of his theological works, only those which Swedenborg published himself are fully divinely inspired.\(^12\)

In *Life on Other Planets*, Swedenborg stated that he conversed with spirits from Jupiter, Mars, Mercury, Saturn, Venus, and the moon.\(^13\) He did not report conversing with spirits from Uranus and Neptune, which were not yet discovered. This lack is seen by some to raise question about the credibility of all his reports on this matter. This issue has been extensively reviewed elsewhere.\(^14\)

Swedenborg explicitly rejected the common explanation of the Trinity as a Trinity of Persons, which he said was not taught in the early Christian church. There was, for instance, no mention in the Apostolic writings of any "Son from eternity".\(^15\) Instead he explained in his theological writings how the Divine Trinity exists in One Person, in One God, the Lord Jesus Christ, which he said is taught in Colossians 2:9. (See also 1 John 5:20, Matthew 28:18 and Acts 20:21)

Swedenborg also rejected the doctrine of salvation through faith alone, since he considered both faith and charity necessary for salvation, not one without the other, whereas the Reformers taught that faith alone procured justification, although it must be a faith which resulted in obedience. The purpose of faith, according to Swedenborg, is to lead a person to a life according to the truths of faith, which is charity, as is taught in 1 Corinthians 13:13 and James 2:20.

Swedenborg's theological writings have elicited a range of responses. However, he made no attempt to found a church.\(^16\)\(^17\) A few years after his death — 15 by one estimate\(^18\) — for the most part in England, small reading groups formed to study the truth they saw in his teachings.\(^19\) As one scholar has noted, Swedenborg’s teachings particularly appealed to the various dissenting groups that sprang up in the first half of the 19th century who were "surfeited with revivalism and narrow-mindedness" and found his optimism and comprehensive explanations appealing.\(^20\)

A variety of important cultural figures, both writers and artists, were influenced by Swedenborg, including Johnny Appleseed, William Blake, Jorge Luis Borges, Daniel Burnham, Arthur Conan Doyle,\(^21\) Ralph Waldo Emerson,\(^22\) John Flaxman, George Inness, Henry James Sr., Carl Jung,\(^23\) Immanuel Kant,\(^24\) Helen Keller, Czesław Miłosz, August Strindberg, D.T. Suzuki, and W.B. Yeats.

His philosophy had a great impact on the Duke of Sodermanland, later King Carl XIII, who as the Grandmaster of Swedish Freemasonry (*Svenska Frimurare Orden*) built its unique system of degrees and wrote its rituals.

In contrast, one of the most prominent Swedish authors of Swedenborg's day, Johan Henric Kellgren, called Swedenborg "nothing but a fool".\(^25\) A heresy trial was initiated in Sweden in 1768 against Swedenborg’s writings and two men who promoted these ideas.\(^26\)

In the two centuries since Swedenborg’s death, various interpretations of his theology have been made, and he has also been scrutinized in biographies and psychological studies.\(^27\)
Biography

Early life

Swedenborg’s father, Jesper Swedberg (1653–1735), descended from a wealthy mining family. He travelled abroad and studied theology, and on returning home he was eloquent enough to impress the Swedish king, Charles XI, with his sermons in Stockholm. Through the King’s influence he would later become professor of theology at Uppsala University and Bishop of Skara.\[28][29]

Jesper took an interest in the beliefs of the dissenting Lutheran Pietist movement, which emphasised the virtues of communion with God rather than relying on sheer faith (\textit{sola fide}).\[30] Sola fide is a tenet of the Lutheran Church, and Jesper was charged with being a pietist heretic. While controversial, the beliefs were to have a major impact on his son Emanuel’s spirituality. Jesper furthermore held the unconventional belief that angels and spirits were present in everyday life. This also came to have a strong impact on Emanuel.\[28][29][31]

Swedenborg completed his university course at Uppsala in 1709, and in 1710 made his grand tour through the Netherlands, France, and Germany, before reaching London, where he would spend the next four years. It was also a flourishing center of scientific ideas and discoveries. Emanuel studied physics, mechanics, and philosophy, and read and wrote poetry. According to the preface of a book by the Swedish critic Olof Lagerkrantz, Swedenborg wrote to his benefactor and brother-in-law Eric Benzelius that he believed he (Swedenborg) might be destined to be a great scientist.\[32][33]

Scientific period

In 1715 Swedenborg returned to Sweden, where he was to devote himself to natural science and engineering projects for the next two decades. A first step was his noted meeting with King Charles XII of Sweden in the city of Lund, in 1716. The Swedish inventor Christopher Polhem, who became a close friend of Swedenborg, was also present. Swedenborg’s purpose was to persuade the king to fund an observatory in northern Sweden. However, the warlike king did not consider this project important enough, but did appoint Swedenborg assessor-extraordinary on the Swedish Board of Mines (\textit{Bergskollegium}) in Stockholm.\[34]

From 1716 to 1718 Swedenborg published a scientific periodical entitled \textit{Daedalus Hyperboreus} ("The Northern Daedalus"), a record of mechanical and mathematical inventions and discoveries. One notable description was that of a flying machine, the same he had been sketching a few years earlier (see Flying Machine (Swedenborg)).\[33]

Upon the death of Charles XII, Queen Ulrika Eleonora ennobled Swedenborg and his siblings. It was common in Sweden during the 17th and 18th centuries for the children of bishops to receive this honour as a recognition of the services of their father. The family name was changed from Swedberg to Swedenborg.\[35] (Note: The reader should be aware that there is question about this and the other Bergquist Notes’ accuracy. See \[36] and scroll down to “Bergquist Footnote problem.”)
In 1724 he was offered the chair of mathematics at Uppsala University but he declined, saying that he had mainly dealt with geometry, chemistry and metallurgy during his career. He also noted that he did not have the gift of eloquent speech because of a speech impediment. The speech impediment in question was stuttering, noted by many acquaintances of his: it forced him to speak slowly and carefully and there are no known occurrences of his speaking in public. The Swedish critic Olof Lagerkrantz proposed that Swedenborg compensated for his impediment by extensive argumentation in writing.

**New direction of studies**

During the 1730s Swedenborg undertook many studies of anatomy and physiology. He had the first anticipation, as far as known, of the neuron concept. It was not till a century later that science recognized the full significance of the nerve cell. He also had prescient ideas about the cerebral cortex, the hierarchical organization of the nervous system, the localization of the cerebrospinal fluid and the functions of the pituitary gland. In some cases his conclusions have been experimentally verified in modern times. There is also evidence that Swedenborg may have preceded Kant by 20 years in the development of the nebular hypothesis.

In the 1730s Swedenborg also became increasingly interested in spiritual matters and was determined to find a theory which would explain how matter relates to spirit. Swedenborg’s desire to understand the order and purpose of creation first led him to investigate the structure of matter and the process of creation itself. In the *Principia* he outlined his philosophical method, which incorporated experience, geometry (the means whereby the inner order of the world can be known), and the power of reason; and he presented his cosmology, which included the first presentation of his Nebular hypothesis. In Leipzig, 1735, he published a three volume work entitled *Opera philosophica et mineralis* ("Philosophical and mineralogical works"), where he tries to conjoin philosophy and metallurgy. The work was mainly appreciated for its chapters on the analysis of the smelting of iron and copper, and it was this work which gave Swedenborg international reputation.

The same year he also published the small manuscript *de Infinito* ("On the Infinite"), where he attempted to explain how the finite is related to the infinite, and how the soul is connected to the body. This was the first manuscript where he touched upon these matters. He knew that it might clash with established theologies, since he presents the view that the soul is based on material substances.

He also conducted dedicated studies of the fashionable philosophers of the time John Locke, Christian von Wolff, Leibniz, and Descartes, as well as returning to earlier thinkers Plato, Aristotle, Plotinus, Augustine, and others.

In 1743, at the age of 55, Swedenborg requested a leave of absence to go abroad. His purpose was to gather source material for *Regnum animale* (The Animal Kingdom, or Kingdom of Life), a subject on which books were not readily available in Sweden. The aim of the book was to explain the soul from an anatomical point of view. He had planned to produce a total of seventeen volumes.

**Journal of Dreams**

By 1744 he had traveled to the Netherlands. Around this time he began having strange dreams. Swedenborg carried a travel journal with him on most of his travels, and did so on this journey. The whereabouts of the diary were long unknown, but it was discovered in the Royal Library in the 1850s and published in 1859 as *Drömboken, or Journal of Dreams*.

He experienced many different dreams and visions, some greatly pleasurable, others highly disturbing. The experiences continued as he traveled to London to continue the publication of *Regnum animale*. This process, which one biographer has proposed as cathartic and comparable to the Catholic concept of Purgatory, continued for six months. He also proposed that what Swedenborg was recording in his *Journal of Dreams* was a battle between the love of his self and the love of God.
Emanuel Swedenborg

Visions and spiritual insights

In the last entry of the journal from October 26–27, 1744, Swedenborg appears to be clear as to which path to follow. He felt he should drop his current project, and write a new book about the worship of God. He soon began working on *De cultu et amore Dei*, or *The Worship and Love of God*. It was never fully completed, but Swedenborg still had it published in London in June 1745.[52]

One explanation why the work was never finished is given in a well-known and often referenced story. In April 1745, Swedenborg was dining in a private room at a tavern in London. By the end of the meal, a darkness fell upon his eyes, and the room shifted character. Suddenly he saw a person sitting at a corner of the room, telling Swedenborg: "Do not eat too much!". Swedenborg, scared, hurried home. Later that night, the same man appeared in his dreams. The man told Swedenborg that He was the Lord, that He had appointed Swedenborg to reveal the spiritual meaning of the Bible, and that He would guide Swedenborg in what to write. The same night, the spiritual world was opened to Swedenborg.[53]

Scriptural commentary and writings

In June 1747, Swedenborg resigned his post as assessor of the board of mines. He explained that he was obliged to complete a work he had begun and requested to receive half his salary as a pension.[54] He took up afresh his study of Hebrew and began to work on the spiritual interpretation of the Bible with the goal of interpreting the spiritual meaning of every verse. From sometime between 1746 and 1747, and for ten years henceforth, he devoted his energy to this task. Usually abbreviated as *Arcana Cœlestia* and under the Latin variant *Arcana Caelestia*[55] (translated as *Heavenly Arcana*, *Heavenly Mysteries*, or *Secrets of Heaven* depending on modern English-language editions), the book became his magnum opus and the basis of his further theological works.[56]

The work was anonymous and Swedenborg was not identified as the author until the late 1750s. It consisted of eight volumes, published between 1749 and 1756. It attracted little attention, as few people could penetrate its meaning.[57][58]

His life from 1747 until his death in 1772 was spent in Stockholm, Holland, and London. During these twenty five years he wrote another fourteen works of a spiritual nature of which most were published during his lifetime.

One of his lesser known works presents a startling claim, that the Last Judgment had begun in the previous year (1757) and was completed by the end of that year[59] and that he had witnessed the whole thing.[60] According to Swedenborg, the Last Judgment took place, not in the physical world, but in the World of Spirits, which is located half-way between heaven and hell, and which everyone passes through on their way to heaven or hell.[61] The Judgment took place because the Christian church had lost its charity and faith, resulting in a loss of spiritual free will that threatened the equilibrium between heaven and hell in everyone’s life.[62][63]

In another of his theological works, Swedenborg wrote that eating meat, regarded in itself, “is something profane,” and was not practiced in the early days of the human race.[64] This teaching appears to have given rise to the idea that Swedenborg was a vegetarian. This conclusion may have been reinforced by the fact that a number of Swedenborg’s early followers were part of the vegetarian movement that arose in Great Britain in the 19th century.[65] However, the only reports on Swedenborg himself are contradictory. His landlord in London, Shearsmith, said he ate no meat but his maid, who served Swedenborg, said that he ate eels and pigeon pie.[66]
Swedenborg published his work in London or Holland due to the freedom of the press unique to those countries.\[67][68]

Throughout this period he was befriended by many people who regarded him as a kind and warm-hearted man. When in the company of others, he was jovial, and conversed about whatever subject was discussed. Those who talked with him understood that he was devoted to his beliefs. He never argued matters of religion, except when ridiculed, when he replied sharply, so that the ridicule would not be repeated.\[69][70]

In July, 1770, at the age of 82, he traveled to Amsterdam to complete the publication of his last work. The book, *Vera Christiana Religio* (*The True Christian Religion*), was published in Amsterdam in 1771 and was one of the most appreciated of his works. Designed to explain his teachings to Lutheran Christians, it was the most concrete of his works.\[71]

In the summer of 1771, he traveled to London. Shortly before Christmas he suffered a stroke and was partially paralyzed and confined to bed. His health improved somewhat, but he died on March 29, 1772. There are several accounts of his last months, made by those he stayed with, and by Arvid Ferelius, a pastor of the Swedish Church in London, who visited him several times.\[72]

There is evidence that Swedenborg wrote a letter to John Wesley, the founder of Methodism, in February, saying he (Swedenborg) had been told in the world of spirits that Wesley wanted to speak with him.\[73] Wesley, startled, since he had not told anyone of his interest in Swedenborg, replied that he was going on a journey for six months and would contact Swedenborg on his return. Swedenborg replied that that would be too late since he (Swedenborg) would be going to the spiritual world for the last time on March 29.\[74] Wesley later read and commented extensively on Swedenborg’s work.\[75] Swedenborg’s landlord’s servant girl, Elizabeth Reynolds, also said Swedenborg had predicted this date, and that Swedenborg was as happy about it as if was “going on holiday or to some merrymaking.”\[76]

In Swedenborg’s final hours, his friend, Pastor Ferelius, told him some people thought he had written his theology just to make a name for himself and asked Swedenborg if he would like to recant. Raising himself up on his bed, his hand on his heart, Swedenborg earnestly replied,

"As truly as you see me before your eyes, so true is everything that I have written; and I could have said more had it been permitted. When you enter eternity you will see everything, and then you and I shall have much to talk about.”\[77]

He then died, in the afternoon, on the date he had predicted, March 29.\[77]

He was buried in the Swedish Church in Shadwell, London. On the 140th anniversary of his death, in 1912/1913, his earthly remains were transferred to Uppsala Cathedral in Sweden, where they now rest close to the grave of the botanist Carolus Linnaeus. In 1917, the Swedish Church in Shadwell was demolished and the Swedish community that had grown around the parish moved to West London. In 1938 the site of the former church where he had been buried in London was redeveloped, and in his honor the local road was renamed Swedenborg Gardens. In 1997 a garden, play area and memorial near the road were created in his memory.
Veracity

Swedenborg's transition from scientist to mystic has fascinated many people ever since it occurred (see list of some of the people involved above, in introduction).

Some have asserted that Swedenborg lost his mind, suffering some sort of mental illness or nervous breakdown. While this idea was not uncommon during Swedenborg's own time, it is mitigated by his activity in the Swedish Riddarhuset (The House of the Nobility), the Riksdag (the Swedish parliament), and the Royal Swedish Academy of Sciences. A close analysis of the historical facts of his life conducted by the Swedenborg Scientific Association concluded that he was sane. Additionally, the system of thought in his theological writings is remarkably coherent.

Swedenborg has had a variety of biographers, favorable and critical. Some propose that he did not in fact have a revelation at all, but rather developed his theological ideas from sources ranging from his father to earlier figures in the history of thought, notably Plotinus. This position was first and most notably taken by the Swedish writer Martin Lamm, who wrote a biography of Swedenborg in 1915, which is still in print. Olof Lagercrantz, the Swedish critic and publicist, had a similar point of view, calling Swedenborg's theological writing "a poem about a foreign country with peculiar laws and customs".

Swedenborg's approach to demonstrating the veracity of his theological teachings was to find and use voluminous quotations from the Old Testament and New Testament to demonstrate agreement between the Bible or Word of God and his theological teachings. The demonstration of this agreement is found throughout his theological writings, since he rejected blind faith and declared true faith is an internal acknowledgment of the truth. The vast and consistent use of Biblical confirmations in Swedenborg's theological writings led a Swedish Royal Council in 1771, examining the heresy charges of 1770 against two Swedish supporters of his theological writings, to declare "there is much that is true and useful in Swedenborg's writings."

Scientific beliefs

Swedenborg proposed many scientific ideas during his lifetime. In his youth, he wanted to present a new idea every day, as he wrote to his brother-in-law Erik Benzelius in 1718. Around 1730, he had changed his mind, and instead believed that higher knowledge is not something that can be acquired, but that it is based on intuition. After 1745, he instead considered himself receiving scientific knowledge in a spontaneous manner from angels.

From 1745, when he considered himself to have entered a spiritual state, he tended to phrase his "experiences" in empirical terms, claiming to report accurately things he had experienced on his spiritual journeys.

One of his ideas that is considered most crucial for the understanding of his theology is his notion of correspondences. But in fact, he first presented the theory of correspondences in 1744, in the first volume of Regnum Animale dealing with the human soul.

The basis of the correspondence theory is that there is a relationship between the natural ("physical"), the spiritual, and the divine worlds. The foundations of this theory can be traced to Neoplatonism and the philosopher Plotinus in particular. With the aid of this scenario, Swedenborg now interpreted the Bible in a different light, claiming that even the most apparently trivial sentences could hold a profound spiritual meaning.
Psychic accounts

Three incidents of purported psychic ability of Swedenborg exist in the literature. There are several versions of each story.

The fire anecdote

The first was from July 29, 1759, when during a dinner in Gothenburg, he excitedly told the party at six o’clock that there was a fire in Stockholm (405 km away), that it consumed his neighbour's home and was threatening his own. Two hours later, he exclaimed with relief that the fire stopped three doors from his home. Two days later, reports confirmed every statement to the precise hour that Swedenborg first expressed the information. However, though the fire was real enough and spared Swedenborg’s house, the fire anecdote – one of the most well-known psychic anecdotes – may have an alternative explanation: In Sweden, the fire is known as Mariabranden (after the church Maria Kyrkan, which was severely damaged). In the high and increasing wind it spread very fast, consumed about 300 houses and made 2000 people homeless. However, the fire undoubtedly broke out Thursday July 19 (about 3 p.m.) and was put out during the following night or early morning. At that time, a messenger could bring the news from Stockholm to Gothenburg within two or three days. Under the July 29 interpretation, Swedenborg did not need any supernatural power or psychic ability to correctly visualize the fire. However, this explanation depends upon there being a belief in the July 29 date-based alternative. Since, as just noted, it seems clear that the July 19 date is correct there appears to be no credible basis for an explanation based on the 29th. It also seems unlikely in the extreme that the many witnesses to Swedenborg’s distress during the fire, and the immediate report of it to the provincial governor, would have believed any such claim.

In the fire anecdote, July 29 is said to be a Saturday. It was a Sunday. It has been proposed that, according to Swedenborg biographer John Garth Wilkinson, "On Saturday, at 4 o’clock, p.m.,” says Kant,” when Swedenborg arrived at Gottenburg [Gothenburg] from England, Mr. William Castel invited him to his house, together with a party of fifteen persons.” If so, Swedenborg could not participate in a party on July 19 because this date was a Thursday. If the dinner was arranged the first Saturday thereafter, on Saturday 21 July, Swedenborg also could be informed on the fire by a natural way.

This interpretation has several problems: One, as noted above, is that current scholarship does place the incident on July 19. The original Knobloch letter quoted from Kant does not specify a day of the week, but the definitive The Swedenborg Epic biography associates the 19th with Saturday. Furthermore, if the 29th is associated with Sunday, as just noted, then the 19th would be associated with Saturday. And, finally, there is, again, the simple logic that, if Swedenborg had received news of the fire at the same time as everyone else in Gothenburg, there would have been no anomaly perceived at the time and recorded for history.

The Queen of Sweden

The second event was in 1758 when Swedenborg visited Queen Louisa Ulrika of Sweden, who asked him to tell her something about her deceased brother Prince Augustus William of Prussia. The next day, Swedenborg whispered something in her ear that turned the Queen pale and she explained that this was something only she and her brother could know about.

The lost document

The third was a woman who had lost an important document, and came to Swedenborg asking if a recently deceased person could tell him where it was, which he (in some sources) was said to have done the following night. Although not typically cited along with these three episodes, there was one further piece of evidence of possible pertinence here: Swedenborg was noted by the seamen of the ships that he sailed between Stockholm and London to always have excellent sailing conditions. When asked about this by a friend, Swedenborg played down the matter,
saying he was surprised by this experience himself and that he was certainly not able to do miracles. [99]

Kant on Swedenborg

In 1763, Immanuel Kant (1724–1804), then at the beginning of his career, was impressed by these accounts and made inquiries to find out if they were true. He also ordered all eight volumes of the expensive Arcana Cœlestia (Heavenly Arcana or Heavenly Mysteries). One Charlotte von Knobloch wrote Kant asking his opinion of Swedenborg’s psychic experiences. [100][101] Kant wrote a very affirmative reply, referring to Swedenborg’s “miraculous” gift, and characterizing him as “reasonable, agreeable, remarkable and sincere” and “a scholar”, in one of his letters to Mendelssohn, [102] and expressing regret that he (Kant) had never met Swedenborg. [103][104] An English friend who investigated the matter for Kant, including visiting Swedenborg’s home, found Swedenborg to be a “sensible, pleasant and openhearted” man and, here again, a scholar. [105]

However, three years later, in 1766, Kant wrote and anonymously published a small book entitled Träume eines Geistersehers (Dreams of a Spirit-Seer) [106] that was a scathing critique of Swedenborg and his writings. He termed Swedenborg a “spook hunter” without official office or occupation. [108] As rationale for his critique Kant said that he wanted to stop “ceaseless questioning” and inquiries about “Dreams” from “inquisitive” persons, “both known and unknown,” and “importunate appeals from known and unknown friends,” as well as from “moon calves.” He also said he did not want to expose himself to “mockery.” More significantly, He became concerned about being seen as an apologist for both Swedenborg and for Spiritism in the guise of the interest in Swedenborg, which might have damaged his career. It seems clear that Dreams was intended as a refutation of all such thinking. This left Kant in the ironic or hypocritical position of trying to free himself of ridicule while at the same time applying ridicule to Swedenborg. [113]

However, there has long been a suspicion among some scholars that, despite "Dreams", Kant actually had a behind-the-scenes respect for Swedenborg. [116] Certainly there were inconsistencies in Kant’s handling of this issue. For instance,

(1) Kant’s writing style was usually “complex, labored, dry ...and earnest” but in “Dreams” was often “playful, ironic and humorous.” [117]

(2) While he mocked Swedenborg in print, in the preserved notes of Kant’s lectures on metaphysics taken by a student named Herder, Kant treated Swedenborg with respect, “not to be sneezed at.” [118][119] At one point, Herder’s notes term Swedenborg’s visions as “quite sublime.” [120]

(3) Kant’s friend Moses Mendelssohn thought there was a “joking pensiveness” in “Dreams” that sometimes left the reader in doubt as to whether “Dreams” was meant to make metaphysics laughable or spirit-seeking credible. [121]

(4) In a one of his letters to Mendelssohn Kant refers to ”Dreams” less-than-enthusiastically as a “desultory little essay”. [122]

Finally, a case has been made that Kant wrote “Dreams” before, not after, the Knobloch letter and that this was accomplished by accidentally or deliberately falsifying the dates of the documents involved, notably that of the Knobloch letter. [123] This alteration, if true, would strengthen the case for Swedenborg’s work being viewed by Kant, in the last analysis, positively. However, the fact of the matter is difficult to determine since the key date involved is that of the original of the Knobloch letter, which is lost. [123]
Theology

For a brief overview of the extensive teachings Swedenborg claimed were revealed to him by Jesus Christ, see the Table of Contents of his book, *The True Christian Religion, Containing the Universal Theology of the New Church*. Swedenborg considered his theology a revelation of the true Christian religion that had become obfuscated through centuries of theology. However, he did not refer to his writings as theology since he considered it based on actual experiences, unlike theology, except in the title of his last work. Neither did he wish to compare it to philosophy, a discipline he discarded in 1748 because it "darkens the mind, blinds us, and wholly rejects the faith".

The foundation of Swedenborg's theology was laid down in *Arcana Cœlestia* (Heavenly Mysteries), published in eight Latin volumes from 1749 to 1756. In a significant portion of that work, he interprets the Biblical passages of Genesis and Exodus. He reviews what he says is the inner spiritual sense of these two works of the Word of God. (He later made a similar review of the inner sense of the book of Revelation in *Apocalypse Revealed*.) Most of all, he was convinced that the Bible describes a human's transformation from a materialistic to a spiritual being, which he calls rebirth or regeneration. He begins this work by outlining how the creation myth was not an account of the creation of Earth, but an account of man's rebirth or regeneration in six steps represented by the six days of creation. Everything related to mankind in the Bible could also be related to Jesus Christ, and how Christ freed himself from materialistic boundaries through the glorification of his human presence by making it Divine. Swedenborg examines this idea in his exposition of Genesis and Exodus.

Marriage

One aspect of Swedenborg's writing that is often discussed is his ideas on marriage. Swedenborg himself remained a bachelor all his life, but that did not hinder him from writing voluminously on the subject. His work on *Marriage Love* (Conjugial Love in older translations) (1768) was dedicated to this purpose.

The quality of the relationship between husband and wife resumes in the spiritual world in whatever state it was at their death in this world. Thus, a couple in true marriage love remain together in that state in heaven into eternity. A couple lacking in that love by one or both partners, however, will separate after death and each will be given a compatible new partner if they wish. A partner is also given to a person who loved the ideal of marriage but never found a true partner in this world. The exception in both cases is a person who hates chaste marriage and thus cannot receive such a partner.

Swedenborg saw creation as a series of pairings, descending from the Divine love and wisdom that define God and are the basis of creation. This duality can be seen in the pairing of good and truth, charity and faith, God and the church, and husband and wife. In each case, the goal for these pairs is to achieve conjunction between the two component parts. In the case of marriage, the object is to bring about the joining together of the two partners at the spiritual and physical levels, and the happiness that comes as a consequence.

Trinity

Swedenborg was sharply opposed to the Christian doctrine of the Trinity as three Persons, the Person of the Father, the Person of the Son, and the Person of the Holy Spirit. Instead, he claimed that the three were different components of the one God, one Person, in whom is the Divine Trinity, and that divinity is impossible if divided into three Persons. The three components are the Divine Himself (the Father), the Divine Human (the Son, Jesus Christ), and the going forth into the world of God's influence, which is the Holy Spirit. All three components, soul, mind and body, can be seen in people, who are created in God's image.

Swedenborg spoke against the Trinity of Persons in virtually all his works. The Divinity or Divine essence of the three is one, as the Person is one. According to Swedenborg, Muslims, Jews and people of other religions are mainly opposed to Christianity because its doctrine of the Trinity of Persons makes One God into three Gods. He considered
the separation of the Trinity into three separate Persons to have originated with the First Council of Nicaea in 325 AD and the Athanasian Creed, circa 500. For example:

From a Trinity of Persons, each one of whom singly is God, according to the Athanasian creed, many discordant and heterogeneous ideas respecting God have arisen, which are phantasies and abortions. [.] All who dwell outside the Christian church, both Mohammedans and Jews, and besides these the Gentiles of every cult, are averse to Christianity solely on account of its belief in three Gods.

— Swedenborg, *True Christian Religion*, section 183

Swedenborg's theological teachings about the Trinity being in the One Person Jesus Christ is labeled by some as modalism because it identifies three aspects (not persons) of One God, a unitarian God.

**Sola fide (Faith Alone)**

He also spoke sharply against the tenet called *Sola fide*, which means that justification based upon imputed righteousness before God is achievable by a gift of God's grace ("Sola gratia"), through faith alone, not on the basis of the person's deeds in life. Sola fide was a doctrine averred by Martin Luther, John Calvin, Ulrich Zwingli and others during the Protestant Reformation, and was a core belief especially in the theology of the Lutheran reformers Martin Luther and Philip Melanchthon. Although the Sola fide of the Reformers also emphasized that saving faith was one that effected works (by faith alone, but not by a faith which is alone), Swedenborg protested against faith alone being the instrument of justification, and held that salvation is only possible through the conjunction of faith and charity in a person, and that the purpose of faith is to lead a person to live according to the truths of faith, which is charity. He further states that faith and charity must be exercised by doing good out of willing good whenever possible, which are good works or good uses or the conjunction perishes. In one section he wrote:

It is very evident from their Epistles that it never entered the mind of any of the apostles that the church of this day would separate faith from charity by teaching that faith alone justifies and saves apart from the works of the law, and that charity therefore cannot be conjoined with faith, since faith is from God, and charity, so far as it is expressed in works, is from man. But this separation and division were introduced into the Christian church when it divided God into three persons, and ascribed to each equal Divinity.

— *True Christian Religion*, section 355

**Works**

List of referenced works by Swedenborg and the year they were first published.

Within parenthesis, the common name used in text, based on the New Church online bookstore. Then follows the name of the original title in its original publication. Various minor reports and tracts have been omitted from the list.

- 1716–1718, (Daedalus Hyperboreus) Swedish: *Daedalus Hyperboreus, eller några nya mathematiska och physicaliska försök.* (English: The Northern inventor, or some new experiments in mathematics and physics)
- 1721, (Principles of Chemistry) Latin: *Prodromus principiorum rerum naturalium : sive novorum tentaminum chymiam et physicam experientia geometrice explicandi*
- 1722, (Miscellaneous Observations) Latin: *Miscellanea de Rebus Naturalibus*
- 1734, (Principia) Latin: *Opera Philosophica et Mineralia* (English: Philosophical and Mineralogical Works), three volumes
  - (Principia, Volume I) Latin: *Tomus I. Principia rerum naturallium sive novorum tentaminum phaenomena mundi elementaris philosophice explicandi*
  - (Principia, Volume II) Latin: *Tomus II. Regnum subterraneum sive minerale de ferro*
  - (Principia, Volume III) Latin: *Tomus III. Regnum subterraneum sive minerale de cupro et orichalco*
- 1734, (The Infinite and Final Cause of Creation) Latin: Prodmomus Philosophi Ratiocinantis de Infinito, et Causa Finali Creationis; de que Mechanismo Operationis Animae et Corporis.
- 1744–1745, (The Animal Kingdom) Latin: Regnum animale, 3 volumes
- 1745, (The Worship and Love of God) Latin: De Cultu et Amore Dei, 2 volumes
- 1749–1756, (Arcana Coelestia (or Cœlestia including Latin variant, Arcana Caelestia (Heavenly Mysteries) Latin: Arcana Cœlestia, quae in Scriptura Sacra seu Verbo Domini sunt, detecta, 8 volumes
- 1758, (Heaven and Hell) Latin: De Caelo et Ejus Mirabilibus et de inferno. Ex Auditis et Visis.
- 1758, (The Last Judgment) Latin: De Ultimo Judicio
- 1763, (Doctrine of the Sacred Scripture) Latin: Doctrina Novæ Hierosolymæ de Scriptura Sacra.
- 1763, (Doctrine of Life) Latin: Doctrina Vitæ pro Nova Hierosolyma ex præceptis Decalogi.
- 1763, (Doctrine of Faith) Latin: Doctrina Novæ Hierosolymæ de Fide.
- 1763, (Continuation of The Last Judgement) Latin: Continuatio De Ultimo Judicio: et de mundo spirituali.
- 1768, (Conjugal Love, or Marriage Love) Latin: Deliciae Sapientiae de Amore Conjugiali: post quas sequuntur voluptates insaniae de amore scortatorio.
- 1769, (Brief Exposition) Latin: Summaria Expositio Doctrinæ Nova Ecclesiae, quæ per Novam Hierosolymam in Apocalypsi intelligitur.
- 1771, (True Christian Religion) Latin: Vera Christiana Religio, continens Universam Theologiam Novae Ecclesiae
- 1859, Drömboken, Journaleanteckningar, 1743–1744

Notes
[1] January 29 Old Style February 8 New Style
[6] (http://www.swedenborgdigitallibrary.org/contets/LJ.html) Swedenborg, E. The Last Judgment and Babylon Destroyed. All the Predictions in the Apocalypse are at This Day Fulfilled. (Swedenborg Foundation 1952, Paragraphs 1-74)


[18] Crompton, S. Emanuel Swedenborg (Chelsea House 2005, p. 76)

[19] Block, Chapter 3


[26] The trial in 1768 was again Gabriel Beyer and Johan Rosén and essentially concerned whether Swedenborg's theological writings were consistent with the Christian doctrines. A royal ordinance in 1770 declared that Swedenborg's writings were "clearly mistaken" and should not be taught. Swedenborg then begged the King for grace and protection in a letter from Amsterdam. A new investigation against Swedenborg stalled and was eventually dropped in 1778. (1999), pp.453–463

[27] This subject is touched on in the preface of Bergquist (1999), who mentions the biography by Martin Lamm (originally published 1917) and its focus on the similarities of Swedenborg's scientific and theological lives. He mentions an earlier biography by the Swedish physician Emil Kleen who concluded that Swedenborg was blatantly mad, suffering "paranoia and hallucinations". A similar conclusion was made recently by psychologist John Johnson in Henry Maudsley on Swedenborg's mesiastic psychosis, British Journal of Psychiatry 165:690–691 (1994), who wrote that Swedenborg suffered hallucinations of "acute schizophrenia or epileptic psychosis." For comment on Johnson's interpretation, see special issue of The New Philosophy on The Madness Hypothesis (http://www.swedenborg-philosophy.org/journal/article.php?issue=sanity&page=1000.)


[31] Martin Lamm (1978) notes that Swedenborg biographies at that time drew similarities between the beliefs of Jesper and Emanuel. Lamm himself partially agrees with them, but he maintains that there were marked differences between them too.


[33] x

[34] The meeting between the King, Polhem and Swedenborg is described in detail in Liljegren, Bengt, Karl XII i Lund : nær Sverige styrdes från Skåne, (Historiska media, Lund, 1999). ISBN 91-88930-51-3


[37] Bergquist (1999), pp.118–119

[38] Proposed by Lagercrantz, also mentioned by Bergquist (1999), p.119


[42] Gross, C. "Three before their time: neuroscientists whose ideas were ignored by their contemporaries" Experimental Brain Research 192:321 2009


[45] Lamm (1987), pp.42–43, notes that by assuming that the soul consists of matter, as Swedenborg did, one becomes a materialist. He further notes that this was also noted by contemporaries.


[48] Jonsson, Inge, Swedenborg och Linné, in Delblanc & Lönnroth, p.325
[49] Bergquist, p.200–208
[50] Bergquist (p.206)
[53] This account is based in Bergquist (1999), pp.227–228. The story was much later told by Swedenborg to Carl Robsahm (see Robsahm, #15)
[56] Bergquist (1999), p.287
[59] The Last Judgment and Babylon in the Apocalypse are At this Day Fullfilled from Things Heard and Seen. From De’ Ultimo Judicio Et De Babylonia Destructa (http://www.swedenborgdigitallibrary.org/contests/LJ.html), Last Judgment, #60
[60] Swedenborg, E. Heaven and Its Wonders From Things Heard and Seen (http://www.swedenborgdigitallibrary.org/contests/HH.html) (Swedenborg Foundation 1946, #421-535)
[66] Robsahm, #38
[69] Bergquist (1999), 471–476. Accounts of Swedenborg’s last days were collected and published in Tafel II:1, pp.577 ff, 556 ff, 560 ff.
[70] Bergquist (1999), 473–474. Swedenborg’s last words were collected and published in Tafel II:1, pp.577 ff, 556 ff, 560 ff.
[71] Bergquist (1999), 473–474. Swedenborg’s last words were collected and published in Tafel II:1, pp.577 ff, 556 ff, 560 ff.
[72] http://books.google.com/books?id=5plNhQ4yfswC&pg=PA106&lpg=PA106&dq=swedenborg+Arcana+Caelstia&source=bl&ots=548ELMOAY&sig=xvFjXKc2eUibBS5YjydyRkhEnMvMex&ei=xK0OgTbjLM5Tu&resnum=7&ved=0CQFQ6AEwBw#v=onepage&q=swedenborg Arcana Caelstia&f=false
[73] Epic, p. 430ff.
[75] Epic, p. 431
[76] ”Epic”, p. 433
[77] ”The Madness Hypothesis,” (http://www.swedenborg-philosophy.org/journal/article.php?issue=sanity&page=1000) a special issue of the academic journal The New Philosophy (1998;101: whole number), in which a number of authors review the question of Swedenborg’s sanity. The issue draws the conclusion based on its analysis of the historical evidence that he was not insane.
[80] Bergquist (1999), p.15
[81] ”en dikt om ett främmande land med sällsamma lagar och seder. Largercrantz (1996), backpage
[82] Sigstedt (1952), p.408
[84] Lamm (1987 [1915]), dedicates a chapter to the correspondence theories, p.85–109
[85] Bergquist (1999), p.312
[86] The accounts are fully described in Bergquist, pp. 312–313 and in Chapter 31 of of The Swedenborg Epic. (http://www. swedenborgdigitallibrary.org/ES/epic31.htm) The primary source for these accounts is a letter from Immanuel Kant in 1768 and the Swedenborg collection by Tafel (see references).
References

- Ahlstrom, S.E. *A Religious History of the American People* (Yale 1972) Includes section on Swedenborg by this scholar.
- Block, M.B. *The New Church in the New World. A study of Swedenborgianism in America* (Holt 1932; Octagon reprint 1968) A detailed history of the ideational and social development of the organized churches based on Swedenborg’s works.
- Crompton, S. *Emanuel Swedenborg* (Chelsea House 2005) Recent biography of Swedenborg.
Emanuel Swedenborg


• Robsahm, Carl, Hallengren, Anders (translation and comments), *Anteckningar om Swedenborg* (Föreningen Swedenborgs Minne: Stockholm 1989), ISBN 91-87856-00-X. Hallengren writes that the first complete publication of the Robsam manuscript was in R.L. Tafel’s *Documents*, Vol. I, 1875 (see section “Further reading”)


Further reading

Newer material:


Older material of importance, some of it not in print:

- The most extensive work is: RL Tafel, *Documents concerning the Life and Character of Swedenborg, collected, translated and annotated* (3 vols., Swedenborg Society, 1875—1877);
- Kant's *Träume eines Geistersehers* (1766; the most recent edition in English is from 1975, ISBN 3-7873-0311-1);
- J. G. Herder's "Emanuel Swedenborg," in his *Adrastea (Werke zur Phil. und Gesch., xii. 110–125).*
- *Swedenborg and Esoteric Islam* (Swedenborg Studies, No 4) by Henry Corbin, Leonard Fox

### External links

- Australian centre providing a range of services and information about Swedenborg and his spiritual teachings. Full on-line catalogue [here](http://www.swedenborg.com.au).
- Works by Emanuel Swedenborg [here](http://www.gutenberg.org/author/Emanuel_Swedenborg) at Project Gutenberg.
- Works by or about Emanuel Swedenborg [here](http://worldcat.org/identities/lccn-n80-44859) in libraries (WorldCat catalog)
- Emanuel Swedenborg Studies [here](http://www.emanuelswedenborg.org) is dedicated to collecting, analyzing, and preserving the historical record of the life and times of Emanuel Swedenborg (1688–1772). Among the existing broad context of apologists and critics of Emanuel Swedenborg, it is the mission of Emanuel Swedenborg Studies to establish an objective and comprehensive record of the facts of Emanuel Swedenborg's Life — all of the facts and only the facts. *About* [here](http://www.emanuelswedenborg.org/about/), Emanuel Swedenborg Studies, accessed April 30, 2007.
- Information Swedenborg Inc [here](http://www.swedenborg.ca/) The mission of Information Swedenborg Inc. is to raise awareness of the life and work of Emanuel Swedenborg. Sells books by, about and related to Swedenborg, worldwide but especially within Canada.
- The Swedenborg Foundation [here](http://www.swedenborg.com) is a non-profit publisher, book seller, and educational organization which publishes the theological works of Swedenborg, contemporary books and videos on spiritual growth, offers lectures and workshops, and maintains a library of Swedenborgian literature.
- The Heavenly Doctrines [here](http://theheavenlydoctrines.org/), a searchable library of Swedenborg's "revelatory phase" theological writings.
- Small Canon Search [here](http://www.smallcanonsearch.com) Swedenborg enumerated in his *Arcana Coelestia* #10,325 the books of the Bible that were, according to his revelation, Divinely inspired. In his *True Christian Religion* # 779 he indicated that books of his revelation that he published were also Divine revelation. This search engine, then, for the convenience of the reader, searches only the works thus inspired. For further review of this issue, see *Which of Swedenborg's books are Divine revelation?* [here](http://www.swedenborgdigitallibrary.org/contents/books.html)
- Emanuel Swedenborg Swicki [here](http://www.emanuelswedenborg.info), a collaborative community searching the World Wide Web for information about Emanuel Swedenborg.
- The Swedenborg Project [here](http://www.swedenborgproject.org/) A 501(c)(3) non-profit organization incorporated in the state of Maryland for the purpose of disseminating the teachings of the Second Coming of Jesus Christ, revealed through Swedenborg. The Project’s website provides an overview and reference information in keeping with that goal.
• The Swedenborg Digital Library (http://www.swedenborgdigitallibrary.org/) contains online full-text versions of books about Swedenborg and the Second Coming as well as access to the books of the Second Coming teachings that Swedenborg himself published. First Translation of Swedenborg's theological writings: 16th Chapter of Genesis as explained in the Arcana Cœlestia (http://www.thelordsnewchurch.com/online_books/english/Arcana_Caelestia_or_Heavenly_Secrets_chapter_16_1750_English_Translation_200dpi.pdf) (This translation from Latin into English was commissioned by Swedenborg himself and is a photocopy of a first edition copy: PDF - 12MB).

• The Swedenborg Society (http://www.swedenborg.org.uk/) The Swedenborg Society translates, prints and publishes works by the Swedish scientist, philosopher and visionary, Emanuel Swedenborg.

• The New Jerusalem and its Heavenly Doctrine According to What Has Been Heard from Heaven With an Introduction Concerning The New Heaven and the New Earth (http://www.swedenborgdigitallibrary.org/contets/njhd.html) (Swedenbog Society 1911; Swedenborg Foundation 1951) This book is one of the Writings but is included in the present section because it provides an extremely compact summary of the Writings that was written by Swedenborg himself.
Raimon Panikkar

<table>
<thead>
<tr>
<th>Raimon Panikkar-Alemany</th>
</tr>
</thead>
<tbody>
<tr>
<td>Born</td>
</tr>
<tr>
<td>Raimundo Panikkar-Alemany</td>
</tr>
<tr>
<td>November 3, 1918</td>
</tr>
<tr>
<td>Barcelona, Catalonia, Spain</td>
</tr>
<tr>
<td>Died</td>
</tr>
<tr>
<td>August 26, 2010 (aged 91)</td>
</tr>
<tr>
<td>Tavertet, Catalonia, Spain</td>
</tr>
<tr>
<td>Occupation</td>
</tr>
<tr>
<td>Roman Catholic priest, theologian, scholar</td>
</tr>
</tbody>
</table>

Raimon Panikkar-Alemany (November 3, 1918 – August 26, 2010; also known as Raymond Panikkar[1]) was a Spanish Roman Catholic priest and a proponent of inter-religious dialogue. As a scholar, he specialized in comparative religion.

Early life and education

Raimundo Pannikar was born as the son of a Spanish Roman Catholic mother and a Hindu Indian father in Barcelona. [2] His mother was well-educated and from the Catalan bourgeoisie. His father belonged to an upper caste Malabar Nair family from South India. Panikkar's father was a freedom fighter during British colonial rule in India and escaped from Britain and married into a Catalan family. Panikkar's father studied in England and was the representative of a German chemical company in Barcelona.

Educated at a Jesuit school, Panikkar studied chemistry and philosophy at the universities of Barcelona, Bonn and Madrid, and Catholic Theology in Madrid and Rome. He earned a doctorate in philosophy at the University of Madrid in 1946 and a doctorate in chemistry in 1958.[3] He earned a third doctorate in theology at the Pontifical Lateran University in Rome in 1961.[3] He compared St. Thomas Aquinas's Philosophy with the eighth-century Hindu philosopher Ādi Śaṅkara's Interpretation of the Brahma Sutras.[3]

Career

In 1940 he entered the Opus Dei organization.

In 1946 he was ordained a Catholic priest, and became a professor of philosophy at the University of Madrid.[3]

He made his first trip to India in 1954 where he studied Indian philosophy and religion at the University of Mysore and Banaras Hindu University, where he met several Western monks seeking Eastern forms for the expression of their Christian beliefs.[3] “I left Europe [for India] as a Christian, I discovered I was a Hindu and returned as a Buddhist without ever having ceased to be Christian,” he later wrote.[3][2]

While in Jerusalem during 1962, he was summoned to Rome by Opus Dei founder and director, Saint Josemaría Escrivá, who expelled him after a brief trial where he was charged with disobedience to the organization.[4]

In 1966 he became a visiting professor at Harvard Divinity School and a professor of religious studies at University of California, Santa Barbara in 1972.[3] For many years he taught in the spring and spent the rest of the year doing research in India.[3]

In 1987 he moved to Tavertet in Catalonia, in the hills north of Barcelona, where he founded the Raimon Panikkar Vivarium Foundation, a center for intercultural studies.[3]

Panikkar authored more than 40 books and 900 articles. His complete works are being published in Italian. His 1989 Gifford Lectures are being published in English by Orbis.

In a statement from his residence in Tavertet dated January 26, 2010 he wrote: "Dear Friends . . . I would like to communicate with you that I believe the moment has come, (put off time and again), to withdraw from all public
activity, both the direct and the intellectual participation, to which I have dedicated all my life as a way of sharing my reflections. I will continue to be close to you in a deeper way, through silence and prayer, and in the same way I would ask you to be close to me in this last period of my existence. You have often heard me say that a person is a knot in a network of relationships; in taking my leave from you I would like to thank you from the bottom of my heart for having enriched me with the relationship I have had with each of you. I am also grateful to all of those who, either in person or through association, continue working to spread my message and the sharing of my ideals, even without me. Thankful for the gift of life which is only such if lived in communion with others: it is with this spirit that I have lived out my ministry.”

Works

By Panikkar

• The Unknown Christ of Hinduism (1964)
• The “crisis” of Madhyamika and Indian philosophy today. University of Hawaii Press (1966)
• Worship and secular man: An essay on the liturgical nature of man, considering secularization as a major phenomenon of our time and worship as an apparent fact of all times; A study towards an integral anthropology. Orbis Books, 1973
• Colligite fragmenta: For an integration of reality. Villanova University Press, 1978


### About Panikkar

• **Theological approach and understanding of religions: Jean Danielou and Raimundo Panikkar: a study in contrast** by Dominic Veliath. Kristu Jyoti College (1988)


### References


### External links

• "Raimon Panikkar talks" (http:www.google.co.in/search?q=Raimon+Panikkar&hl=en&rlz=1B3GGGL_enIN351IN351&tbs=vid:1&tbo=u&ei=6SW6S53RGMTGrAfO2v3DCg&sa=X&oi=video_result_group&ct=title&resnum=9&ved=0CCwQqwQwCA)


• Official website (http://www.raimon-panikkar.org)

• Web in Raimon Panikkar honoris (http://www.raimonpanikkar.org)

• The new innocence: Interview with Raimon Panikkar by Carmen Font (http://www.share-international.org/ARCHIVES/religion/rl_cfnew-innocence.htm)

• **Religion, Philosophy and Culture** by Raimon Panikkar (http://them.polylog.org/1/fpr-en.htm)
Omega Point

Omega Point is a term coined by the French Jesuit Pierre Teilhard de Chardin (1881–1955) to describe a maximum level of complexity and consciousness towards which he believed the universe was evolving.

In this theory, developed by Teilhard in The Future of Man (1950), the universe is constantly developing towards higher levels of material complexity and consciousness, a theory of evolution that Teilhard called the Law of Complexity/Consciousness. For Teilhard, the universe can only move in the direction of more complexity and consciousness if it is being drawn by a supreme point of complexity and consciousness.

Thus Teilhard postulates the Omega Point as this supreme point of complexity and consciousness, which in his view is the actual cause for the universe to grow in complexity and consciousness. In other words, the Omega Point exists as supremely complex and conscious, transcendent and independent of the evolving universe.

Teilhard argued that the Omega Point resembles the Christian Logos, namely Christ, who draws all things into himself, who in the words of the Nicene Creed, is "God from God", "Light from Light", "True God from true God," and "through him all things were made."

Teilhard's term recurs in later writings, such as those of John David Garcia (1971), Frank Tipler (1994) or Ray Kurzweil, as well as in science fiction literature.

Five attributes of the Omega Point

Teilhard de Chardin's The Phenomenon of Man states that the Omega Point must possess the following five attributes. It is:

• Already existing.
  • Only thus can the rise of the universe towards higher stages of consciousness be explained.

• Personal – an intellectual being and not an abstract idea.
  • The increasing complexity of matter has not only led to higher forms of consciousness, but accordingly to more personalization, of which human beings are the highest attained form in the known universe. They are completely individualized, free centers of operation. It is in this way that man is said to be made in the image of God, who is the highest form of personality. Teilhard expressly stated that in the Omega Point, when the universe becomes One, human persons will not be suppressed, but super-personalized. Personality will be infinitely enriched. This is because the Omega Point unites creation, and the more it unites, the increasing complexity of the universe aids in higher levels of consciousness. Thus, as God creates, the universe evolves towards higher forms of complexity, consciousness, and finally with humans, personality, because God, who is drawing the universe towards Him, is a person.

• Transcendent.
  • The Omega Point cannot be the result of the universe's final complex stage of itself on consciousness. Instead, the Omega Point must exist even before the universe's evolution, because the Omega Point is responsible for the rise of the universe towards more complexity, consciousness and personality. Which essentially means that the Omega Point is outside the framework in which the universe rises, because it is by the attraction of the Omega Point that the universe evolves towards Him.

• Autonomous
  • That is, free from the limitations of space (nonlocality) and time (atemporality).

• Irreversible
  • That is attainable and imperative; it must happen and cannot be undone.
Related concepts

Garcia and increasing creativity

In 1971, John David Garcia expanded on Teilhard's Omega Point idea. In particular, he stressed that even more than the increase of intelligence, the constant increase of ethics is essential for humankind to reach the Omega Point. He applied the term creativity to the combination of intelligence and ethics and announced that increasing creativity is the correct and proper goal of human life. He specifically rejected increasing happiness as a proper ultimate goal: when faced with a choice between increasing creativity and increasing happiness, a person ought to choose creativity, he wrote. But the two are exclusively connected to where human kind is always finding creative ways to be happy.

Tipler

Frank Tipler uses the term Omega Point to describe what he maintains is the ultimate fate of the universe required by the laws of physics. Tipler identifies this concept as the Christian god and in later writing, infers correctness of Christian mythology from this concept. Tipler (1994) has summarized his theory as follows:

• The universe has finite spatial size and the topology of a three-sphere;
• There are no event horizons, implying the future c-boundary is a point, called the Omega Point;
• Sentient life must eventually engulf the entire universe and control it;
• The amount of information processed between now and the Omega Point is infinite;
• The amount of information stored in the universe asymptotically goes to infinity as the Omega Point is approached.¹

Key to Tipler's exploration of the Omega Point is that the supposition of a closed universe evolving towards a future collapse. Within this universe, Tipler assumes a massive processing capability. As the universe becomes smaller, the processing capability becomes larger, due to the decreasing cost of communications as the systems shrink in size. At the same time, information from previously disconnected points in space becomes visible, giving the processors access to more and more information. Tipler's Omega Point occurs when the processing capability effectively becomes infinite, as the processors will be able to simulate every possible future before the universe ends - a state also known as "Aleph".

Within this environment, Tipler imagines that intelligent beings, human personalities, will be run as simulations within the system. As a result, after the Omega Point, humans will have omnipotence, able to see all of history and predict all of the future. Additionally, as all history becomes available, past personalities will be able to run as well. Within the simulation, this appears to be the dead rising. Tipler equates this state with the Christian heaven.

Technological singularity

Some transhumanists argue that the accelerating technological progress inherent in the Law of Accelerating Returns will, in the relatively near future, lead to what Vernor Vinge called a technological singularity or "prediction wall." These transhumanists believe we will soon enter a time in which we must eventually make the transition to a "runaway positive feedback loop" in high-level autonomous machine computation. A result will be that our technological and computational tools eventually completely surpass human capacities.² Some transhumanist writings refer to this moment as the Omega Point, paying homage to Teilhard's prior use of the term. Other transhumanists, in particular Ray Kurzweil, refer to the technological singularity as simply "The Singularity".
Science fiction literature

- In the 1937 science fiction novel Star Maker by Olaf Stapledon, what later came to be called the Omega Point by Teilhard de Chardin was reached when the Cosmic Mind encountered the Star Maker (the Creator of the Cosmos).
- In the Isaac Asimov short-story *The Last Question*, Humanity merges its collective consciousness with its own creation: an all-powerful cosmic computer. The resulting intelligence contemplates the cyclic nature of the universe, ending with a twist.
- In *Childhood's End*, a novel by Arthur C. Clarke, the destiny of humanity - as well as most of the other intelligent species in the universe - seems to merge with an overall cosmic intelligence.
- In Dan Simmons's *Hyperion Cantos*, the Omega Point is used extensively. The catholic priest character Father Hoyt/Duré who is introduced to the story frame as one of the pilgrims in the first two volumes of the tetralogy (*Hyperion* and *The Fall of Hyperion*) eventually becomes Pope Teilhard I.
- In *Darwinia*, a novel by Robert Charles Wilson, a mysterious event in 1912 transforms Europe into an immeasurably strange place, full of hitherto unknown flora and fauna, and it is revealed at the very end that the entire story is a tiny part of a virtual war inside what is effectively an Omega Point metacomputer at the end of time.
- In the first part of Poul Anderson's novel *Harvest of Stars*, North America is ruled by the Avantists, an oppressive pseudo-religious regime that draws its justification from a commitment to take humanity to what they call the Omega Point. It uses the Greek infinity symbol as a logo, and it is deemed politically correct to greet each other with "alpha", to which the reply is "omega". However, since the Avantist Advisory Synod believes in social engineering and technical progress as the means to advance humanity, its teachings are in fact transhumanist.
- In *Tomorrow and Tomorrow*, a novel by Charles Sheffield, the main character Drake Merlin is on a quest to cure his dying wife. He has her frozen and then freezes himself in the hope that the future holds the cure. Eventually, he finds that the only hope to having her back is to wait out the aeons until the Omega Point, at which time she will again be accessible.
- George Zebrowski wrote a trilogy of space opera novellas, collectively called *The Omega Point Trilogy* and published as a single volume in 1983. The name appears to be a coincidence; it predates Tipler by many years and does not involve any of the Omega Point ideas listed above.
- In Peter F. Hamilton's Night's Dawn Trilogy, the Omega Point is a repository for the souls of the dead of all sentient species in the Universe. It is implied that this is also the point to which the universe will eventually collapse.
- Humayun Ahmed's novel *Omega Point* (2000) concerns multiverses, a developing theory of time and a manifestation of the Omega Point that interferes with history to allow the theory to reach fruition.
- Stephen Baxter writes about the Omega Point in many books including *Manifold: Time* and *Timelike Infinity*.
- Julian May's *Galactic Milieu Series* draws heavily for both plot and background on the concepts of Teilhard de Chardin's Omega point theories.
- *Shantaram*, a novel by Gregory David Roberts, refers to the philosophical theory that the universe "tends towards complexity."
References


External links

• Chardin, Pierre Teilhard de ♦ The Phenomenon of Man (http://arthursbookshelf.com/other-stuff/phenom10.html) An HTML version of the book (without illustrations)
• Human Evolution Research Institute (http://www.humanevol.com)
• Princeton Noosphere project (http://noosphere.princeton.edu/) cites Teilhard de Chardin
• Teilhard de Chardin on evolution (http://www.kheper.net/topics/Teilhard/Teilhard-evolution.html)
• Essays by Tipler on the Omega Point (http://www.math.tulane.edu/~tipler/summary.html)
Frank Jennings Tipler (born February 1, 1947 in Andalusia, Alabama\(^2\)) is a mathematical physicist and cosmologist, holding a joint appointment in the Departments of Mathematics and Physics at Tulane University.\(^3\) Tipler has authored books and papers on the Omega Point, which he claims is a mechanism for the resurrection of the dead. It has been labeled as pseudoscience by some.\(^4\) Tipler is a fellow of the International Society for Complexity, Information, and Design, a society advocating intelligent design.\(^5\)

**Biography**

Tipler is the son of Frank Jennings Tipler Jr., a lawyer, and Anne Tipler, a homemaker.\(^2\) From 1965 through 1969, Tipler attended the Massachusetts Institute of Technology, where he completed a bachelor of science degree in physics.\(^3\) In 1976 he earned his doctor of philosophy (Ph.D.) degree from the University of Maryland.\(^6\) Tipler was next hired in a series of postdoctoral researcher positions in physics at three universities, with the final one being at the University of Texas, working under John Archibald Wheeler, Abraham Taub, Rainer Sachs, and Dennis Sciama.\(^3\) Tipler became an Associate Professor in mathematical physics in 1981, and a full Professor in 1987 at Tulane University, where he has been a faculty member ever since.\(^3\)

**The Omega Point cosmology**

The *Omega Point* is a term Tipler uses to describe a cosmological state in the distant proper time future of the universe that he maintains is required by the known physical laws. According to Tipler's Omega Point cosmology, for the known laws of physics to be mutually consistent it is required that intelligent life take over all matter in the universe and eventually force the collapse of the universe. During that collapse the computational capacity of the universe diverges to infinity and environments emulated with that computational capacity last for infinite duration as the universe goes into a solitary-point cosmological singularity (with life eventually using elementary particles to directly compute on, due to the temperature's diverging to infinity), which singularity Tipler terms the Omega Point.\(^7\) With computational resources diverging to infinity, Tipler states that the far-future society will be able to resurrect the dead by perfectly emulating all alternate universes of our universe from its start at the Big Bang.\(^8\) Tipler identifies the Omega Point final singularity as God since in his view the Omega Point has all the properties claimed for God by most of the traditional religions.\(^8\)^\(^9\)
Tipler's argument that the Omega Point cosmology is required by the known physical laws is a more recent development that came after the publication of his 1994 book *The Physics of Immortality*. In that book, and in papers Tipler published up to that time, he had offered the Omega Point cosmology as a hypothesis, while still claiming to confine the analysis to the known laws of physics.[10]

Tipler defined the "final anthropic principle" (FAP) along with co-author physicist John D. Barrow in their highly cited 1986 book *The Anthropic Cosmological Principle* as a generalization of the anthropic principle[11] as follows:

*Intelligent information-processing must come into existence in the Universe, and, once it comes into existence, will never die out.*

Critics of the final anthropic principle say its arguments violate the Copernican principle, that it incorrectly applies the laws of probability, and that it is really a theology or metaphysics principle made to sound plausible to laypeople by using the esoteric language of physics. Martin Gardner dubbed FAP the "completely ridiculous anthropic principle" (CRAP).[12] Oxford-based philosopher Nick Bostrom writes that the final anthropic principle has no claim on any special methodological status, it is "pure speculation", despite attempts to elevate it by calling it a "principle".[13] Philosopher Rem B. Edwards called it "futuristic, pseudoscientific eschatology" that is "highly conjectural, unverified, and improbable".[14]

Physicist David Deutsch incorporates Tipler's Omega Point cosmology as a central feature of the fourth strand of his "four strands" concept of fundamental reality and defends the physics of the Omega Point cosmology,[15] although he is highly critical of Tipler's theological conclusions[16] and what Deutsch states are exaggerated claims that have caused other scientists and philosophers to reject his theory out of hand.[17] Researcher Anders Sandberg pointed out that he believes the Omega Point Theory has many flaws, including missing proofs.[18]

Tipler's Omega Point theories have received criticism by physicists and skeptics.[19][20][21] George Ellis, writing in the journal *Nature*, described Tipler's book on the Omega Point as "a masterpiece of pseudoscience ... the product of a fertile and creative imagination unhampered by the normal constraints of scientific and philosophical discipline",[4] and Michael Shermer devoted a chapter of *Why People Believe Weird Things* to enumerating what he thought to be flaws in Tipler's thesis.[22] Physicist Sean M. Carroll thought Tipler's early work was constructive but that now he has become a "crackpot".[23]

**Selected writings**

**Books**

Articles


References

In astrophysics and cosmology, the **anthropic principle** is the philosophical argument that observations of the physical Universe must be compatible with the conscious life that observes it. Some proponents of the argument reason that it explains why the Universe has the age and the fundamental physical constants necessary to accommodate conscious life. As a result, they believe that the fact is unremarkable that the universe's fundamental constants happen to fall within the narrow range thought to allow life.

The strong anthropic principle (SAP) as explained by Barrow and Tipler (see variants) states that this is all the case because the Universe is compelled, in some sense, to have conscious life eventually emerge. Douglas Adams used the metaphor of a living puddle examining its own shape, since, to those living creatures, the universe may appear to fit them perfectly (while in fact, they simply fit the universe perfectly). Critics argue in favor of a weak anthropic principle (WAP) similar to the one defined by Brandon Carter, which states that the universe's ostensible fine tuning is the result of selection bias: i.e., in the long term, only survivors can observe and report their location in time and space.

**Definition and basis**

The principle was formulated as a response to a series of observations that the laws of nature and parameters of the Universe take on values that are consistent with conditions for life as we know it rather than a set of values that would not be consistent with life on Earth. The anthropic principle states that this is a necessity, because if life were impossible, no one would know it. That is, it must be possible to observe some Universe, and hence, the laws and constants of any such universe must accommodate that possibility.

The term *anthropic* in "anthropic principle" has been argued[^1] to be a misnomer.[^2] While singling out our kind of carbon-based life, none of the finely tuned phenomena require human life or some kind of carbon chauvinism.[^3][^4] Any form of intelligent life would do; so, specifying carbon-based life, *per se*, is irrelevant.

The anthropic principle has given rise to some confusion and controversy, partly because the phrase has been applied to several distinct ideas. All versions of the principle have been accused of discouraging the search for a deeper physical understanding of the universe. The anthropic principle is often criticized for lacking falsifiability and therefore critics of the anthropic principle may point out that the anthropic principle is a non-scientific concept, even though the weak anthropic principle, "*conditions that are observed in the universe must allow the observer to exist*"[^5] is "easy" to support in mathematics and philosophy, i.e. it is a tautology or truism. However, building a substantive argument based on a tautological foundation is problematic. Stronger variants of the anthropic principle are not tautologies and thus make claims considered controversial by some and that are contingent upon empirical evidence.

---


[^4]: http://math.tulane.edu/~tipler/intelligentlife.pdf

[^5]: http://math.tulane.edu/~tipler/starofbethlehem.pdf

---

**External links**

- International Society for Complexity Information and Design page (http://www.iscid.org/frank-tipler.php)
- Faculty page for Frank J. Tipler (http://www.math.tulane.edu/faculty/tipler.html)
- Personal website for Frank J. Tipler (http://129.81.170.14/~tipler/)
Anthropic principle

 verification. [6][7]

**Anthropic coincidences**

In 1961, Robert Dicke noted that the age of the universe, as seen by living observers, cannot be random.[8] Instead, biological factors constrain the universe to be more or less in a "golden age," neither too young nor too old. [9] If the universe were one tenth as old as its present age, there would not have been sufficient time to build up appreciable levels of metallicity (levels of elements besides hydrogen and helium) especially carbon, by nucleosynthesis. Small rocky planets did not yet exist. If the universe were 10 times older than it actually is, most stars would be too old to remain on the main sequence and would have turned into white dwarfs, aside from the dimmest red dwarfs, and stable planetary systems would have already come to an end. Thus Dicke explained away the rough coincidence between large dimensionless numbers constructed from the constants of physics and the age of the universe, a coincidence which had inspired Dirac's varying-G theory.

Dicke later reasoned that the density of matter in the universe must be almost exactly the critical density needed to prevent the Big Crunch (the "Dicke coincidences" argument). The most recent measurements may suggest that the observed density of baryonic matter, and some theoretical predictions of the amount of dark matter account for about 30% of this critical density, with the rest contributed by a cosmological constant. Steven Weinberg[10] gave an anthropic explanation for this fact: he noted that the cosmological constant has a remarkably low value, some 120 orders of magnitude smaller than the value particle physics predicts (this has been described as the "worst prediction in physics").[11] However, if the cosmological constant were more than about 10 times its observed value, the universe would suffer catastrophic inflation, which would preclude the formation of stars, and hence life.

The observed values of the dimensionless physical constants (such as the fine-structure constant) governing the four fundamental interactions are balanced as if fine-tuned to permit the formation of commonly found matter and subsequently the emergence of life. A slight increase in the strong nuclear force would bind the dineutron and the diproton, and nuclear fusion would have converted all hydrogen in the early universe to helium. Water and the long-lived stable stars essential for the emergence of life would not exist. More generally, small changes in the relative strengths of the four fundamental interactions can greatly affect the universe's age, structure, and capacity for life.

**Origin**

The phrase "anthropic principle" first appeared in Brandon Carter's contribution to a 1973 Kraków symposium honouring Copernicus's 500th birthday. Carter, a theoretical astrophysicist, articulated the Anthropic Principle in reaction to the Copernican Principle, which states that humans do not occupy a privileged position in the Universe. As Carter said: "Although our situation is not necessarily central, it is inevitably privileged to some extent."[12] Specifically, Carter disagreed with using the Copernican principle to justify the Perfect Cosmological Principle, which states that all large regions and times in the universe must be statistically identical. The latter principle underlay the steady-state theory, which had recently been falsified by the 1965 discovery of the cosmic microwave background radiation. This discovery was unequivocal evidence that the universe has changed radically over time (for example, via the Big Bang).

Carter defined two forms of the Anthropic Principle, a "weak" one which referred only to anthropic selection of privileged spacetime locations in the universe, and a more controversial "strong" form which addressed the values of the fundamental constants of physics.

Roger Penrose explained the weak form as follows:

"The argument can be used to explain why the conditions happen to be just right for the existence of (intelligent) life on the earth at the present time. For if they were not just right, then we should not have found ourselves to be here now, but somewhere else, at some other appropriate time. This principle was used very
effectively by Brandon Carter and Robert Dicke to resolve an issue that had puzzled physicists for a good many years. The issue concerned various striking numerical relations that are observed to hold between the physical constants (the gravitational constant, the mass of the proton, the age of the universe, etc.). A puzzling aspect of this was that some of the relations hold only at the present epoch in the earth's history, so we appear, coincidentally, to be living at a very special time (give or take a few million years!). This was later explained, by Carter and Dicke, by the fact that this epoch coincided with the lifetime of what are called main-sequence stars, such as the sun. At any other epoch, so the argument ran, there would be no intelligent life around in order to measure the physical constants in question — so the coincidence had to hold, simply because there would be intelligent life around only at the particular time that the coincidence did hold!" —The Emperor's New Mind, Chapter 10

One reason this is plausible is that there are many other places and times in which we can imagine finding ourselves. But when applying the strong principle, we only have one Universe, with one set of fundamental parameters, so what exactly is the point being made? Carter offers two possibilities: First, we can use our own existence to make "predictions" about the parameters. But second, "as a last resort", we can convert these predictions into explanations by assuming that there is more than one Universe, in fact a large and possibly infinite collection of universes, something that is now called a multiverse ("world ensemble" was Carter's term), in which the parameters (and perhaps the laws of physics) vary across universes. The strong principle then becomes an example of a selection effect, exactly analogous to the weak principle. Postulating a multiverse is certainly a radical step, but taking it could provide at least a partial answer to a question which had seemed to be out of the reach of normal science: "why do the fundamental laws of physics take the particular form we observe and not another?"

Since Carter's 1973 paper, the term "Anthropic Principle" has been extended to cover a number of ideas which differ in important ways from those he espoused. Particular confusion was caused in 1986 by the book The Anthropic Cosmological Principle by John D. Barrow and Frank Tipler, published that year which distinguished between "weak" and "strong" anthropic principle in a way very different from Carter's, as discussed in the next section.

Carter was not the first to invoke some form of the anthropic principle. In fact, the evolutionary biologist Alfred Russel Wallace anticipated the anthropic principle as long ago as 1904: "Such a vast and complex universe as that which we know exists around us, may have been absolutely required ... in order to produce a world that should be precisely adapted in every detail for the orderly development of life culminating in man." In 1957, Robert Dicke wrote: "The age of the Universe 'now' is not random but conditioned by biological factors ... [changes in the values of the fundamental constants of physics] would preclude the existence of man to consider the problem." In their 1986 book, The Anthropic Cosmological Principle, John Barrow and Frank Tipler depart from Carter and define the WAP and SAP as follows:

**Weak anthropic principle (WAP)** (Carter): "we must be prepared to take account of the fact that our location in the universe is necessarily privileged to the extent of being compatible with our existence as observers." Note that for Carter, "location" refers to our location in time as well as space.

**Strong anthropic principle (SAP)** (Carter): "the Universe (and hence the fundamental parameters on which it depends) must be such as to admit the creation of observers within it at some stage. To paraphrase Descartes, cogito ergo mundus talis est."

The Latin tag ("I think, therefore the world is such [as it is]") makes it clear that "must" indicates a deduction from the fact of our existence; the statement is thus a truism.

In their 1986 book, The Anthropic Cosmological Principle, John Barrow and Frank Tipler depart from Carter and define the WAP and SAP as follows:

**Weak anthropic principle (WAP)** (Barrow and Tipler): "The observed values of all physical and cosmological quantities are not equally probable but they take on values restricted by the requirement that there exist sites where carbon-based life can evolve and by the requirements that the Universe be old enough for it to have already done..."
so.”[18]

Unlike Carter they restrict the principle to carbon-based life, rather than just "observers." A more important difference is that they apply the WAP to the fundamental physical constants, such as the fine structure constant, the number of spacetime dimensions, and the cosmological constant —, topics that fall under Carter's SAP.

**Strong anthropic principle (SAP)** (Barrow and Tipler): "The Universe must have those properties which allow life to develop within it at some stage in its history."[19]

This looks very similar to Carter's SAP, but unlike the case with Carter's SAP, the "must" is an imperative, as shown by the following three possible elaborations of the SAP, each proposed by Barrow and Tipler:[20]

- "There exists one possible Universe 'designed' with the goal of generating and sustaining 'observers.'"
  This can be seen as simply the classic design argument restated in the garb of contemporary cosmology. It implies that the purpose of the universe is to give rise to intelligent life, with the laws of nature and their fundamental physical constants set to ensure that life as we know it will emerge and evolve.

- "Observers are necessary to bring the Universe into being."
  Barrow and Tipler believe that this is a valid conclusion from quantum mechanics, as John Archibald Wheeler has suggested, especially via his participatory universe and **Participatory Anthropic Principle (PAP)**.

- "An ensemble of other different universes is necessary for the existence of our Universe."
  By contrast, Carter merely says that an ensemble of universes is necessary for the SAP to count as an explanation.

**Modified anthropic principle (MAP)** (Schmidhuber): The 'problem' of existence is only relevant to a species capable of formulating the question. Prior to *Homo sapiens*; intellectual evolution to the point where the nature of the observed universe - and humans' place within same - spawned deep inquiry into its origins, the 'problem' simply did not exist.[21]

The philosophers John Leslie[22] and Nick Bostrom[23] reject the Barrow and Tipler SAP as a fundamental misreading of Carter. For Bostrom, Carter's anthropic principle just warns us to make allowance for **anthropic bias**, that is, the bias created by anthropic selection effects (which Bostrom calls "observation" selection effects) — the necessity for observers to exist in order to get a result. He writes:

"Many 'anthropic principles' are simply confused. Some, especially those drawing inspiration from Brandon Carter's seminal papers, are sound, but... they are too weak to do any real scientific work. In particular, I argue that existing methodology does not permit any observational consequences to be derived from contemporary cosmological theories, though these theories quite plainly can be and are being tested empirically by astronomers. What is needed to bridge this methodological gap is a more adequate formulation of how observation selection effects are to be taken into account."

— *Anthropic Bias*, Introduction.,[24]

**Strong self-sampling assumption (SSSA)** (Bostrom): "Each observer-moment should reason as if it were randomly selected from the class of all observer-moments in its reference class."

Analysing an observer's experience into a sequence of "observer-moments" helps avoid certain paradoxes; but the main ambiguity is the selection of the appropriate "reference class": for Carter's WAP this might correspond to all real or potential observer-moments in our universe; for the SAP, to all in the multiverse. Bostrom's mathematical development shows that choosing either too broad or too narrow a reference class leads to counter-intuitive results, but he is not able to prescribe an ideal choice.

According to Jürgen Schmidhuber, the anthropic principle essentially just says that the conditional probability of finding yourself in a universe compatible with your existence is always 1. It does not allow for any additional nontrivial predictions such as "gravity won't change tomorrow." To gain more predictive power, additional assumptions on the prior distribution of alternative universes are necessary.[21][25]

Playwright and novelist Michael Frayn describes a form of the Strong Anthropic Principle in his 2006 book *The Human Touch*, which explores what he characterises as "the central oddity of the Universe":

---

**Anthropic principle**

73
"It's this simple paradox. The Universe is very old and very large. Humankind, by comparison, is only a tiny disturbance in one small corner of it - and a very recent one. Yet the universe is only very large and very old because we are here to say it is... And yet, of course, we all know perfectly well that it is what it is whether we are here or not.”

—[26]

Character of anthropic reasoning

Carter chose to focus on a tautological aspect of his ideas, which has resulted in much confusion. In fact, anthropic reasoning interests scientists because of something that is only implicit in the above formal definitions, namely that we should give serious consideration to there being other universes with different values of the "fundamental parameters" — that is, the dimensionless physical constants and initial conditions for the Big Bang. Carter and others have argued that life as we know it would not be possible in most such universes. In other words, the universe we are in is fine tuned to permit life. Collins & Hawking (1973) characterized Carter's then-unpublished big idea as the postulate that "there is not one universe but a whole infinite ensemble of universes with all possible initial conditions".[27] If this is granted, the anthropic principle provides a plausible explanation for the fine tuning of our universe: the "typical" universe is not fine-tuned, but given enough universes, a small fraction thereof will be capable of supporting intelligent life. Ours must be one of these, and so the observed fine tuning should be no cause for wonder.

Although philosophers have discussed related concepts for centuries, in the early 1970s the only genuine physical theory yielding a multiverse of sorts was the many worlds interpretation of quantum mechanics. This would allow variation in initial conditions, but not in the truly fundamental constants. Since that time a number of mechanisms for producing a multiverse have been suggested: see the review by Max Tegmark.[28] An important development in the 1980s was the combination of inflation theory with the hypothesis that some parameters are determined by symmetry breaking in the early universe, which allows parameters previously thought of as “fundamental constants” to vary over very large distances, thus eroding the distinction between Carter's weak and strong principles. At the beginning of the 21st century, the string landscape emerged as a mechanism for varying essentially all the constants, including the number of spatial dimensions.[29]

The anthropic idea that fundamental parameters are selected from a multitude of different possibilities (each actual in some universe or other) contrasts with the traditional hope of physicists for a theory of everything having no free parameters: as Einstein said, "What really interests me is whether God had any choice in the creation of the world.” Quite recently, proponents of the leading candidate for a "theory of everything", string theory, proclaimed "the end of the anthropic principle"[30] since there would be no free parameters to select. Ironically, string theory now seems to offer no hope of predicting fundamental parameters, and now some who advocate it invoke the anthropic principle as well (see below).

The modern form of a design argument is put forth by Intelligent design. Proponents of intelligent design often cite the fine-tuning observations that (in part) preceded the formulation of the anthropic principle by Carter as a proof of an intelligent designer. Opponents of intelligent design are not limited to those who hypothesize that other universes exist; they may also argue, anti-anthropically, that the universe is less fine-tuned than often claimed, or that accepting fine tuning as a brute fact is less astonishing than the idea of an intelligent creator. Furthermore, even accepting fine tuning, Sober (2005)[31] and Ikeda and Jefferys,[32][33] argue that the Anthropic Principle as conventionally stated actually undermines intelligent design; see fine-tuned universe.

Paul Davies's book The Goldilocks Enigma (2006) reviews the current state of the fine tuning debate in detail, and concludes by enumerating the following responses to that debate:

1. The absurd universe

   Our universe just happens to be the way it is.
2. The unique universe

There is a deep underlying unity in physics which necessitates the universe being the way it is. Some Theory of Everything will explain why the various features of the Universe must have exactly the values that we see.

3. The multiverse

Multiple Universes exist, having all possible combinations of characteristics, and we inevitably find ourselves within a Universe that allows us to exist.

4. Creationism

A creator designed the Universe with the purpose of supporting complexity and the emergence of Intelligence.

5. The life principle

There is an underlying principle that constrains the universe to evolve towards life and mind.

6. The self-explaining universe

A closed explanatory or causal loop: "perhaps only universes with a capacity for consciousness can exist."
This is Wheeler's Participatory Anthropic Principle (PAP).

7. The fake universe

We live inside a virtual reality simulation.

Omitted here is Lee Smolin's model of cosmological natural selection, also known as "fecund universes," which proposes that universes have "offspring" which are more plentiful if they resemble our universe. Also see Gardner (2005).[34]

Clearly each of these hypotheses resolve some aspects of the puzzle, while leaving others unanswered. Followers of Carter would admit only option 3 as an anthropic explanation, whereas 3 through 6 are covered by different versions of Barrow and Tipler's SAP (which would also include 7 if it is considered a variant of 4, as in Tipler 1994).

The anthropic principle, at least as Carter conceived it, can be applied on scales much smaller than the whole universe. For example, Carter (1983)[35] inverted the usual line of reasoning and pointed out that when interpreting the evolutionary record, one must take into account cosmological and astrophysical considerations. With this in mind, Carter concluded that given the best estimates of the age of the universe, the evolutionary chain culminating in *Homo sapiens* probably admits only one or two low probability links. Antonio Feoli and Salvatore Rampone dispute this conclusion, arguing instead that the estimated size of our universe and the number of planets in it allows for a higher bound, so that there is no need to invoke intelligent design to explain evolution. [36]

### Observational evidence

No possible observational evidence bears on Carter's WAP, as it is merely advice to the scientist and asserts nothing debatable. The obvious test of Barrow's SAP, which says that the Universe is "required" to support life, is to find evidence of life in universes other than ours. Any other universe is, by most definitions, unobservable (otherwise it would be included in *our* portion of *this* universe), however in principle, Barrow's SAP cannot be falsified by observing a universe in which an observer cannot exist.

Philosopher John Leslie[37] states that the Carter SAP (with multiverse) predicts the following:

- Physical theory will evolve so as to strengthen the hypothesis that early phase transitions occur probabilistically rather than deterministically, in which case there will be no deep physical reason for the values of fundamental constants;
- Various theories for generating multiple universes will prove robust;
- Evidence that the universe is fine tuned will continue to accumulate;
- No life with a non-carbon chemistry will be discovered;
- Mathematical studies of galaxy formation will confirm that it is sensitive to the rate of expansion of the universe.
Hogan\[38\] has emphasised that it would be very strange if all fundamental constants were strictly determined, since this would leave us with no ready explanation for apparent fine tuning. In fact we might have to resort to something akin to Barrow and Tipler's SAP: there would be no option for such a universe not to support life.

Probabilistic predictions of parameter values can be made given:
(i) a particular multiverse with a "measure", i.e. a well defined "density of universes" (so, for parameter \(X\), one can calculate the prior probability \(P(X_0) \, dX\) that \(X\) is in the range \(X_0 < X < X_0 + dX\), and
(ii) an estimate of the number of observers in each universe, \(N(X)\) (e.g., this might be taken as proportional to the number of stars in the universe).

The probability of observing value \(X\) is then proportional to \(N(X) \, P(X)\). (A more sophisticated analysis is that of Nick Bostrom.)\[39\] A generic feature of an analysis of this nature is that the expected values of the fundamental physical constants should not be "over-tuned," i.e. if there is some perfectly tuned predicted value (e.g. zero), the observed value need be no closer to that predicted value than what is required to make life possible. The small but finite value of the cosmological constant can be regarded as a successful prediction in this sense.

One thing that would not count as evidence for the Anthropic Principle is evidence that the Earth or the solar system occupied a privileged position in the universe, in violation of the Copernican principle (for possible counterevidence to this principle, see Copernican principle), unless there was some reason to think that that position was a necessary condition for our existence as observers.

**Applications of the principle**

**The nucleosynthesis of carbon-12**

Fred Hoyle may have invoked anthropic reasoning to predict an astrophysical phenomenon. He is said to have reasoned from the prevalence on earth of life forms whose chemistry was based on carbon-12 atoms, that there must be an undiscovered resonance in the carbon-12 nucleus facilitating its synthesis in stellar interiors via the triple-alpha process. He then calculated the energy of this undiscovered resonance to be 7.6 million electron-volts.\[40\]\[41\] Willie Fowler's research group soon found this resonance, and its measured energy was close to Hoyle's prediction.

However, a recently released paper argues that Hoyle did not use anthropic reasoning to make this prediction.\[42\]

**Cosmic inflation**

Don Page criticized the entire theory of cosmic inflation as follows.\[43\] He emphasized that initial conditions which made possible a thermodynamic arrow of time in a universe with a Big Bang origin, must include the assumption that at the initial singularity, the entropy of the universe was low and therefore extremely improbable. Paul Davies rebutted this criticism by invoking an inflationary version of the anthropic principle.\[44\] While Davies accepted the premise that the initial state of the visible Universe (which filled a microscopic amount of space before inflating) had to possess a very low entropy value — due to random quantum fluctuations — to account for the observed thermodynamic arrow of time, he deemed this fact an advantage for the theory. That the tiny patch of space from which our observable Universe grew had to be extremely orderly, to allow the post-inflation universe to have an arrow of time, makes it unnecessary to adopt any "ad hoc" hypotheses about the initial entropy state, hypotheses other Big Bang theories require.

**String theory**

String theory predicts a large number of possible universes, called the "backgrounds" or "vacua." The set of these vacua is often called the "multiverse" or "anthropic landscape" or "string landscape." Leonard Susskind has argued that the existence of a large number of vacua puts anthropic reasoning on firm ground: only universes whose properties are such as to allow observers to exist are observed, while a possibly much larger set of universes lacking such properties go unnoticed.
Steven Weinberg\textsuperscript{[45]} believes the Anthropic Principle may be appropriated by cosmologists committed to nontheism, and refers to that Principle as a "turning point" in modern science because applying it to the string landscape "...may explain how the constants of nature that we observe can take values suitable for life without being fine-tuned by a benevolent creator." Others, most notably David Gross but also Lubos Motl, Peter Woit, and Lee Smolin, argue that this is not predictive. Max Tegmark,\textsuperscript{[46]} Mario Livio, and Martin Rees\textsuperscript{[47]} argue that only some aspects of a physical theory need be observable and/or testable for the theory to be accepted, and that many well-accepted theories are far from completely testable at present.

Jürgen Schmidhuber (2000–2002) points out that Ray Solomonoff's theory of universal inductive inference and its extensions already provide a framework for maximizing our confidence in any theory, given a limited sequence of physical observations, and some prior distribution on the set of possible explanations of the universe.

**Ice density**

When water freezes into ice, the ice floats because ice is less dense than liquid water. This is one possible example of the anthropic principle, because if ice did not float, it might have been difficult or impossible for living organisms to have existed in water; without the insulating properties of a top ice layer, lakes and ponds would tend to freeze solid and thaw very little during warmer periods. This principle has been criticized as neglecting the existence of the tropical zone and other warmer climates.

Ice is unusual in that it is approximately 9\% less dense than liquid water. Water is the only known non-metallic substance to expand when it freezes. The density of ice is 0.9167 g/cm\textsuperscript{3} at 0°C, whereas water has a density of 0.9998 g/cm\textsuperscript{3} at the same temperature. Liquid water is densest, essentially 1.00 g/cm\textsuperscript{3}, at 4°C and becomes less dense as the water molecules begin to form the hexagonal crystals\textsuperscript{[48]} of ice as the freezing point is reached. This is due to hydrogen bonding dominating the intermolecular forces, which results in a packing of molecules less compact in the solid.

**The Anthropic Cosmological Principle**

A thorough extant study of the anthropic principle is the book *The Anthropic Cosmological Principle* by John D. Barrow, a cosmologist, and Frank J. Tipler, a theosophist and mathematical physicist. This book sets out in detail the many known anthropic coincidences and constraints, including many found by its authors. While the book is primarily a work of theoretical astrophysics, it also touches on quantum physics, chemistry, and earth science. An entire chapter argues that *Homo sapiens* is, with high probability, the only intelligent species in the Milky Way.

The book begins with an extensive review of many topics in the history of ideas the authors deem relevant to the anthropic principle, because the authors believe that principle has important antecedents in the notions of teleology and intelligent design. They discuss the writings of Fichte, Hegel, Bergson, and Alfred North Whitehead, and the Omega Point cosmology of Teilhard de Chardin. Barrow and Tipler carefully distinguish teleological reasoning from eutaxiological reasoning; the former asserts that order must have a consequent purpose; the latter asserts more modestly that order must have a planned cause. They attribute this important but nearly always overlooked distinction to an obscure 1883 book by L. E. Hicks.\textsuperscript{[49]}

Seeing little sense in a principle requiring intelligent life to emerge while remaining indifferent to the possibility of its eventual extinction, Barrow and Tipler propose the:

"Final anthropic principle (FAP): Intelligent information-processing must come into existence in the Universe, and, once it comes into existence, it will never die out."

\textsuperscript{[50]}

Barrow and Tipler submit that the FAP is both a valid physical statement and "closely connected with moral values." FAP places strong constraints on the structure of the universe, constraints developed further in Tipler's *The Physics of Immortality*.\textsuperscript{[51]} One such constraint is that the universe must end in a big crunch, which seems unlikely in view of
the tentative conclusions drawn since 1998 about dark energy, based on observations of very distant supernovas. In his review\cite{52} of Barrow and Tipler, Martin Gardner ridiculed the FAP by quoting the last two sentences of their book as defining a Completely Ridiculous Anthropic Principle (CRAP):

"At the instant the Omega Point is reached, life will have gained control of all matter and forces not only in a single universe, but in all universes whose existence is logically possible; life will have spread into all spatial regions in all universes which could logically exist, and will have stored an infinite amount of information, including all bits of knowledge which it is logically possible to know. And this is the end."\cite{53}

**Criticism**

Carter himself\cite{54} has frequently regretted his own choice of the word "anthropic," because it conveys the misleading impression that the principle involves humans specifically, rather than intelligent observers in general. Others\cite{55} have criticised the word "principle" as being too grandiose to describe straightforward applications of selection effects.

A common criticism of Carter's SAP is that it is an easy deus ex machina which discourages searches for physical explanations. To quote Penrose again: "it tends to be invoked by theorists whenever they do not have a good enough theory to explain the observed facts."\cite{56}

Carter's SAP and Barrow and Tipler's WAP have been dismissed as truisms or trivial tautologies, that is, statements true solely by virtue of their logical form (the conclusion is identical to the premise) and not because a substantive claim is made and supported by observation of reality. As such, they are criticized as being too grandiose to describe straightforward applications of selection effects.

Criticisms of the Barrow and Tipler SAP claim that it is neither testable nor falsifiable, and thus is not a scientific statement but rather a philosophical one. The same criticism has been leveled against the hypothesis of a multiverse, although some argue that it does make falsifiable predictions. A modified version of this criticism is that we understand so little about the emergence of life, especially intelligent life, that it is effectively impossible to calculate the number of observers in each universe. Also, the prior distribution of universes as a function of the fundamental constants is easily modified to get any desired result.\cite{57}

Many criticisms focus on versions of the Strong Anthropic Principle, such as Barrett and Tipler's anthropic cosmological principle, which are teleological notions that tend to describe the existence of life as a necessary prerequisite for the observable constants of physics. In a lecture titled "The Confusion of Cause and Effect in Bad Science," the paleophysicist Caroline Miller said:\cite{58}

"The Anthropic Principle is based on the underlying belief that the universe was created for our benefit. Unfortunately for its adherents, all of the reality-based evidence at our disposal contradicts this belief. In a nonanthropocentric universe, there is no need for multiple universes or supernatural entities to explain life as we know it."

Similarly, Stephen Jay Gould,\cite{59,60} Michael Shermer\cite{61} and others claim that the stronger versions of the Anthropic Principle seem to reverse known causes and effects. Gould compared the claim that the universe is fine-tuned for the benefit of our kind of life to saying that sausages were made long and narrow so that they could fit into modern hotdog buns, or saying that ships had been invented to house barnacles. These critics cite the vast
physical, fossil, genetic, and other biological evidence consistent with life having been fine-tuned through natural selection to adapt to the physical and geophysical environment in which life exists. Life appears to have adapted to physics, and not vice versa.

Some applications of the anthropic principle have been criticized as an argument by lack of imagination, for tacitly assuming that carbon compounds and water are the only possible chemistry of life (sometimes called "carbon chauvinism", see also alternative biochemistry). The range of fundamental physical constants consistent with the evolution of carbon-based life may also be wider than those who advocate a fine tuned universe have argued. For instance, Harnik et al. propose a weakless universe in which the weak nuclear force is eliminated. They show that this has no significant effect on the other fundamental interactions, provided some adjustments are made in how those interactions work. However, if some of the fine-tuned details of our universe were violated, that would rule out complex structures of any kind — stars, planets, galaxies, etc.

Lee Smolin has offered a theory designed to improve on the lack of imagination that anthropic principles have been accused of. He puts forth his fecund universes theory, which assumes universes have "offspring" through the creation of black holes, and that these offspring universes have values of physical constants that depend on these of the mother universe. Some versions of the anthropic principle are only interesting if the range of physical constants that allow certain kinds of life are unlikely in a landscape of possible universes. But Lee Smolin assumes that conditions for carbon based life are similar to conditions for black hole creation, which would change the a priori distribution of universes such that universes containing life would be likely. In the string theorist Leonard Susskind disagrees about some assumptions in Lee Smolin's theory, while Smolin defends his theory.

The philosophers of cosmology John Earman, Ernan McMullin and Jesús Mosterín contend that "in its weak version, the anthropic principle is a mere tautology, which does not allow us to explain anything or to predict anything that we did not already know. In its strong version, it is a gratuitous speculation". A further criticism by Mosterín concerns the flawed "anthropic" inference from the assumption of an infinity of worlds to the existence of one like ours:

"The suggestion that an infinity of objects characterized by certain numbers or properties implies the existence among them of objects with any combination of those numbers or characteristics [...] is mistaken. An infinity does not imply at all that any arrangement is present or repeated. [...] The assumption that all possible worlds are realized in an infinite universe is equivalent to the assertion that any infinite set of numbers contains all numbers (or at least all Gödel numbers of the [defining] sequences), which is obviously false."

Footnotes

[2] "anthropic" means "of or pertaining to mankind or humans"
Anthropic principle


[29] Strictly speaking, the number of non-compact dimensions, see String theory.


[37] Leslie, J. (1986) op. cit.


[40] University of Birmingham Life, Bent Chains and the Anthropic Principle (http://www.np.ph.bham.ac.uk/research/anthropic.htm)

[41] Rev. Mod. Phys. 29 (1957) 547


[48] The word crystal derives from Greek word for frost.

The Anthropic Cosmological Principle


References


Anthropic principle

doi:10.1088/0264-9381/14/4/002. A simple anthropic argument for why there are 3 spatial and 1 temporal dimensions.


**External links**

- Caner, Taslaman, Anthropic Principle and Infinite Universes (http://bigbang.ws/articles.asp?id=73)
- "Anthropic Coincidence" (http://www.starlarvae.org/Star_Larvae_Anthropic_Coincidence.html)—the anthropic controversy as a segue to Lee Smolin's theory of cosmological natural selection.
- Evolutionary Probability and Fine Tuning (http://www.epicidiot.com/evo_cre/13cards.htm)
- Critical review of "The Privileged Planet" (http://www.epicidiot.com/evo_cre/vr_privileged_planet.htm)
Fine-tuned Universe

The **fine-tuned universe** is the proposition that the conditions that allow life in the Universe can only occur when certain universal fundamental physical constants lie within a very narrow range, so that if any of several fundamental constants were only slightly different the universe would be unlikely to be conducive to the establishment and development of matter, astronomical structures, elemental diversity, or life as it is presently understood.\[1\] The existence and extent of fine-tuning in the universe is a matter of dispute in the scientific community.

Physicist Paul Davies has stated that "There is now broad agreement among physicists and cosmologists that the universe is in several respects 'fine-tuned' for life".\[2\] However he continues "...the conclusion is not so much that the universe is fine-tuned for life; rather it is fine-tuned for the building blocks and environments that life requires."\[2\] He also states that "... 'anthropic' reasoning fails to distinguish between minimally biophilic universes, in which life is permitted but only marginally possible, and optimally biophilic universes, in which life flourishes because biogenesis occurs frequently ..."\[2\] Among scientists who find the evidence persuasive, a variety of natural explanations have been proposed, e.g., the anthropic principle along with multiple universes. The proposition is also discussed among philosophers, theologians, creationists and intelligent design proponents.

**History**

In 1913, the chemist Lawrence Joseph Henderson (1878–1942) wrote *The Fitness of the Environment*, one of the first books to explore concepts of fine tuning in the universe. Henderson discusses the importance of water and the environment with respect to living things, pointing out that life depends entirely on the very specific environmental conditions on Earth, especially with regard to the prevalence and properties of water.\[3\]

In 1961, the physicist Robert H. Dicke claimed that certain forces in physics, such as gravity and electromagnetism, must be perfectly fine-tuned for life to exist anywhere in the universe.\[4\]\[5\] Fred Hoyle also argued for a fine-tuned universe in his 1984 book *Intelligent Universe*. He compares "the chance of obtaining even a single functioning protein by chance combination of amino acids to a solar system full of blind men solving Rubik's Cube simultaneously".\[6\]

John Gribbin and Martin Rees wrote a detailed history and defence of the fine-tuning argument in their book *Cosmic Coincidences* (1989). According to Gribbin and Rees, carbon-based life was not haphazardly arrived at, but the deliberate end of a universe "tailor made for man."\[7\]

**Premise**

The premise of the fine-tuned universe assertion is that a small change in several of the dimensionless fundamental physical constants would make the universe radically different. As Stephen Hawking has noted, "The laws of science, as we know them at present, contain many fundamental numbers, like the size of the electric charge of the electron and the ratio of the masses of the proton and the electron. ... The remarkable fact is that..."
the values of these numbers seem to have been very finely adjusted to make possible the development of life."[8]

If, for example, the strong nuclear force were 2% stronger than it is (i.e., if the coupling constant representing its strength were 2% larger), while the other constants were left unchanged, diprotons would be stable and hydrogen would fuse into them instead of deuterium and helium.[9] This would drastically alter the physics of stars, and presumably preclude the existence of life similar to what we observe on Earth. The existence of the di-proton would short circuit the slow fusion of hydrogen into deuterium. Hydrogen would fuse so easily that it is likely that all of the universe's hydrogen would be consumed in the first few minutes after the big bang.[9] However, some of the fundamental constants describe the properties of the unstable strange, charmed, bottom and top quarks and mu and tau leptons which seem to play little part in the universe or the structure of matter.

The precise formulation of the idea is made difficult by the fact that physicists do not yet know how many independent physical constants there are. The current standard model of particle physics has 25 freely adjustable parameters (there is an additional parameter for gravitation, the cosmological constant). However, because the standard model is not mathematically self-consistent under certain conditions (e.g., at very high energies, at which both quantum mechanics and general relativity are relevant), physicists believe that it is underlaid by some other theory, such as a grand unified theory, string theory, or loop quantum gravity. In some candidate theories, the actual number of independent physical constants may be as small as 1. For example, the cosmological constant may be a fundamental constant, but attempts have also been made to calculate it from other constants, and according to the author of one such calculation, "the small value of the cosmological constant is telling us that a remarkably precise and totally unexpected relation exists among all the parameters of the Standard Model of particle physics, the bare cosmological constant and unknown physics."[10]

Martin Rees[11] formulates the fine-tuning of the universe in terms of the following six dimensionless constants:

- **$N$** = ratio of the strengths of gravity to that of electromagnetism;
- **$\varepsilon$** = strength of the force binding nucleons into nuclei;
- **$\omega$** = relative importance of gravity and expansion energy in the universe;
- **$\lambda$** = cosmological constant;
- **$Q$** = ratio of the gravitational energy required to pull a large galaxy apart to the energy equivalent of its mass;
- **$D$** = number of spatial dimensions in spacetime.

### Disputes regarding the existence and extent of fine-tuning

Computer simulations suggest that not all of the purportedly "fine-tuned" parameters may be as fine-tuned as has been claimed. Victor Stenger has simulated different universes in which four fundamental parameters are varied. He found that long-lived stars could exist over a wide parameter range, and concluded that "... a wide variation of constants of physics leads to universes that are long-lived enough for life to evolve, although human life need not exist in such universes".[12]

Fred Adams has done a similar study to Stenger, investigating the structure of stars in universes with different values of the gravitational constant $G$, the fine-structure constant $\alpha$, and a nuclear reaction rate parameter $C$. His study suggests that roughly 25% of this parameter space allows stars to exist.[13] Harnik, Kribs and Perez have argued for the viability of a universe with no weak interaction at all. However, they noted that their analysis does not extend to the supposed fine tuning of the cosmological constant, and concluded that "the fine-tuning problems associated with the electroweak breaking scale and the cosmological constant appear to be qualitatively different from the perspective of obtaining a habitable universe."[14]

The validity of fine tuning examples is sometimes questioned on the grounds that such reasoning is subjective anthropomorphism applied to natural physical constants. Critics also suggest that the fine-tuned universe assertion and the anthropic principle are essentially tautologies.[15] The fine-tuned universe argument has also been criticized as an argument by lack of imagination because it assumes no other forms of life, sometimes referred to as carbon chauvinism. Conceptually, alternative biochemistry or other forms of life are possible.[16] In addition, critics argue
that humans are adapted to the universe through the process of evolution, rather than the universe being adapted to
humans (see puddle thinking). They also see it as an example of the logical flaw of hubris or anthropocentrism in its
assertion that humans are the purpose of the universe.[17]

Possible naturalistic explanations

There are fine tuning arguments that are naturalistic.[18] As modern cosmology developed, various hypotheses have
been proposed. One is an oscillatory universe or a multiverse where fundamental physical constants are postulated to
resolve themselves to random values in different iterations of reality.[19] Under this hypothesis, separate parts of
reality would have wildly different characteristics. In such scenarios the issue of fine-tuning does not arise at all, as
only those “universes” with constants hospitable to life (such as what we observe) would develop life capable of
contemplating the question of the origin of fine-tuning.

Based upon the Anthropic principle, physicist Robert H. Dicke proposed the "Dicke coincidence” argument that the
structure (age, physical constants, etc.) of the universe as seen by living observers is not random, but is constrained
by biological factors that require it to be roughly a "golden age".[20]

Multiverse

The Multiverse hypothesis assumes the existence of many universes with different physical constants, some of which
are hospitable to intelligent life (see multiverse: anthropic principle). Because we are intelligent beings, we are by
definition in a hospitable one. Mathematician Michael Ikeda and astronomer William H. Jefferys have argued that
the anthropic principle resolves the entire issue of fine-tuning.[21][22] as does philosopher of science Elliott Sober.[23]
Philosopher and theologian Richard Swinburne reaches the opposite conclusion using Bayesian probability.[24]

This approach has led to considerable research into the anthropic principle and has been of particular interest to
particle physicists because theories of everything do apparently generate large numbers of universes in which the
physical constants vary widely. As of yet, there is no evidence for the existence of a multiverse, but some versions of
the theory do make predictions which some researchers studying M-theory and gravity leaks hope to see some
evidence of soon.[25] Some multiverse theories are not falsifiable, thus scientists may be reluctant to call any
multiverse theory "scientific". UNC-Chapel Hill professor Laura Mersini-Houghton claims that the WMAP cold spot
may provide testable empirical evidence for a parallel universe.

Variants on this approach include Lee Smolin's notion of cosmological natural selection, the Ekpyrotic universe, and
the Bubble universe theory.

Critics of the multiverse-related explanations argue that there is no evidence that other universes exist.

Bubble universe theory

The bubble universe model by physicist Andrei Linde, postulates that our universe is one of many that grew from a
multiverse consisting of vacuum that had not yet decayed to its ground state.

According to this scenario, by means of a random quantum fluctuation the universe "tunneled” from pure
vacuum ("nothing") to what is called a false vacuum, a region of space that contains no matter or radiation but
is not quite "nothing." The space inside this bubble of false vacuum was curved, or warped. A small amount of
energy was contained in that curvature, somewhat like the energy stored in a strung bow. This ostensible
violation of energy conservation is allowed by the Heisenberg uncertainty principle for sufficiently small time
intervals.

The bubble then inflated exponentially and the universe grew by many orders of magnitude in a tiny fraction
of a second. (For a not-too-technical discussion, see Stenger 1990[26]). As the bubble expanded, its curvature
energy was converted into matter and radiation, inflation stopped, and the more linear big bang expansion we
now experience commenced. The universe cooled and its structure spontaneously froze out, as formless water
vapor freezes into snowflakes whose unique patterns arise from a combination of symmetry and randomness.


In standard inflation, inflationary expansion occurred while the universe was in a false vacuum state, halting when the universe decayed to a true vacuum state. The bubble universe model proposes that different parts of this inflationary universe (termed a Multiverse) decayed at different times, with decaying regions corresponding to universes not in causal contact with each other. It further supposes that each bubble universe may have different physical constants.

**Top-down cosmology**

Stephen Hawking, along with Thomas Hertog of CERN, proposed that the universe's initial conditions consisted of a superposition of many possible initial conditions, only a small fraction of which contributed to the conditions we see today.[^28] According to their theory, it is inevitable that we find our universe's "fine-tuned" physical constants, as the current universe "selects" only those past histories that led to the present conditions. In this way, top-down cosmology provides an anthropic explanation for why we find ourselves in a universe that allows matter and life, without invoking the existence of the multiverse.

**Alien design**

One hypothesis is that the Universe may have been designed by extra-universal aliens. Some believe this would solve the problem of how a designer or design team capable of fine-tuning the Universe could come to exist. Cosmologist Alan Guth believes humans will in time be able to generate new universes. By implication previous intelligent entities may have generated our universe.[^29] This idea leads to the possibility that the extraterrestrial designer/designers are themselves the product of an evolutionary process in their own universe, which must therefore itself be able to sustain life.

The Simulation hypothesis promoted by Nick Bostrom and others suggests that our universe may be a computer simulation by aliens.[^30]

The Biocosm hypothesis and the Meduso-anthropic principle both suggest that natural selection has made the universe biophilic. The universe enables intelligence because intelligent entities later create new biophilic universes. This is different from the suggestion above that aliens from a universe which is less finely tuned than ours made our universe finely tuned.

The Designer Universe theory of John Gribbin suggests that the universe could have been made deliberately by a member or members of a technologically advanced civilization in another part of the multiverse and that this advanced civilization may have been responsible for causing the big bang.[^31]

**Religious Arguments**

As with theistic evolution, some individual scientists, theologians, and philosophers as well as certain religious groups argue that providence or creation are responsible for fine-tuning.

Christian philosopher Alvin Plantinga argues that random chance, applied to a single and sole universe, only raises the question as to why this universe could be so "lucky" as to have precise conditions that support life at least at some place (the Earth) and time (within millions of years of the present).

One reaction to these apparent enormous coincidences is to see them as substantiating the theistic claim that the universe has been created by a personal God and as offering the material for a properly restrained theistic argument—hence the fine-tuning argument. It's as if there are a large number of dials that have to be tuned to within extremely narrow limits for life to be possible in our universe. It is extremely unlikely that this should happen by chance, but much more likely that this should happen if there is such a person as God.

—Alvin Plantinga, *The Dawkins Confusion; Naturalism ad absurdum*[^32]
This fine-tuning of the universe is cited\textsuperscript{33} by theologian and philosopher William Lane Craig as an evidence for the existence of God or some form of intelligence capable of manipulating (or designing) the basic physics that governs the universe. Craig argues, however, "that the postulate of a divine Designer does not settle for us the religious question."

**Intelligent design**

Proponents of Intelligent design argue that certain features of the universe and of living things are best explained by an intelligent cause, not an undirected process such as natural selection. The fine-tuned universe argument is a central premise or presented as a given in many of the published works of prominent intelligent design proponents, such as William A. Dembski and Michael Behe.

**Other religious creation views**

Most religions have some kind of account of the creation of the universe, although they generally differ in detail from the ones listed above. Some of these may be compatible with known scientific facts (Old Earth Creationism, Theistic Evolution, Progressive Creationism). Others are either incompatible with, or indifferent to, scientific understandings (Young Earth Creationism). For example scientist-theologians such as John Polkinghorne emphasize the implications of *Anthropic Fine-Tuning* within an orthodox Christian framework whilst fully accepting the scientific findings about Evolution and the age of the Universe. This is also the position of the Roman Catholic Church and of most Anglican theologians.\textsuperscript{34} The Jewish physicist Gerald Schroeder argues that the apparent discrepancy between the "days" in Genesis and the billions of years in a scientific understanding are due to the differences in frames of reference. Other scientists with similar views are physicist Freeman Dyson and astronomer Owen Gingerich.

**Counter argument to religious views**

Victor Stenger argues that "... The fine-tuning argument and other recent intelligent design arguments are modern versions of God of the gaps reasoning, where a God is deemed necessary whenever science has not fully explained some phenomenon."\textsuperscript{12} The argument from imperfection suggests that if the universe were designed to be fine-tuned for life, it should be the best one possible and that evidence suggests that it is not.\textsuperscript{35} In fact, most of the universe is highly hostile to life. Additionally Stenger argues, "We have no reason to believe that our kind of carbon-based life is all that is possible. Furthermore, modern cosmology indicates that multiple universes may exist with different constants and laws of physics. So, it is not surprising that we live in the one suited for us. The universe is not fine-tuned to life; life is fine-tuned to the universe."\textsuperscript{36}

**In fiction and popular culture**

- Robert J. Sawyer discusses the fine-tuned universe at length in his novel *Calculating God* (2000).
- Author Neal Stephenson discussed the issue of fine-tuning in the conclusion to his essay *In the Beginning... was the Command Line.*\textsuperscript{37}
- *Puddle thinking* is a satirical illustration of the "life is fine-tuned to the universe" argument above coined by Douglas Adams to satirize the Fine-tuned Universe argument for supernatural creationism.\textsuperscript{38}\textsuperscript{39} As quoted in Richard Dawkins' eulogy for Douglas Adams:\textsuperscript{40} ...

  ... imagine a puddle waking up one morning and thinking, 'This is an interesting world I find myself in, an interesting hole I find myself in, fits me rather neatly, doesn't it? In fact it fits me staggeringly well, must have been made to have me in it!' This is such a powerful idea that as the sun rises in the sky and the air heats up and as, gradually, the puddle gets smaller and smaller, it's still frantically hanging on to
the notion that everything's going to be all right, because this world was meant to have him in it, was built to have him in it; so the moment he disappears catches him rather by surprise. I think this may be something we need to be on the watch out for.

References

[27] The Anthropic Coincidences (http://www.colorado.edu/philosophy/vstenger/Cosmo/anthro_skelent.html)
[34] See, e.g., Alister McGrath's books Scientific Theology and The Science of God.
Further reading


External links

Defend fine-tuning:
- God: new evidence — a series of six videos exploring how evidence from cosmic fine tuning points to the reality of a creator God (http://www.focus.org.uk/)
- Robin Collins:
  - Fine-Tuning website. (http://home.messiah.edu/~rcollins/)
  - " Cosmological fine-tuning. (http://academic.udayton.edu/WilliamRichards/Intro essays/Collins, Fine-tuning.htm)"
- Hugh Ross:
  - " Evidence For Design In The Universe. (http://doesgodexist.com/Charts/EvidenceForDesignInTheUniverse.html)"
- The cosmos is fine-tuned to permit human life (http://www.talkorigins.org/indexcc/CI/CI301.html) at the talk.origins index to creationist claims.
- Interview (http://www.berkeley.edu/news/media/releases/2005/06/17_townes.shtml) with Charles Townes discussing science and religion.
- Home page (http://www.templeton.org/biochem-finetuning/purpose.html) of Templeton Foundation project on fine-tuning.
Fine-tuned Universe

Criticize fine tuning:

- Bibliography of online Links to criticisms of the Fine-Tuning Argument. (http://www.infidels.org/library/modern/theism/design.html#fine) Secular Web.
- Victor Stenger:
  - "Does the Cosmos Show Evidence of Purpose? (http://www.colorado.edu/philosophy/vstenger/Cosmo/anthro.skinq.html)"
  - "Is the Universe fine-tuned for us? (http://www.colorado.edu/philosophy/vstenger/Cosmo/FineTune.pdf)"

Multiverse

The multiverse (or meta-universe, metaverse) is the hypothetical set of multiple possible universes (including the historical universe we consistently experience) that together comprise everything that exists and can exist: the entirety of space, time, matter, and energy as well as the physical laws and constants that describe them. The term was coined in 1895 by the American philosopher and psychologist William James.[1] The various universes within the multiverse are sometimes called parallel universes.

The structure of the multiverse, the nature of each universe within it and the relationship between the various constituent universes, depend on the specific multiverse hypothesis considered. Multiverses have been hypothesized in cosmology, physics, astronomy, religion, philosophy, transpersonal psychology and fiction, particularly in science fiction and fantasy. In these contexts, parallel universes are also called "alternative universes", "quantum universes", "interpenetrating dimensions", "parallel dimensions", "parallel worlds", "alternative realities", "alternative timelines", and "dimensional planes," among others.

Multiverse hypotheses in physics

Tegmark's classification

Cosmologist Max Tegmark has provided a taxonomy of universes beyond the familiar observable universe. The levels according to Tegmark's classification are arranged such that subsequent levels can be understood to encompass and expand upon previous levels, and they are briefly described below. [2][3]
Level I: Beyond our cosmological horizon

A generic prediction of chaotic inflation is an infinite ergodic universe, which, being infinite, must contain Hubble volumes realizing all initial conditions.

Accordingly, an infinite universe will contain an infinite number of Hubble volumes, all having the same physical laws and physical constants. In regard to configurations such as the distribution of matter, almost all will differ from our Hubble volume. However, because there are infinitely many, far beyond the cosmological horizon, there will eventually be Hubble volumes with similar, and even identical, configurations. Tegmark estimates that an identical volume to ours should be about $10^{10} \times 115$ meters away from us. This estimate implies use of the cosmological principle, wherein one assumes our Hubble volume is not special or unique. By extension of the same reasoning, there would, in fact, be an infinite number of Hubble volumes identical to ours in the universe.

Level II: Universes with different physical constants

In the chaotic inflation theory, a variant of the cosmic inflation theory, the multiverse as a whole is stretching and will continue doing so forever, but some regions of space stop stretching and form distinct bubbles, like gas pockets in a loaf of rising bread. Such bubbles are embryonic level I multiverses. Linde and Vanchurin calculated the number of these universes to be on the scale of $10^{10} \times 10,000,000$.

Different bubbles may experience different spontaneous symmetry breaking resulting in different properties such as different physical constants.

This level also includes John Archibald Wheeler's oscillatory universe theory and Lee Smolin's fecund universes theory.

Level III: Many-worlds interpretation of quantum mechanics

Hugh Everett's many-worlds interpretation (MWI) is one of several mainstream interpretations of quantum mechanics. In brief, one aspect of quantum mechanics is that certain observations cannot be predicted absolutely. Instead, there is a range of possible observations, each with a different probability. According to the MWI, each of these possible observations corresponds to a different universe. Suppose a die is thrown that contains six sides and that the numeric result of the throw corresponds to a quantum mechanics observable. All six possible ways the die can fall correspond to six different universes. (More correctly, in MWI there is only a single universe but after the "split" into "many worlds" these cannot in general interact.)

Tegmark argues that a level III multiverse does not contain more possibilities in the Hubble volume than a level I-II multiverse. In effect, all the different "worlds" created by "splits" in a level III multiverse with the same physical constants can be found in some Hubble volume in a level I multiverse. Tegmark writes that "The only difference between Level I and Level III is where your doppelgängers reside. In Level I they live elsewhere in good old three-dimensional space. In Level III they live on another quantum branch in infinite-dimensional Hilbert space." Similarly, all level II bubble universes with different physical constants can in effect be found as "worlds" created by "splits" at the moment of spontaneous symmetry breaking in a level III multiverse.

Related to the many-worlds idea are Richard Feynman's multiple histories interpretation and H. Dieter Zeh's many-minds interpretation.
Level IV: Ultimate Ensemble

The Ultimate Ensemble is the hypothesis of Tegmark himself. This level considers equally real all universes that can be described by different mathematical structures. Tegmark writes that "abstract mathematics is so general that any Theory Of Everything (TOE) that is definable in purely formal terms (independent of vague human terminology) is also a mathematical structure. For instance, a TOE involving a set of different types of entities (denoted by words, say) and relations between them (denoted by additional words) is nothing but what mathematicians call a set-theoretical model, and one can generally find a formal system that it is a model of." He argues this "implies that any conceivable parallel universe theory can be described at Level IV" and "subsumes all other ensembles, therefore brings closure to the hierarchy of multiverses, and there cannot be a Level V."[8]

Jürgen Schmidhuber, however, says the "set of mathematical structures" is not even well-defined, and admits only universe representations describable by constructive mathematics, that is, computer programs. He explicitly includes universe representations describable by non-halting programs whose output bits converge after finite time, although the convergence time itself may not be predictable by a halting program, due to Kurt Gödel's limitations.[9][10][11] He also explicitly discusses the more restricted ensemble of quickly computable universes.[12]

Cyclic theories

In several theories there is a series of infinite, self-sustaining cycles (for example: an eternity of Big Bang-Big crunches).

M-theory

A multiverse of a somewhat different kind has been envisaged within the multi-dimensional extension of string theory known as M-theory, also known as Membrane Theory.[13] In M-theory our universe and others are created by collisions between p-branes in a space with 11 and 26 dimensions (the number of dimensions depends on the chirality of the observer);[14][15] each universe takes the form of a D-brane.[14][15] Objects in each universe are essentially confined to the D-brane of their universe, but may be able to interact with other universes via gravity, a force which is not restricted to D-branes.[16] This is unlike the universes in the "quantum multiverse", but both concepts can operate at the same time.

Anthropic principle

The concept of other universes has been proposed to explain why our universe seems to be fine-tuned for conscious life as we experience it. If there were a large number (possibly infinite) of different physical laws (or fundamental constants) in as many universes, some of these would have laws that were suitable for stars, planets and life to exist. The weak anthropic principle could then be applied to conclude that we would only consciously exist in those universes which were finely tuned for our conscious existence. Thus, while the probability might be extremely small that there is life in most of the universes, this scarcity of life-supporting universes does not imply intelligent design as the only explanation of our existence.

Criticism

Naming

People have criticized the name "multiverse". In the July 5, 2010 episode of the Colbert Report (Episode 6088) Steven confronted his guest, Michio Kaku, on this issue. His logic was that the phrase "multiverse" is self-contradictory due to the definition of universe in the original "Greek". Colbert was slightly wrong on this: universe is a Latin term, but he was right overall as it means "entirety" [17] and it is impossible to have more than one entirety. However, 'universe' means 'turned into one' (versus is the past participle of vertere, to turn) so it's arguably that 'multiverse' means 'turned into many'. 'Versus' does not mean 'entirety'.[17][18]
Non-scientific claims

In his book, *A Brief History of the Multiverse*, author and cosmologist, Paul Davies, offers a variety of non-scientific arguments against multiverse theories:[19]

For a start, how is the existence of the other universes to be tested? To be sure, all cosmologists accept that there are some regions of the universe that lie beyond the reach of our telescopes, but somewhere on the slippery slope between that and the idea that there are an infinite number of universes, credibility reaches a limit. As one slips down that slope, more and more must be accepted on faith, and less and less is open to scientific verification. Extreme multiverse explanations are therefore reminiscent of theological discussions. Indeed, invoking an infinity of unseen universes to explain the unusual features of the one we do see is just as ad hoc as invoking an unseen Creator. The multiverse theory may be dressed up in scientific language, but in essence it requires the same leap of faith.

— Paul Davies, *A Brief History of the Multiverse*

Taking cosmic inflation as a popular case in point, George Ellis provides a balanced criticism of not only the science, but as he suggests, the scientific philosophy, by which multiverse theories are generally substantiated. He, like most cosmologists, accepts Tegmark's level I "domains", even though they lie far beyond the cosmological horizon. Likewise, the multiverse of cosmic inflation is said to exist very far away. It would be so far away, however, that it's very unlikely any evidence of an early interaction will be found. He argues that for many theorists, the lack of empirical testability or falsifiability is not a major concern. "Many physicists who talk about the multiverse, especially advocates of the string landscape, do not care much about parallel universes per se. For them, objections to the multiverse as a concept are unimportant. Their theories live or die based on internal consistency and, one hopes, eventual laboratory testing." Although he believes there's little hope that will ever be possible, he grants that the theories on which the speculation is based, are not without scientific merit. He concludes that multiverse theory is a "productive research program".[20]

As skeptical as I am, I think the contemplation of the multiverse is an excellent opportunity to reflect on the nature of science and on the ultimate nature of existence: why we are here… In looking at this concept, we need an open mind, though not too open. It is a delicate path to tread. Parallel universes may or may not exist; the case is unproved. We are going to have to live with that uncertainty. Nothing is wrong with scientifically based philosophical speculation, which is what multiverse proposals are. But we should name it for what it is.

— George Ellis, *Scientific American*, Does the Multiverse Really Exist?

Indirect evidence

The logical foundation of modern science is hypothetico-deductive logic which permits a theory to propose unobservable entities if these help explain observable outcomes, either by theory-based predictions (of future observations) or retroductionism (of already known observations).[21]

Occam's razor

Critics argue that to postulate a practically infinite number of unobservable universes just to explain our own seems contrary to Occam's razor.[22]

Max Tegmark answers:

"A skeptic worries about all the information necessary to specify all those unseen worlds. But an entire ensemble is often much simpler than one of its members. This principle can be stated more formally using the notion of algorithmic information content. The algorithmic information content in a number is, roughly speaking, the length of the shortest computer program that will produce that number as output. For example, consider the set of all integers. Which is simpler, the whole set or just one number? Naively, you might think that a single number is simpler, but the entire set can be generated by quite a trivial computer program, whereas a single number can be hugely long. Therefore, the whole set is
actually simpler. Similarly, the set of all solutions to Einstein's field equations is simpler than a specific solution. The former is described by a few equations, whereas the latter requires the specification of vast amounts of initial data on some hypersurface. The lesson is that complexity increases when we restrict our attention to one particular element in an ensemble, thereby losing the symmetry and simplicity that were inherent in the totality of all the elements taken together. In this sense, the higher-level multiverses are simpler. Going from our universe to the Level I multiverse eliminates the need to specify initial conditions, upgrading to Level II eliminates the need to specify physical constants, and the Level IV multiverse eliminates the need to specify anything at all."

He continues:

"A common feature of all four multiverse levels is that the simplest and arguably most elegant theory involves parallel universes by default. To deny the existence of those universes, one needs to complicate the theory by adding experimentally unsupported processes and ad hoc postulates: finite space, wave function collapse and ontological asymmetry. Our judgment therefore comes down to which we find more wasteful and inelegant: many worlds or many words. Perhaps we will gradually get used to the weird ways of our cosmos and find its strangeness to be part of its charm."[4]

Multiverse hypotheses in philosophy and logic

Modal realism

Possible worlds are a way of explaining probability, hypothetical statements and the like, and some philosophers such as David Lewis believe that all possible worlds exist, and are just as real as the actual world (a position known as modal realism).[23]

Trans-world identity

A metaphysical issue that crops up in multiverse schema that posit infinite identical copies of any given universe is that of the notion that there can be identical objects in different possible worlds. According to the counterpart theory of David Lewis, the objects should be regarded as similar rather than identical.[24][25]

Fictional realism

The view that because fictions exist, fictional characters exist as well. There are fictional entities, in the same sense in which, setting aside philosophical disputes, there are people, Mondays, numbers and planets.[26][27]

Multiverse hypotheses in religion and spirituality

Cosmology in medieval Islam

Fakhr al-Din al-Razi (1149–1209), in dealing with his conception of physics and the physical world in his Matalib al-'Aliya, criticizes the idea of the Earth's centrality within the universe and "explores the notion of the existence of a multiverse in the context of his commentary" on the Qur'anic verse, "All praise belongs to God, Lord of the Worlds." He raises the question of whether the term "worlds" in this verse refers to "multiple worlds within this single universe or cosmos, or to many other universes or a multiverse beyond this known universe."[28]
**Multiverse**

**Hinduism**
The concept of multiple universes is mentioned many times in Hindu Puranic literature, such as in the Bhagavata Purana:

*Because You are unlimited, neither the lords of heaven nor even You Yourself can ever reach the end of Your glories. The countless universes, each enveloped in its shell, are compelled by the wheel of time to wander within You, like particles of dust blowing about in the sky. The śrutis, following their method of eliminating everything separate from the Supreme, become successful by revealing You as their final conclusion* (Bhagavata Purana 10.87.41)

**Buddhism**
The concept of infinite worlds is mentioned in the Apannaka Jataka:

"Disciples," the Buddha said "nowhere between the lowest of hells below and the highest heaven above, nowhere in all the infinite worlds that stretch right and left, is there the equal, much less the superior, of a Buddha. Incalculable is the excellence which springs from obeying the Precepts and from other virtuous conduct." - Apannaka Jataka

**New Age**
The philosopher and forerunner of the New Age movement P. D. Ouspensky stated in 1934:

"Our mind follows the development of possibilities always in one direction only. But in fact every moment contains a very large number of possibilities. And all of them are actualised, only we do not see it and do not know it. We always see only one of the actualisations, and in this lie the poverty and limitation of the human mind. But if we try to imagine the actualisation of all the possibilities of the present moment, then of the next moment, and so on, we shall feel the world growing infinitely, incessantly multiplying by itself and becoming immeasurably rich and utterly unlike the flat and limited world we have pictured to ourselves up to this moment." [29]

**Planes of existence**
Certain religions and esoteric cosmologies propound the idea of a whole series of subtle emanated planes or worlds.

**Afterlife**
Many religions include an afterlife existence in realms, such as heavens and hells, which may be very different from the observable universe.

**Eschatology**
Eschatological scenarios may include a new different world after the end time of the current one. For example, Hindu cosmology includes the idea of an infinite cycle of births and deaths and an infinite number of universes with each cycle lasting 8.4 billion years.[30]

Similar eschatological scenarios appear in other religions, in the form of belief in there being a new and different world after the end time of the current one.
Multiverse

References

Notes

[1] James, William, *The Will to Believe*, 1895; and earlier in 1895, as cited in OED's new 2003 entry for "multiverse": “1895 W. JAMES in Internat. Jnl. Ethics 6.10. Visible nature is all plasticity and indifference, a multiverse, as one might call it, and not a universe.”


[21] Craig Rusbult, Ph.D


[27] The Australian National University (http://consciousness.anu.edu.au/thomasson/Fictional Entities.doc)


Bibliography


External links

- Max Tegmark (2003) "Parallel Universes. Not just a staple of science fiction, other universes are a direct implication of cosmological observations. ([http://space.mit.edu/home/tegmark/PDF/multiverse_sciam.pdf](http://space.mit.edu/home/tegmark/PDF/multiverse_sciam.pdf))"
- Michael Price's Everett FAQ. ([http://www.hedweb.com/manworld.htm](http://www.hedweb.com/manworld.htm))
- Jürgen Schmidhuber, "The ensemble of universes describable by constructive mathematics. ([http://www.idsia.ch/~juergen/computeruniverse.html](http://www.idsia.ch/~juergen/computeruniverse.html))"
- Joseph Pine II about Multiverse ([http://www.upstream.nl/comments.php?id=751_0_1_0_C](http://www.upstream.nl/comments.php?id=751_0_1_0_C)), Presentation at Mobile Monday Amsterdam, 2008
- Multiverse - Radio-discussion on [[BBC Four](http://www.bbc.co.uk/programmes/b008z744)] with Melvyn Bragg
Ultimate fate of the universe

The ultimate fate of the universe is a topic in physical cosmology. Many possible fates are predicted by rival scientific theories, including futures of both finite and infinite duration.

Once the notion that the universe started with a rapid inflation nicknamed the Big Bang became accepted by the majority of scientists,[1] the ultimate fate of the universe became a valid cosmological question, one depending upon the physical properties of the mass/energy in the universe, its average density, and the rate of expansion.

Emerging scientific basis

Theory

The theoretical scientific exploration of the ultimate fate of the universe became possible with Albert Einstein's 1916 theory of general relativity. General relativity can be employed to describe the universe on the largest possible scale. There are many possible solutions to the equations of general relativity, and each solution implies a possible ultimate fate of the universe. Alexander Friedman proposed a number of such solutions in 1922 as did Georges Lemaître in 1927.[2] In some of these the universe has been expanding from an initial singularity; this is, essentially, the Big Bang.

Observation

In 1931, Edwin Hubble published his conclusion, based on his observations of Cepheid variable stars in distant galaxies, that the universe was expanding. From then on, the beginning of the universe and its possible end have been the subjects of serious scientific investigation.

Big Bang and Steady state theories

In 1927, Georges Lemaître set out a theory that has since come to be called the Big Bang theory of the origin of the universe.[2] In 1948, Fred Hoyle set out his opposing steady state theory in which the universe continually expanded but remained statistically unchanged as new matter is constantly created. These two theories were active contenders until the 1965 discovery, by Arno Penzias and Robert Wilson, of the cosmic microwave background radiation, a fact that is a straightforward prediction of the Big Bang theory, and one that the original Steady State theory could not account for. As a result The Big Bang theory quickly became the most widely held view of the origin of the universe.

Cosmological constant

When Einstein formulated general relativity, he and his contemporaries believed in a static universe. When Einstein found that his equations could easily be solved in such a way as to allow the universe to be expanding now, and to contract in the far future, he added to those equations what he called a cosmological constant, essentially a constant energy density unaffected by any expansion or contraction, whose role was to offset the effect of gravity on the universe as a whole in such a way that the universe would remain static. After Hubble announced his conclusion that the universe was expanding, Einstein wrote that his cosmological constant was "the greatest blunder of my life."[3]
Density parameter

An important parameter in fate of the universe theory is the Density parameter, Omega (Ω), defined as the average matter density of the universe divided by a critical value of that density. This selects one of three possible geometries depending on whether Ω is equal to, less than, or greater than 1. These are called, respectively, the flat, open and closed universes. These three adjectives refer to the overall geometry of the universe, and not to the local curving of spacetime caused by smaller clumps of mass (for example, galaxies and stars). If the primary content of the universe is inert matter, as in the dust models popular for much of the 20th century, there is a particular fate corresponding to each geometry. Hence cosmologists aimed to determine the fate of the universe by measuring Ω, or equivalently the rate at which the expansion was decelerating.

Repulsive force

Starting in 1998, observations of supernovae in distant galaxies have been interpreted as consistent with a universe whose expansion is accelerating. Subsequent cosmological theorizing has been designed so as to allow for this possible acceleration, nearly always by invoking dark energy, which in its simplest form is just a positive cosmological constant. In general dark energy is a catch-all term for any hypothesised field with negative pressure, usually with a density that changes as the universe expands.

Role of the shape of the universe

The current scientific consensus of most cosmologists is that the ultimate fate of the universe depends on its overall shape, how much dark energy it contains, and on the equation of state which determines how the dark energy density responds to the expansion of the universe. Recent observations have shown that, from 7.5 billion years after the Big Bang onwards, the expansion rate of the universe has actually been increasing, commensurate with the Open Universe theory.

Closed universe

If Ω > 1, then the geometry of space is closed like the surface of a sphere. The sum of the angles of a triangle exceeds 180 degrees and there are no parallel lines; all lines eventually meet. The geometry of the universe is, at least on a very large scale, elliptic.

In a closed universe lacking the repulsive effect of dark energy, gravity eventually stops the expansion of the universe, after which it starts to contract until all matter in the universe collapses to a point, a final singularity termed the "Big Crunch", by analogy with Big Bang. However, if the universe has a significant amount of dark energy that will be used as an infinite force, then the expansion of the universe can continue forever—even if Ω > 1.
**Open universe**

If $\Omega < 1$, the geometry of space is open, i.e., negatively curved like the surface of a saddle. The angles of a triangle sum to less than 180 degrees, and lines that do not meet are never equidistant; they have a point of least distance and otherwise grow apart. The geometry of such a universe is hyperbolic.

Even without dark energy, a negatively curved universe expands forever, with gravity barely slowing the rate of expansion. With dark energy, the expansion not only continues but accelerates. The ultimate fate of an open universe is either universal heat death, the "Big Freeze", or the "Big Rip", where the acceleration caused by dark energy eventually becomes so strong that it completely overwhelms the effects of the gravitational, electromagnetic and strong binding forces.

Conversely, a *negative* cosmological constant, which would correspond to a negative energy density and positive pressure, would cause even an open universe to recollapse to a big crunch. This option has been ruled out by observations.

**Flat universe**

If the average density of the universe exactly equals the critical density so that $\Omega = 1$, then the geometry of the universe is flat: as in Euclidean geometry, the sum of the angles of a triangle is 180 degrees and parallel lines continuously maintain the same distance.

Absent dark energy, a flat universe expands forever but at a continually decelerating rate, with expansion asymptotically approaching zero. With dark energy, the expansion rate of the universe initially slows down, due to the effect of gravity, but eventually increases. The ultimate fate of the universe is the same as an open universe.

**Theories about the end of the universe**

The fate of the universe is determined by the density of the universe. The preponderance of evidence to date, based on measurements of the rate of expansion and the mass density, favors a universe that will continue to expand indefinitely, resulting in the "big freeze" scenario below.\[^4\] However, new understandings of the nature of dark matter also suggest its interactions with mass and gravity demonstrate the possibility of an oscillating universe.\[^5\]

**Big Freeze or heat death**

The Big Freeze is a scenario under which continued expansion results in a universe that asymptotically approaches absolute zero temperature. It could, in the absence of dark energy, occur only under a flat or hyperbolic geometry. With a positive cosmological constant, it could also occur in a closed universe. This scenario is currently the most commonly accepted theory within the scientific community. A related scenario is heat death, which states that the universe goes to a state of maximum entropy in which everything is evenly distributed, and there are no gradients — which are needed to sustain information processing, one form of which is life. The heat death scenario is compatible with any of the three spatial models, but requires that the universe reach an eventual temperature minimum.\[^6\]

**Big Rip**

In the special case of phantom dark energy, which has even more negative pressure than a simple cosmological constant, the density of dark energy increases with time, causing the *rate* of acceleration to increase, leading to a steady increase in the Hubble constant. As a result, all material objects in the universe, starting with galaxies and eventually (in a finite time) all forms, no matter how small, will disintegrate into unbound elementary particles and radiation, ripped apart by the phantom energy force and shooting apart from each other. The end state of the universe is a singularity, as the dark energy density and expansion rate becomes infinite. For a possible timeline based on current physical theories, see 1 E19 s and more.
**Big Crunch**

The Big Crunch theory is a symmetric view of the ultimate fate of the Universe. Just as the Big Bang started a cosmological expansion, this theory assumes that the average density of the universe is enough to stop its expansion and begin contracting. The end result is unknown; a simple estimation would have all the matter and space-time in the universe collapse into a dimensionless singularity, but at these scales unknown quantum effects need to be considered (see Quantum gravity).

This scenario allows the Big Bang to be immediately after the Big Crunch of a preceding universe. If this occurs repeatedly, we have a cyclic model which is also known as an oscillatory universe. The universe could then consist of an infinite sequence of finite universes, each finite universe ending with a Big Crunch that is also the Big Bang of the next universe. Theoretically, the cyclic universe could not be reconciled with the second law of thermodynamics: entropy would build up from oscillation to oscillation and cause heat death. Other measurements suggested the universe is not closed. These arguments caused cosmologists to abandon the oscillating universe model. A somewhat similar idea is embraced by the cyclic model, but this idea evades heat death, because of an expansion of the branes that dilutes entropy accumulated in the previous cycle.

**Big Bounce**

The Big Bounce is a theorized scientific model related to the beginning of the known universe. It derives from the oscillatory universe or cyclic repetition interpretation of the Big Bang where the first cosmological event was the result of the collapse of a previous universe.

According to one version of the Big Bang theory of cosmology, in the beginning the universe had infinite density. Such a description seems to be at odds with everything else in physics, and especially quantum mechanics and its uncertainty principle. It is not surprising, therefore, that quantum mechanics has given rise to an alternative version of the Big Bang theory. Also, if the universe is closed, this theory would predict that once this universe collapses it will spawn another universe in an event similar to the Big Bang after a universal singularity is reached or a repulsive quantum force causes re-expansion.

**Multiverse: no complete end**

One multiverse hypothesis states that our uni-"verse" is merely one Big Bang among an infinite number of simultaneously expanding Big Bangs that are spread out over endless distances (open space).

Each "verse" may be either matter or antimatter, with an equal number in existence at any given time. As the "verses" expand they collide and matter and antimatter annihilate, releasing energy. Heat death of a finite universe would be predicted as entropy increases; however, the infinite size of the multiverse and the infinite number of "verses" could mean that new "verses" would be formed as old "verses" were annihilated.

A chain reaction multiverse would be analogous to a fireworks display (each explosion representing a Big Bang) that starts in one neighborhood and is followed by fireworks displays in surrounding neighborhoods and then in neighborhoods further out. The chain reaction of Big Bangs would continue to expand as Big Bang fuel is consumed. If the multiverse is open and the fuel is infinite, then the chain reaction would expand forever. Of course, it is not
known what the "fuel" is, but it is logical to assume that matter and energy are the product of a transformation from a real reactant, possibly the Higgs boson.

The multiverse as a whole may never end completely.

**False vacuum**

If the vacuum is not in its lowest energy state (a false vacuum), it could tunnel into a lower energy state.[7] This is called the vacuum metastability event. This has the potential to fundamentally alter our universe; in more audacious scenarios even the various physical constants could have different values, severely affecting the foundations of matter, energy, and spacetime. It is also possible that all structures will be destroyed instantaneously, without any forewarning.[8]

According to the many-worlds interpretation of quantum mechanics, the universe will not end this way. Instead, each time a quantum event happens that causes the universe to decay from a false vacuum to a true vacuum state, the universe splits into several new worlds. In some of the new worlds the universe decays; in some others the universe continues as before.

**Cosmic uncertainty**

Each possibility described so far is based on a very simple form for the dark energy equation of state. But as the name is meant to imply, we know almost nothing of the real physics of the dark energy. If the theory of inflation is true, the universe went through an episode dominated by a different form of dark energy in the first moments of the Big Bang; but inflation ended, indicating an equation of state much more complicated than those assumed so far for present-day dark energy. It is possible that the dark energy equation of state could change again resulting in an event that would have consequences which are extremely difficult to parametrize or predict.

**Observational constraints on theories**

Choosing among these rival scenarios is done by 'weighing' the universe, for example, measuring the relative contributions of matter, radiation, dark matter and dark energy to the critical density. More concretely, competing scenarios are evaluated against data on galaxy clustering and distant supernovae, and on the anisotropies in the Cosmic Microwave Background.

**Life in a mortal universe**

Dyson's eternal intelligence hypothesis proposes that an advanced civilization could survive for an effectively infinite period of time while consuming only a finite amount of energy. Such a civilization would alternate brief periods of activity with ever longer periods of hibernation.[9][10]

Recent work in inflationary cosmology, string theory, and quantum mechanics has moved the discussion of the ultimate fate of the universe in directions distinct from the scenarios set out by Dyson. Theoretical work by Eric Chaisson finds that an expanding spacetime gives rise to an increasing "entropy gap", casting doubt on the heat death hypothesis. Invoking Ilya Prigogine's work on far-from-equilibrium thermodynamics, their analysis suggests that this entropy gap may contribute to information, and hence to the formation of structure.

Meanwhile, Andrei Linde, Alan Guth, Ted Harrison, and Ernest Sternglass argue that inflationary cosmology strongly suggests the presence of a multiverse, and that it would be practical even with today's knowledge for intelligent beings to generate and transmit de novo information into a distinct universe. Alan Guth has speculated that a civilization at the top of the Kardashev scale might create fine-tuned universes in a continuation of the evolutionary drive to exist, grow, and multiply. This has been further developed by the Selfish Biocosm Hypothesis, and by the proposal that the existence of the fundamental physical constants may be subject to a kind of cosmological natural selection.[11] Moreover, recent theoretical work on the unresolved quantum gravity problem
and the holographic principle suggests that traditional physical quantities may possibly themselves be describable in
terms of exchanges of information, which in turn raises questions about the applicability of older cosmological
models.

**In science fiction**

Scientific speculation about the ultimate fate of life in the universe merges almost seamlessly into science fiction. Many works describe the end of the universe—occasionally purely educational exercises describing theories of the
day, more often exploiting its potential as the ultimate sense of wonder plot device, or satirising the pretensions of
humanity in general and cosmologists in particular. Science fiction can try to suggest a scientific eschatology that
searches for meaning in the face of the new knowledge. Countless sci-fi and fantasy works use the threatened
destruction of the universe as their plot device, usually with an evil supervillain and/or the incompetence of
humanity as the cause, and usually with human ingenuity saving the day.

The topic of heat death was explored in science fiction as early as 1895 in H. G. Wells' *The Time Machine*, which
includes an evocation of the heat death of the universe as imagined by scientists like Lord Kelvin at that time,
consisting of the fading out of the Sun to an exhausted red ember and a vision of Earth as a cold and bland eroded
desert, to as recently as 2007 in the Doctor Who episode *Utopia*, with the last remnants of society struggling to
survive in a universe without stars and few planets still capable of supporting life.

Religion is not wholly excluded from science fiction's explorations of the end of our universe. Olaf Stapledon's 1937
science fiction novel *Star Maker* describes intelligent life in the far future in each galaxy merging into hive mind-like
_Galactic Minds_ which themselves finally merge into a _Cosmic Mind_ which, ascending into hyperspace, encounters
God (the _Star Maker_). The "Star Maker" reveals to the "Cosmic Mind" a vision of the simpler Cosmoses He created
in the past and of those more complex Cosmoses He will create in the future. Arthur C. Clarke's 1953 short story
"The Nine Billion Names of God" treats non-scientific eschatology seriously. Its famous last line ominously
chronicles the end of the universe as observed by mankind: *Overhead, without any fuss, the stars were going out*.

James Blish's *Cities in Flight* series of books (1955 and 1962) ends with the disruption of the Universe in accordance
with the hypercollision theory. The protagonists are able to 'seed' the resultant new universes with their own bodies
(dying in the process) by using technology which isolates them from local space-time at the instant of the collision.

Isaac Asimov's short story, "The Last Question" was published in 1956. The story is broken up into several
segments, with each segment revolving around an artificial, evolving supercomputer. In each segment, humans pose
the question "Can entropy be reversed?" to the computer, to which the computer responds, "There is insufficient data
for a meaningful answer." At the end of the story, humankind has long since succumbed to heat death (the only
cosmological end-scenario articulated at the time). The evolving super-computer, now having evolved to the point
where it existed without physical form in hyperspace, finally discovers how to reverse the process and with the
proclamation "LET THERE BE LIGHT!" And there was light—" the story ends.

Piers Anthony's soft science fiction novel _Ghost_, deals with the topic of an energy-poor future humanity struggling to
find every energy resource possible, and deals with the eventual dying of a universe. In the novel, near limitless
energy is able to be found by effectively cannibalizing dead galaxies from other dead universes. Even though the
novel does not necessarily give a plausible scientific answer, it does bring up the question of what happens when a
galaxy's central black hole becomes so massive that not even gravity can escape it, and what happens when a black
hole's event horizon is so far from the central point that it does not have significant gravitational effects. The title of
the book, "Ghost" refers to the remains of such a devoured galaxy.

The Big Crunch as the fate of the Universe was also explored in Poul Anderson's 1970 novel _Tau Zero_ which posits
a cyclic universe where the big crunch will be surrounded by a cloud of hydrogen, and that a starship could navigate
a course to avoid the singularity and emerge into the new universe after the subsequent big bang.
The plot of Spider Robinson's Callahan's Key focuses on the efforts of the group to prevent a vacuum metastability event caused by a high-energy point created through a combination of random factors.

The end of the universe has been used for satirical and comedic effect. In Douglas Adams's science-fiction series *The Hitchhiker's Guide to the Galaxy*, the "Restaurant at the End of the Universe" and its patrons are projected through time to the end of the universe, for guests to watch the event as dinner entertainment. Zaphod Beeblebrox, the three-armed, two-headed former President of the Galaxy, scorned the main event, describing it as nothing but a "gnaB giB", or the Big Bang in reverse. The astronomical cost of this exercise is paid for by depositing a small sum in the restaurant's account when the booking is made—by the end of the universe this has become a huge fortune due to the operation of compound interest.

The concept of an end to the universe has inspired some authors to explore the more human-centric topics of fate and free will. In Kurt Vonnegut's classic novel *Slaughterhouse Five*, the primary character is a war veteran who is contacted by aliens from the planet Tralfamadore who claim that one of their scientists will accidentally destroy the universe while testing a new type of spaceship fuel. Tralfamadorians are aware of this event because they perceive all of time instantaneously, in a similar way to how someone would observe an entire range of mountains in one instant.

Though intended for comedic purposes, the *Star Trek: Deep Space Nine* episode "Chrysalis" features a trio of genetically-enhanced humans contemplating the end of the universe. They come to agree that the universe is far too massive, and that it will inevitably collapse in on itself; essentially, a Big Crunch. The quandary is depicted in the episode as evidence of the characters' eccentricities.

Bungie's video game, Marathon, has an AI who tries to escape the end of the universe. The end of Marathon Infinity takes place at the universe's final moments.

In the *Futurama* episode The Late Philip J. Fry, a time machine is invented that can only travel into the future. An accident during the initial test hurdles Fry, Bender and Professor Farnsworth 10,000 years in the future. With no hope of getting back to their own time, the trio decide to kick back and watch the end of the universe together. Eventual Heat Death occurs, which leads to another Big Bang after which all time simply repeats itself indefinitely allowing the main characters to travel forward to their familiar location in the continuum and resume their lives unaffected. Even after making the same mistake again, Professor Farnsworth simply suggest that they "bring her around again". This 3rd universe is 10 feet lower than the old one however.

The setting for Greg Bear's *City at the End of Time* is one hundred trillion years in the future and explores the cold death of the universe.

In Stephen Baxter's short story "Last Contact" describes a Big Rip.

References
Further reading

Nonfiction


Fiction
• Anderson, Poul. Tau Zero.
• Asimov, Isaac. The Last Question.
• Barrow, John. Impossibility.
• Modesitt, L. E., Jr. Gravity Dreams.

External links
• Baez, J., 2004, "The End of the Universe" (http://math.ucr.edu/home/baez/end.html).
**Zygon: Journal of Religion & Science**

<table>
<thead>
<tr>
<th>Discipline</th>
<th>Religious Studies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Language</td>
<td>English</td>
</tr>
</tbody>
</table>

**Publication details**

- **Publisher**: Wiley-Blackwell (United States)
- **Publication history**: 1966 to present
- **ISSN**: 0591-2385

**Links**

- [Journal homepage](#)

*Zygon: Journal of Religion & Science* is an academic journal published quarterly by Wiley-Blackwell. *Zygon: Journal of Religion and Science* is a premier scholarly journal publishing in the area of religion and science dialogue since 1966 until present.

The name “Zygon” [mod. L., ad. ζυγόν Gr. yoke.] according to the journal founder Ralph Wendell Burhoe is the Greek term for anything which joins two bodies, especially the yoking or harnessing of a team which must pull together effectively, is the symbol of this journal. Its aim is to reunite the split team, values and knowledge, where coordination is essential for a viable dynamics of human culture.

Journal *Zygon* is published through Blackwell Publishing by the Joint Publication Board of Zygon. *Zygon's* sponsoring organizations which appoint its Joint Publication Board are:

1. Institute on Religion in an Age of Science (IRAS) founded in 1954.
2. Center for Advanced Study in Religion and Science (CASIRAS) founded in 1972.

Editors of *Zygon* are Philip Hefner, professor emeritus of Systematic Theology, Lutheran School of Theology at Chicago and Karl E. Peters, professor emeritus of Philosophy and Religion, Rollins College, Dutch theologian Willem B. Drees.

Editorial offices of *Zygon* are located at Lutheran School of Theology at Chicago together with the Zygon Center for Religion and Science.

According to EBSCO Publishing, it is "[a]n international forum for exploring ways to unite what in modern times has been disconnected: values from knowledge, goodness from truth, religion from science."
External links

- Publisher site [3]

References


Teleological argument

A teleological or design argument[^1][^2][^3] is an a posteriori argument for the existence of God based on apparent design and purpose in the universe. The argument is based on an interpretation of teleology wherein purpose and design appear to exist in nature beyond the scope of any such human activities. The teleological argument suggests that, given this premise, the existence of a designer can be assumed, typically presented as God.

Various concepts of teleology originated in ancient philosophy and theology. Some philosophers, such as Plato, proposed a divine Artificer as the designer; others, including Aristotle, rejected that conclusion in favor of a more naturalistic teleology. In the middle-ages, the Islamic philosopher Averroes introduces a teleological argument. Later, a teleological argument is the fifth of Saint Thomas Aquinas’ Five Ways, his rational proofs for the existence of God. The teleological argument was continued by empiricists in the seventeenth and eighteenth centuries, who believed that the order in the world suggested the existence of God. William Paley developed these ideas with his version of the watch maker analogy. He argued that in the same way a watch's complexity implies the existence of its maker, so too one may infer the Creator exists, given the evident complexity of Nature. This argument resonates with a notion of the fine-tuned Universe, understood as an alternative to the anthropic principle.

Many philosophers and theologians have expounded and criticized different versions of the teleological argument. Commonly, they argue that any implied designer need not have the qualities commonly attributed to the God of classical theism. Scientists have shown alternative explanations for biological complexity, notably natural selection, with no requirement for supernatural design.

From the 1990s, creation science was rebranded as intelligent design, presenting the teleological argument while avoiding naming the designer with the aim of presenting this as science and getting it taught in public school science classes. In 2005, a U.S. Federal Court ruled that intelligent design is a religious argument and is not science, and was being used to give pseudoscientific support for creationism, the religious belief in a god-like designer.
History

Classical and early Christian writers

According to Xenophon, Socrates (c. 469–399 B.C.) argued that the adaptation of human parts to one another, such as the eyelids protecting the eyeballs, could not have been due to chance and was a sign of wise planning in the universe.[4]

Plato (c. 427–c. 347 B.C.) posited a "demiurge" of supreme wisdom and intelligence as the creator of the cosmos in his work *Timaeus*. Plato's teleological perspective is also built upon the analysis of *a priori* order and structure in the world that he had already presented in *The Republic*. Plato does not propose creation *ex nihilo*; rather, the demiurge made order from the chaos of the cosmos, imitating the eternal Forms.[5]

Plato's world of eternal and unchanging Forms, imperfectly represented in matter by a divine Artisan, contrasts sharply with the various mechanistic Weltanschauungen, of which atomism was, by the fourth century at least, the most prominent... This debate was to persist throughout the ancient world. Atomistic mechanism got a shot in the arm from Epicurus... while the Stoics adopted a divine teleology... The choice seems simple: either show how a structured, regular world could arise out of undirected processes, or inject intelligence into the system. This was how Aristotle (384–322 bc), when still a young acolyte of Plato, saw matters. Cicero (On the Nature of the Gods 2. 95 = Fr. 12) preserves Aristotle's own cave-image: if troglodytes were brought on a sudden into the upper world, they would immediately suppose it to have been intelligently arranged. But Aristotle grew to abandon this view; although he believes in a divine being, the Prime Mover is not the efficient cause of action in the Universe, and plays no part in constructing or arranging it... But, although he rejects the divine Artificer, Aristotle does not resort to a pure mechanism of random forces. Instead he seeks to find a middle way between the two positions, one which relies heavily on the notion of Nature, or phusis.[6]

— R. J. Hankinson, *Cause and Explanation in Ancient Greek Thought*

Aristotle (c. 384–322 B.C.) argued that the most complete explanation in regard to the natural, as well as the artificial, is for the most part teleological.[7] Based solely on the study of immature specimens, for example, one wouldn't feel confident in one's knowledge of the species.[7][8][9] Similarly, knowledge of what use an animal makes of a feature is crucial to understanding it (for example, that birds use wings for flight).[10] Aristotle did not believe nature is endowed with the same rational purpose and direction as human activity and artifacts.[7] However, he did believe that the adult form is present in the offspring, having been copied from of the parent,[9] and that the parts of an organism are good for their purpose.[11][12][13] He maintained that by an imperfect but compelling analogy, one could almost say they're purpose built to suit their essential function.[7][14] Furthermore, knowledge of that function or end-purpose is essential because any other *aitia*, or explanations one could offer for the organ, would be tremendously informed given the *telos*.[7]

In his *Metaphysics*, Aristotle addressed the existence of gods. Rather that envisioning an Artificer as Plato did, he believed that the eternal cosmos required no creation.[9] Aristotle argued for the existence of one or more unmoved movers to serve as nature's role models and constant inspiration (see Prime Mover and Daimon).[8][9][15] Aristotle described the movers as immaterial "active intellects", incapable of perceiving or interacting with the cosmos, thus
assuredly "unmoved". To the extent permitted by the vagrancies of matter, he believed the natural pleroma is exerting its full potential, because it has had an eternity in which to do so.\[^9\] This is not to imply a naïve, panglossian idealism, but a logically valid argument from a natural scientist who took a great deal of interest in efficient causal analyses.\[^7\] As a more unsettled account of the species, he briefly recounted survival of the fittest,\[^16\][\(^17\)] well known even in Aristotle's time.\[^7\][\(^18\)][\(^19\)] It would have been infinitely long ago, he argued, and thus would have remained effectively unchanged for an infinitely long duration.\[^20\] Conceding that monstrosities come about by chance,\[^21\][\(^22\)] he disagrees with those who, like Democritus, ascribe all nature purely to chance\[^23\] because he believes science can only provide a general account of that which is normal, “always, or for the most part”.\[^24\]

Cicero (c. 106–c. 43 B.C.) presented an early teleological argument in *De Natura Deorum* (*On the Nature of the Gods*), arguing that that divine power can be found in reason, which exists throughout nature. He developed an early version of the watchmaker analogy, which was later developed by William Paley.

> When you see a sundial or a water-clock, you see that it tells the time by design and not by chance. How then can you imagine that the universe as a whole is devoid of purpose and intelligence, when it embraces everything, including these artifacts themselves and their artificers?”
>
> —Cicero, *De Natura Deorum*, ii. 34\(^{25}\)

Marcus Minucius Felix (late 2nd-3rd c.), an Early Christian writer, argued for the existence of God based on the analogy of an ordered house in his *The Orders of Minucius Felix*.\(^{26}\)

Augustine of Hippo (A.D. 354–430) presented a classic teleological perspective in his work *City of God*. He describes the "city of man" and essentially posits that God's plan is to replace the city of man with the city of God (at some as-yet-unknown point in the future). Whether this is to happen gradually or suddenly is not made clear in Augustine's work. He did not, however, make a formal argument for the existence of God; rather, God's existence is already presumed and Augustine is giving a proposed view of God's teleology. Augustine's perspective follows from and is built upon the neo-Platonic views of his era, which in turn have their original roots in Plato's cosmogony.

**Averroes**

Averroes (Ibn Rushd) introduced teleological arguments into his interpretations of Aristotle from an Islamic perspective in Moorish Spain in the latter half of the 12th Century. His work was highly controversial, officially banned in both Christendom and Islamic Spain.\(^{27}\) Averroes' teleological arguments can be characterized as presuming one god.\(^{28}\) He proposes that order and continual motion in the world is caused by God's intellect. In knowing all forms and patterns, God provides order to the Lesser Intelligences.\(^{29}\)
Aquinas

Thomas Aquinas (c. 1100-1500) presented a form of the teleological argument in his *Summa Theologica*. In his work, Aquinas presented five ways in which he attempted to prove the existence of God. These arguments feature only a posteriori arguments, rather than traditional dogma. He sums up his teleological argument as follows.

The fifth way is taken from the governance of the world. We see that things which lack knowledge, such as natural bodies, act for an end, and this is evident from their acting always, or nearly always, in the same way, so as to obtain the best result. Hence it is plain that they achieve their end, not fortuitously, but designedly. Now whatever lacks knowledge cannot move towards an end, unless it be directed by some being endowed with knowledge and intelligence; as the arrow is directed by the archer. Therefore, some intelligent being exists by whom all natural things are directed to their end; and this being we call God.

—St Thomas Aquinas, *Summa Theologica: Article 3, Question 2*

Aquinas notes that objects in the nature world seem to work towards a specific purpose and that, in the world, an object working to a purpose can always be explained by the existence of an intelligent being to give the object purpose. As everything in the universe works to a purpose, there must, he reasons, exist a being to provide that purpose. That being is what we call God.

British empiricists

The 17th century Dutch writers Lessius and Grotius argued that the intricate structure of the world, like that of a house, was unlikely to have arisen by chance. The empiricist John Locke, writing in the late 17th century, developed the Aristotelian idea that, excluding geometry, all science must attain its knowledge a posteriori - through sensual experience. In response to Locke, Anglican Irish Bishop George Berkeley advanced a form of idealism in which things only continue to exist when they are perceived. When humans do not perceive objects, they continue to exist because God is perceiving them. Therefore, in order for objects to remain in existence, God must exist omnipresently.

David Hume, in the mid-18th century, presented arguments both for and against the teleological argument in his *Dialogues Concerning Natural Religion*. The character Cleanthes, summarizing the teleological argument, likens the universe to a man-made machine, and concludes by the principle of similar effects and similar causes that it must have a designing intelligence. Philo is not satisfied with the teleological argument, however. He attempts a number of refutations, including one that arguably foreshadows Darwin's theory, and makes the point that if God resembles a human designer, then assuming divine characteristics such as omnipotence and omniscience is not justified. He goes on to joke that far from being the perfect creation of a perfect designer, this universe may be "only the first rude essay of some infant deity... the object of derision to his superiors".
Teleological argument

exactly, though it much exceeds, the productions of human contrivance; of human design, thought, wisdom, and intelligence. Since therefore the effects resemble each other, we are led to infer, by all the rules of analogy, that the causes also resemble; and that the Author of Nature is somewhat similar to the mind of man; though possessed of much larger faculties, proportioned to the grandeur of the work which he has executed. By this argument a posteriori, and by this argument alone, do we prove at once the existence of a Deity, and his similarity to human mind and intelligence.[36]

— David Hume, Dialogues Concerning Natural Religion

Watchmaker analogy

The watchmaker analogy, framing the argument with reference to a timepiece, dates back to Cicero, who used the example of a sundial or water-clock in his reasoning that the presence of order and purpose signify the existence of a designer. It was also used by Robert Hooke[37] and Voltaire, the latter of whom remarked: "L'univers m'embarrasse, et je ne puis songer Que cette horloge existe, et n'aït point d'horloger",[38] 'I'm puzzled by the world; I cannot dream The timepiece real, its maker but a dream'.[39]

William Paley presented the watchmaker analogy in his Natural Theology (1802).[40]

[S]uppose I found a watch upon the ground, and it should be inquired how the watch happened to be in that place, I should hardly think … that, for anything I knew, the watch might have always been there. Yet why should not this answer serve for the watch as well as for [a] stone [that happened to be lying on the ground]?… For this reason, and for no other; namely, that, if the different parts had been differently shaped from what they are, if a different size from what they are, or placed after any other manner, or in any order than that in which they are placed, either no motion at all would have been carried on in the machine, or none which would have answered the use that is now served by it.

—William Paley, Natural Theology[41]

Paley wrote in response to Hume's objection to analogy between artefacts and worlds, choosing to use the example of a watch as a reliable indicator of divine design. He identifies two features of a watch which demonstrate that it is designed. First, a watch performs a valuable purpose, timekeeping, which a designer would find useful; secondly, the watch would be unable to perform such a purpose if its parts were any different, or arranged in any other way. Paley argued that the world of nature displays more functional complexity than that found in the watch. As the adaptation found in natural organisms seems to be both complex and achieves a purpose, Paley reasons that this must be evidence of divine design.

Natural theology strongly influenced British science, with the expectation as expressed by Adam Sedgwick in 1831 that truths revealed by science could not conflict with the moral truths of religion.[42] These natural philosophers saw God as the first cause, and sought secondary causes to explain design in nature: the leading figure Sir John Herschel wrote in 1836 that by analogy with other intermediate causes "the origination of fresh species, could it ever come under our cognizance, would be found to be a natural in contradistinction to a miraculous process".[43]

As a theology student, Charles Darwin found Paley's arguments compelling. However, he later developed his theory of evolution in his 1859 book On the Origin of Species by Means of Natural Selection, or the Preservation of Favoured Races in the Struggle for Life, which offers an alternate explanation of biological order. In his autobiography, Darwin wrote that "The old argument of design in nature, as given by Paley, which formerly seemed
to me so conclusive, fails, now that the law of natural selection has been discovered".[44] Darwin struggled with the problem of evil of suffering in nature, but remained inclined to believe that nature depended upon "designed laws" and commended Asa Gray for pointing out that Darwin's work supported teleology.[45]

**Fine-tuned Universe**

A modern variation of the teleological argument is built upon the concept of the fine-tuned Universe. The fine-tuning of the Universe is the apparent delicate balance of conditions necessary for human life. In this view, speculation about a vast range of possible conditions in which life cannot exist is used to explore the probability of conditions in which life can and does exist.[46] In terms of a teleological argument, the intuition in relation to a fine-tuned universe would be that God must have been responsible, if achieving such perfect conditions is so improbable.[41] Kenneth Himma offers the following sound argument in regard to fine-tuning, however, he advises: "The mere fact that it is enormously improbable that an event occurred by chance, by itself, gives us no reason to think that it occurred by design... As intuitively tempting as it may be to conclude from just the apparent improbability of a fine-tuned universe that it is the result of divine agency, the inference is unsound".[41] Himma attributes the "Argument from Suspicious Improbabilities", a formalization of "the fine-tuning intuition" to George N. Schlesinger:

To understand Schlesinger's argument, consider your reaction to two different events. If John wins a 1-in-1,000,000,000 lottery game, you would not immediately be tempted to think that John (or someone acting on his behalf) cheated. If, however, John won three consecutive 1-in-1,000 lotteries, you would immediately be tempted to think that John (or someone acting on his behalf) cheated. Schlesinger believes that the intuitive sound argument in regard to fine-tuning, however, he advises: "The mere fact that it is enormously improbable that an event occurred by chance, by itself, gives us no reason to think that it occurred by design... As intuitively tempting as it may be to conclude from just the apparent improbability of a fine-tuned universe that it is the result of divine agency, the inference is unsound".[41] Himma attributes the “Argument from Suspicious Improbabilities”, a formalization of "the fine-tuning intuition" to George N. Schlesinger:

Antony Flew, who spent most of his life as an atheist, converted to deism late in life because of the anthropic principle.[47] He concluded that the fine-tuning of the universe was too precise to be the result of chance, so accepted the existence of God. He said that his commitment to "go where the evidence leads" meant that he ended up accepting the existence of God.[48] Flew proposed the view, held earlier by Fred Hoyle, that the universe is too young for life to have developed purely by chance and that, therefore, an intelligent being must exist which was involved in designing the conditions required for life to evolve.[47]
Would you not say to yourself, “Some super-calculating intellect must have designed the properties of the carbon atom, otherwise the chance of my finding such an atom through the blind forces of nature would be utterly minuscule.” Of course you would… A common sense interpretation of the facts suggests that a superintellect has monkeyed with physics, as well as with chemistry and biology, and that there are no blind forces worth speaking about in nature. The numbers one calculates from the facts seem to me so overwhelming as to put this conclusion almost beyond question.[49]

— Fred Hoyle, *Engineering and Science*, The Universe: Past and Present Reflections

### Intelligent design movement

In the wake of the "fine-tuned universe" observations and arguments published in the 1980s, the intelligent design movement picked up some of the above concepts, added some additional ones such as *irreducible complexity* (a variant of the watchmaker analogy) and *specified complexity* (closely resembling a fine-tuning argument) and attempted to cast the resulting combined form of the teleological argument as scientific rather than speculative. The vast majority of scientists have disagreed with the assertion that it is scientific, as did the findings of a federal court in the United States in a 2005 decision, which ruled that the "intelligent design" arguments are essentially religious in nature and unscientific. (See Other issues below.)[50]

Proponents of the movement such as Cornelius G. Hunter, have asserted that the methodological naturalism upon which science is based is religious in nature.[51] They commonly refer to it as 'scientific materialism' or as 'methodological materialism' and conflate it with 'metaphysical naturalism'.[52] They use this assertion to support their claim that modern science is atheistic, and contrast it with their preferred approach of a revived natural philosophy which welcomes supernatural explanations for natural phenomena and supports theistic science. This ignores the distinction between science and religion, established in Ancient Greece.[50] In medieval European Scholasticism, science as taught at universities was obliged to restrict its attention to the natural world. From a standpoint of modern science, Stephen Jay Gould's concept of Nonoverlapping Magisteria (NOMA), states that science and religion should be considered two compatible, complementary fields, or "magisteria", whose authority does not overlap.

**Michael Behe**

Michael Behe proposed a development of Payley’s watch analogy in which he argued in favour of intelligent design. Unlike Paley, Behe only attempts to prove the existence of an intelligent designer, rather than the God of classical theism. Though this accomplishes less, it makes his argument more resilient to criticism, especially that of David Hume. Behe uses the analogy of a mousetrap to propose irreducible complexity: if a mousetrap loses just one of its parts, it can no longer function as a mousetrap. Therefore, he argues, irreducible complexity in an object guarantees the presence of intelligent design. Behe claims that there are instances of irreducible complexity in the natural world and, therefore, parts of the world must have been designed.[53]

### Modern developments

University of Chicago geneticist James A. Shapiro, writing in the Boston Review, states that advancements in microbiology, molecular biology and genetics, in so far as they overlap with information science, introduces hard science with implications for the teleological argument. Genome reorganization is a biological process discovered by Nobel Laureate Barbara McClintock. Shapiro states that these natural genetic engineering systems can produce radical reorganizations of the 'genetic apparatus within a single cell generation'. One protozoa called Oxytricha in response to stress, is capable of splitting its chromosomes into thousands of pieces which are then reassembled into a 'distinct kind of functional genome'.[54] Shapiro suggests what he calls a ‘Third Way'; a non-creationist, non-Darwinian type of evolution:
What significance does an emerging interface between biology and information science hold for thinking about evolution? It opens up the possibility of addressing scientifically rather than ideologically the central issue so hotly contested by fundamentalists on both sides of the Creationist-Darwinist debate: Is there any guiding intelligence at work in the origin of species displaying exquisite adaptations… "[54]

Criticisms

David Hume

David Hume presented a criticism of the teleological argument in his Dialogues Concerning Natural Religion. The character Philo, a religious sceptic, voices Hume's criticisms of the argument. He argues that the design argument is built upon a faulty analogy as, unlike with man-made objects, we have not witnessed the design of a universe, so do not know whether the universe was the result of design. Moreover, the size of the universe makes the analogy problematic: although our experience of the universe is of order, there may be chaos in other parts of the universe.[55] Philo argues:

A very small part of this great system, during a very short time, is very imperfectly discovered to us; and do we thence pronounce decisively concerning the origin of the whole?

—David Hume, Dialogues[55]

Philo also proposes that the order in nature may be due to nature alone. If nature contains a principle of order within it, the need for a designer is removed. Philo argues that even if the universe is indeed designed, it is unreasonable to justify the conclusion that the designed must be an omnipotent, omniscient, benevolent God - the God of classical theism.[55] It is impossible, he argues, to infer the perfect nature of a creator from the nature of its creation. Philo argues that the designer may have been defective or otherwise imperfect, suggesting that the universe may have been a poor first attempt at design. Hume also pointed out that the argument does not necessarily lead to the existence of one God: “why may not several deities combine in contriving and framing the world?” (p. 108).[36]

Wesley C. Salmon developed Hume's insights, arguing that all things in the universe which exhibit order are, to our knowledge, created by material, imperfect, finite beings or forces. He also argued that there are no known instances of an immaterial, perfect, infinite being creating anything. Using the probability calculus of Bayes Theorem, Salmon concludes that it is very improbable that the universe was created by the type of intelligent being theists argue for.[57] Nancy Cartwright accuses Salmon of begging the question. One piece of evidence he uses in his probabilistic argument - that atoms and molecules are not caused by design - is equivalent to the conclusion he draws, that the universe is probably not caused by design. The atoms and molecules are what the universe is made up of and whose origins are at issue. Therefore, they cannot be used as evidence against the theistic conclusion.[58]

Complexity does not imply design

The teleological argument assumes that one can infer the existence of intelligent design merely by examination, and because life is reminiscent of something a human might design, it too must have been designed. Life is described as "orderly" or "ordered", as well as other natural products of physical processes, such as diamonds and snowflakes. It is argued, however, that the presence of this kind of natural physical process is also evidence for a designer, and that these particular systems are repetitive in nature and less complex than a non-repetitive system like DNA.
Teleological argument

The design claim is often challenged as an argument from ignorance, since it is often unexplained or unsupported, or explained by conjecture. Supporters of design suggest that natural objects and man-made objects have similar properties, therefore both must be designed. However, different objects can have similar properties for different reasons, such as stars and light bulbs. Proponents must therefore demonstrate that only design can cause one or more orderly systems.

Most professional biologists support the modern evolutionary synthesis, not merely as an alternative explanation for the complexity of life but a better explanation with more supporting evidence. Living organisms obey the same physical laws as inanimate objects. Over very long periods of time self-replicating structures arose and later formed DNA. This has been simulated artificially with the Avida program.

Does not prove the existence of God

In his *Traité de métaphysique* Voltaire observed that, even if the argument from design could prove the existence of a powerful intelligent designer, it would not prove that this designer is God.[59]

... from this sole argument I cannot conclude anything further than that it is probable that an intelligent and superior being has skillfully prepared and fashioned the matter. I cannot conclude from that alone that this being has made matter out of nothing and that he is infinite in every sense.

— Voltaire, *Traité de métaphysique*[59]

Søren Kierkegaard questioned the existence of God, rejecting all rational arguments for God's existence (including the teleological argument) on the grounds that reason is inevitably accompanied by doubt.[60] He proposed that the argument from design does not take into consideration future events which may serve to undermine the proof of God's existence: the argument would never finish proving God's existence.[61] In the *Philosophical Fragments*, Kierkegaard writes:

The works of God are such that only God can perform them. Just so, but where then are the works of the God? The works from which I would deduce his existence are not directly and immediately given. The wisdom in nature, the goodness, the wisdom in the governance of the world -- are all these manifest, perhaps, upon the very face of things? Are we not here confronted with the most terrible temptations to doubt, and is it not impossible finally to dispose of all these doubts? But from such an order of things I will surely not attempt to prove God's existence; and even if I began I would never finish, and would in addition have to live constantly in suspense, lest something so terrible should suddenly happen that my bit of proof would be demolished.

— Søren Kierkegaard, *Philosophical Fragments*[61]

Argument from improbability

Richard Dawkins is harshly critical of theology, creation and intelligent design in his book *The God Delusion* in which he contends that an appeal to intelligent design can provide no explanation for biology because it not only begs the question of the designer's own origin; but an intelligent designer must itself be far more complex and difficult to explain than anything it's capable of designing.[62] He believes the chances of life arising on a planet like the Earth are many orders of magnitude less probable than most people would think, but the anthropic principle effectively counters skepticism with regard to improbability. For example, Fred Hoyle suggested that potential for
life on Earth was no more probable than a Boeing 747 being assembled by a hurricane from the scrapyard. He argues that a one-time event is subject to improbability but once underway, natural selection itself is nothing like random chance. Furthermore, he refers to his counter argument to the argument from improbability by that same name: \[62\]

The argument from improbability is the big one. In the traditional guise of the argument from design, it is easily today's most popular argument offered in favour of the existence of God and it is seen, by an amazingly large number of theists, as completely and utterly convincing. It is indeed a very strong and, I suspect, unanswerable argument—but in precisely the opposite direction from the theist's intention. The argument from improbability, properly deployed, comes close to proving that God does not exist. My name for the statistical demonstration that God almost certainly does not exist is the Ultimate Boeing 747 gambit.

The creationist misappropriation of the argument from improbability always takes the same general form, and it doesn't make any difference… [if called] 'intelligent design' (ID). Some observed phenomenon—often a living creature or one of its more complex organs, but it could be anything from a molecule up to the universe itself—is correctly extolled as statistically improbable. Sometimes the language of information theory is used: the Darwinian is challenged to explain the source all the information in living matter, in the technical sense of information content as a measure of improbability or 'surprise value'… However statistically improbable the entity you seek to explain by invoking a designer, the designer himself has got to be at least as improbable. God is the Ultimate Boeing 747.

…The whole argument turns on the familiar question 'Who made God?'… A designer God cannot be used to explain organized complexity because any God capable of designing anything would have to be complex enough to demand the same kind of explanation in his own right. God presents an infinite regress from which he cannot help us to escape. This argument… demonstrates that God, though not technically disprovable, is very very improbable indeed.\[62\]

— Richard Dawkins, \textit{The God Delusion}

Dawkins considered the argument from improbability to be "much more powerful" than the teleological argument, or argument from design, although he sometimes implies the terms are used interchangeably. He paraphrases St.Thomas' teleological argument as follows: "Things in the world, especially living things, look as though they have been designed. Nothing that we know looks designed unless it is designed. Therefore there must have been a designer, and we call him God." \[62\]

George H. Smith, in his book \textit{Atheism: The Case Against God}, points out what he considers to be a flaw in the argument from design:

Consider the idea that nature itself is the product of design. How could this be demonstrated? Nature… provides the basis of comparison by which we distinguish between designed objects and natural objects. We are able to infer the presence of design only to the extent that the characteristics of an object differ from natural characteristics. Therefore, to claim that nature as a whole was designed is to destroy the basis by which we differentiate between artifacts and natural objects. (p. 268)

\textbf{Intelligent design arguments in biology}

Richard Dawkins, a high-profile advocate of atheism, suggests that while biology can at first seem to be purposeful and ordered, upon closer inspection its true function becomes questionable. Dawkins rejects the claim that biology serves any actual function, claiming rather that biology only mimics purpose. In his book \textit{The Blind Watchmaker}, Dawkins states that animals are the most complex things in the known universe: "Biology is the study of complicated things that give the appearance of having been designed for a purpose." He argues that natural selection should suffice as an explanation of biological complexity without recourse to divine provenance. \[63\]

Proponents of design, such as William A. Dembski question the philosophical assumptions made by critics with regard to what a designer would or would not do. Dembski notes that such arguments aren't merely beyond the purview of science, often they're tacitly or overtly theological while failing to provide a serious analysis of the hypothetical objective's relative merit. Some critics, such as Stephen Jay Gould even suggest that any purported 'cosmic' designer would only design optimally, while at the same time offering numerous biological criticisms to
Teleological argument
demonstrate that ideal is manifestly untenable. Dembski characterizes both Dawkins’ and Gould’s argument as a rhetorical straw man. He suggests a principle of constrained optimization more realistically describes the best any designer could hope to achieve:

Not knowing the objectives of the designer, Gould was in no position to say whether the designer proposed a faulty compromise among those objectives… In criticizing design, biologists tend to place a premium on functionalities of individual organisms and see design as optimal to the degree that those individual functionalities are maximized. But higher-order designs of entire ecosystems might require lower-order designs of individual organisms to fall short of maximal function.


### Notes


Teleological argument


[40] Paley 1809, p. 1 (http://darwin-online.org.uk/content/frameset?itemID=A142&viewtype=text&pageseq=7).


[44] Darwin 1958, pp. 59 (http://darwin-online.org.uk/content/frameset?viewtype=text&itemID=F1497&pageseq=61), 87 (http://darwin-online.org.uk/content/frameset?viewtype=text&itemID=F1497&pageseq=89).


[46] For example, if the force of the Big Bang explosion had been different by 1/1060 or the strong interaction force was only 5% different, life would be impossible. (Himma, 2009).


[50] Pigliucci, Massimo (2010). Nonsense on Stilts: How to Tell Science from Bunk (http://books.google.com/books?id=euOoq2OcC&pg=PA177&ppg=PA177). University of Chicago Press. p. 177. ISBN 9780226668767. LCCN 2009049778. "[E]ven back in Aristotle's time, a fundamental assumption of doing things scientifically is that the supernatural is out: no explanations that invoke non-natural causes are allowed."


[61] Søren Kierkegaard, Philosophical Fragments (1844).


References

Further reading

• Richard Dawkins (1986) The Blind Watchmaker (takes a view against the teleological argument).
• Evidence For Design In The Universe (http://www.doesgodexist.org/Charts/EvidenceForDesignInTheUniverse.html) from Limits for the Universe by Hugh Ross, Ph.D. in Astronomy
• Eric Sotnak, "Analysis of the Teleological Argument (http://www.infidels.org/library/modern/theism/design.html)"
External links

- Design argument (http://etext.lib.virginia.edu/cgi-local/DHI/dhi.cgi?id=dv1-80) from the Dictionary of the history of Ideas
- Design arguments for the existence of God (http://www.iep.utm.edu/d/design.htm) from the Internet encyclopedia of philosophy
- The Skeptic's Dictionary on argument from design (http://skepdic.com/design.html)

Anne Conway, Viscountess Conway

Anne Conway, Viscountess Conway (*née* Finch) (14 December 1631 – 18 February 1679) was an English philosopher whose work, in the tradition of the Cambridge Platonists, was an influence on Leibniz.

She was born to Sir Heneage Finch (who had held the posts of the Recorder of London and Speaker of the House of Commons under Charles I) and his second wife, Elizabeth (daughter of William Cradock of Staffordshire). Her father died the week before her birth. Her early education was by tutors and included Latin, to which she later added Greek and Hebrew. Her stepbrother, John Finch, was educated at Cambridge, and Anne Finch (as she then was) came into contact with one of his tutors, the Platonist Henry More. This led to a correspondence between them on the subject of Descartes' philosophy, in the course of which Anne grew from More's informal pupil to his intellectual equal. More said of her that he had "scarce ever met with any Person, Man or Woman, of better Natural parts than Lady Conway" (quoted in Richard Ward's *The Life of Henry More* (1710) p. 193). In 1651 she married Edward Conway, later 1st Earl of Conway, and in the following year More dedicated his book *Antidote against Atheism* to her. Her husband was also interested in philosophy and had himself been tutored by More, but she went far beyond him in both the depth of her thought and the variety of her interests. She became interested in the Lurianic Kabbalah, and then in Quakerism, to which she converted in 1677. In England at that time the Quakers were generally disliked and feared, and suffered persecution and even imprisonment. Conway's decision to convert, to make her house a centre for Quaker activity, and to proselytise actively was thus particularly bold and courageous.

Her life from the age of twelve (when she suffered a period of fever) was marked by the recurrence of severe migraines. These meant that she was often incapacitated by pain, and she spent much time under medical supervision and trying various cures (at one point even having her jugular veins opened). She had medical consults from Dr. Thomas Willis. None of the treatments had any effect. She died in 1679 at the age of forty-seven.

A picture that is regularly offered as representing Anne Conway is not in fact of her. The authority for this is the Mauritshuis in The Hague, which owns the picture and attributes this result to recent scholarship. There is, alas, no known picture of Anne Conway.
References

Bibliography

Primary Sources
- she collaborated with Franciscus Mercurius van Helmont (1614–1698) for

Secondary Sources

External links
- Peter King's page (http://users.ox.ac.uk/~worc0337/authors/anne.conway.html)
- William Uzgalis' page (http://www.orst.edu/instruct/phl302/philosophers/conway.html)
- Readable version of Principles of the ancient and modern philosophy (http://www.earlymoderntexts.com)
- Lady Anne Conway (http://plato.stanford.edu/entries/conway) entry by Sarah Hutton in the *Stanford Encyclopedia of Philosophy*
Pierre Teilhard de Chardin

<table>
<thead>
<tr>
<th>Pierre Teilhard de Chardin</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Born</strong></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td><strong>Died</strong></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td><strong>Nationality</strong></td>
</tr>
<tr>
<td><strong>Fields</strong></td>
</tr>
<tr>
<td><strong>Known for</strong></td>
</tr>
</tbody>
</table>

Pierre Teilhard de Chardin SJ (French pronunciation: [pjɛʁ tejaʁ de ʃaʁdɛ]; May 1, 1881 – April 10, 1955) was a French philosopher and Jesuit priest who trained as a paleontologist and geologist and took part in the discovery of both Piltdown Man and Peking Man. Teilhard conceived the idea of the Omega Point and developed Vladimir Vernadsky's concept of Noosphere. Some of his ideas came into conflict with the Magisterium of the Catholic Church, and several of his books were censured.

Teilhard's primary book, *The Phenomenon of Man*, set forth a sweeping account of the unfolding of the cosmos. He abandoned traditional interpretations of creation in the Book of Genesis in favor of a less strict interpretation. This displeased certain officials in the Roman Curia and in his own order who thought that it undermined the doctrine of original sin developed by Saint Augustine. Teilhard's position was opposed by his Church superiors, and some of his work was denied publication during his lifetime by the Roman Holy Office. The 1950 encyclical *Humani generis* condemned several of Teilhard's opinions, while leaving other questions open. However, some of Teilhard's views became influential in the reforms of the Second Vatican Council. More recently, Pope John Paul II indicated a positive attitude towards some of Teilhard's ideas. In 2009, Pope Benedict XVI praised Teilhard's idea of the universe as a "living host".\[1\]

**Life**

---

[1]: Pope John Paul II indicated a positive attitude towards some of Teilhard's ideas. In 2009, Pope Benedict XVI praised Teilhard's idea of the universe as a "living host".
Early years

Pierre Teilhard de Chardin was born in the Château of Sarcenat at Orcines, close to Clermont-Ferrand, France on May 1, 1881. On the Teilhard side he is descended from an ancient family of magistrates from Auvergne originating in Murat, Cantal, and on the de Chardin side he is descended from a family which was ennobled under Louis XVIII. He was the fourth of eleven children. His father, Emmanuel Teilhard (1844–1932), an amateur naturalist, collected stones, insects and plants, and promoted the observation of nature in the household. Pierre Teilhard's spirituality was awakened by his mother, Berthe de Dompiere. When he was 12, he went to the Jesuit college of Mongré, in Villefranche-sur-Saône, where he completed baccalaureates of philosophy and mathematics. Then, in 1899, he entered the Jesuit novitiate at Aix-en-Provence where he began a philosophical, theological and spiritual career.

As of the summer 1901, the Waldeck-Rousseau laws, which submitted congregational associations' properties to state control, prompted some of the Jesuits to exile themselves in the United Kingdom. Young Jesuit students continued their studies in Jersey. In the meantime, Teilhard earned a licentiate in literature in Caen in 1902.

Academic career

From 1905 to 1908, he taught physics and chemistry in Cairo, Egypt, at the Jesuit College of the Holy Family. He wrote "...it is the dazzling of the East foreseen and drunk greedily... in its lights, its vegetation, its fauna and its deserts." (Letters from Egypt (1905–1908) — Editions Aubier)

Teilhard studied theology in Hastings, in Sussex (United Kingdom), from 1908 to 1912. There he synthesized his scientific, philosophical and theological knowledge in the light of evolution. His reading of L'Évolution Créatrice (The Creative Evolution) by Henri Bergson was, he said, the "catalyst of a fire which devoured already its heart and its spirit." His views on evolution and religion particularly inspired the evolutionary biologist Theodosius Dobzhansky. Teilhard was ordained a priest on August 24, 1911, aged 30.
Pierre Teilhard de Chardin

Paleontology

From 1912 to 1914, Teilhard worked in the paleontology laboratory of the Musée National d'Histoire Naturelle, in Paris, studying the mammals of the middle Tertiary period. Later he studied elsewhere in Europe. In June 1912 he formed part of the original digging team, with Arthur Smith Woodward and Charles Dawson, to perform follow-up investigations at the Piltdown site, after the discovery of the first fragments of the (fraudulent) "Piltdown Man". Professor Marcellin Boule (specialist in Neanderthal studies), who so early as 1915 astutely recognised the non-hominid origins of the Piltdown finds, gradually guided Teilhard towards human paleontology. At the museum's Institute of Human Paleontology, he became a friend of Henri Breuil and took part with him, in 1913, in excavations in the prehistoric painted caves in the northwest of Spain, at the Cave of Castillo.

Service in World War I

Mobilised in December 1914, Teilhard served in World War I as a stretcher-bearer in the 8th Moroccan Rifles. For his valour, he received several citations including the Médaille militaire and the Legion of Honour.

Throughout these years of war he developed his reflections in his diaries and in letters to his cousin, Marguerite Teillard-Chambon, who later edited them into a book: Genèse d'une pensée (Genesis of a thought). He confessed later: "...the war was a meeting ... with the Absolute." In 1916, he wrote his first essay: La Vie Cosmique (Cosmic life), where his scientific and philosophical thought was revealed just as his mystical life. He pronounced his solemn vows as a Jesuit in Sainte-Foy-lès-Lyon, on May 26, 1918, during a leave. In August 1919, in Jersey, he would write Puissance spirituelle de la Matière (the spiritual Power of Matter). The complete essays written between 1916 and 1919 are published under the following titles:

- **Ecrits du temps de la Guerre (Written in time of the War)** (TXII of complete Works) – Editions du Seuil
- **Genèse d'une pensée (letters of 1914 to 1918)** – Editions Grasset

Teilhard followed at the Sorbonne three unit degrees of natural science: geology, botany and zoology. His thesis treated of the mammals of the French lower Eocene and their stratigraphy. After 1920, he lectured in geology at the Catholic Institute of Paris, then became an assistant professor after being granted a science Doctorate in 1922.

Research in China

In 1923 he traveled to China with Father Emile Licent, who was in charge in Tianjin for a significant laboratory collaborating with the Natural History Museum in Paris and Marcellin Boule's laboratory. Licent carried out considerable basic work in connection with missionaries who accumulated observations of a scientific nature in their spare time. He was known as 德日進 (pinyin: Dérijìn) in China.

Teilhard wrote several essays, including La Messe sur le Monde (the Mass on the World), in the Ordos Desert. In the following year he continued lecturing at the Catholic Institute and participated in a cycle of conferences for the students of the Engineers' Schools. Two theological essays on Original Sin” sent to a theologian, on his request, on a purely personal basis, were wrongly understood.

- July 1920: *Chute, Rédemption et Géocentrie* (Fall, Redemption and Geocentry)
- Spring 1922: *Notes sur quelques représentations historiques possibles du Péché originel* (Notes on few possible historical representations of original sin) (Works, Tome X)

The Church required him to give up his lecturing at the Catholic Institute and to continue his geological research in China.

Teilhard travelled again to China in April 1926. He would remain there more or less twenty years, with many voyages throughout the world. He settled until 1932 in Tientsin with Emile Licent then in Beijing. From 1926 to 1935, Teilhard made five geological research expeditions in China. They enabled him to establish a general geological map of China.

1926 : Fr. de Chardin’s Superiors in the Jesuit Order forbade him to teach any longer.
In 1926–1927 after a missed campaign in Gansu he travelled in the Sang-Kan-Ho valley near Kalgan (Zhangjiakou) and made a tour in Eastern Mongolia. He wrote *Le Milieu Divin* (the divine Medium). Teilhard prepared the first pages of his main work *Le Phénomène humain* (The Human Phenomenon).


He joined the ongoing excavations of the Peking Man Site at Zhoukoudian as an advisor in 1926 and continued in the role for the Cenozoic Research Laboratory of the Geological Survey of China following its founding in 1928. He resided in Manchuria with Emile Licent, then stayed in Western Shansi (Shanxi) and northern Shensi (Shaanxi) with the Chinese paleontologist C. C. Young and with Davidson Black, Chairman of the Geological Survey of China.

After a tour in Manchuria in the area of Great Khingan with Chinese geologists, Teilhard joined the team of American Expedition Center-Asia in the Gobi organised in June and July, by the American Museum of Natural History with Roy Chapman Andrews.

Henri Breuil and Teilhard discovered that the *Peking Man*, the nearest relative of *Pithecanthropus* from Java, was a "fabbre" (worker of stones and controller of fire). Teilhard wrote *L'Esprit de la Terre* (the Spirit of the Earth).

Teilhard took part as a scientist in the famous "Croisiere Jaune" or "Yellow Cruise" financed by Andre Citroen in Central Asia. Northwest of Beijing in Kalgan he joined the China group who joined the second part of the team, the Pamir group, in Aksu. He remained with his colleagues for several months in Urumqi, capital of Sinkiang. The following year the Sino-Japanese War (1937–1945) began. 1933: Rome ordered him to give up his post in Paris.

During all these years, Teilhard strongly contributed to the constitution of an international network of research in human paleontology related to the whole Eastern and south Eastern zone of the Asian continent. He would be particularly associated in this task with two friends, the English/Canadian Davidson Black and the Scot George B. Barbour. Many times he would visit France or the United States, only to leave these countries to go on further expeditions.

**World travels**

From 1927–1928 Teilhard stayed in France, based in Paris. He journeyed to Leuven, Belgium, to Cantal, and to Ariège, France. Between several articles in reviews, he met new people such as Paul Valéry and Bruno de Solages, who were to help him in issues with the Catholic Church.

Answering an invitation from Henry de Monfreid, Teilhard undertook a journey of two months in Obock in Harrar and in Somalia with his colleague Pierre Lamarre, geologist, before embarking in Djibouti to return to Tianjin. While in China, Teilhard developed a deep and personal friendship with Lucile Swan.[2]

From 1930–1931 Teilhard stayed in France and in the United States. During a conference in Paris, Teilhard stated: "For the observers of the Future, the greatest event will be the sudden appearance of a collective humane conscience and a human work to make."

From 1932–1933 he began to meet people to clarify issues with the Congregation for the Doctrine of the Faith, regarding *Le Milieu Divin* and *L'Esprit de la Terre*. He met Helmut de Terra, a German geologist in the International Geology Congress in Washington, DC.

Teilhard participated in the 1935 Yale–Cambridge expedition in northern and central India with the geologist Helmut de Terra and Patterson, who verified their assumptions on Indian Paleolithic civilisations in Kashmir and the Salt Range Valley.
He then made a short stay in Java, on the invitation of Professor Ralph van Koenigswald to the site of Java man. A second cranium, more complete, was discovered. This Dutch paleontologist had found (in 1933) a tooth in a Chinese apothecary shop in 1934 that he believed belonged to a giant tall ape that lived around half a million years ago.

In 1937 Teilhard wrote *Le Phénomène spirituel (The Phenomenon of the Spirit)* on board the boat *the Empress of Japan*, where he met the Raja of Sarawak. The ship conveyed him to the United States. He received the Mendel medal granted by Villanova University during the Congress of Philadelphia in recognition of his works on human paleontology. He made a speech about evolution, origins and the destiny of Man. The *New York Times* dated March 19, 1937 presented Teilhard as the Jesuit who held that man descended from monkeys. Some days later, he was to be granted the *Doctor Honoris Causa* distinction from Boston College. Upon arrival in that city, he was told that the award had been cancelled.

1939 : Rome banned his work *L’Energie Humaine*.

He then stayed in France, where he was immobilized by malaria. During his return voyage to Beijing he wrote *L’Energie spirituelle de la Souffrance (Spiritual Energy of Suffering)* (Complete Works, tome VII).

1941 : de Chardin submitted to Rome his most important work *Le Phénomène Humain*.

1947 : Rome forbade him to write or teach on philosophical subjects.

1948 : de Chardin was called to Rome by the Superior General of the Jesuits who hoped to acquire permission from the Holy See for the publication of his most important work *Le Phénomène Humain*. But the prohibition to publish it issued in 1944, was again renewed. Teilhard was also forbidden to take a teaching post in the College de France.

1949 : Permission to publish *Le Groupe Zoologique* was refused.

1950: de Chardin was named to the French Academy of Sciences.

1955 : de Chardin forbidden by his Superiors to attend the “International Congress of Paleontology”.

1957 : The Supreme Authority of the Holy Office in a decree dated 15 Nov 1957, forbade the works of de Chardin to be retained in libraries, including those of religious institutes. His books were not to be sold in Catholic bookshops and were not to be translated in other languages.

1958 : In April of this year, all Jesuit publications in Spain (“Razón y Fe”, “Sal Terrae”, “Estudios de Deusto”) etc., carried a notice from the Spanish Provincial of the Jesuits, that de Chardin’s works had been published in Spanish without previous ecclesiastical examination and in defiance of the decrees of the Holy See.

1962 : A decree of the Holy Office dated 30 June, under the authority of Pope John XX III. warned that “... it is obvious that in philosophical and theological matters, the said works (de Chardin’s) are replete with ambiguities or rather with serious errors which offend Catholic doctrine. That is why ... the Rev. Fathers of the Holy Office urge all Ordinaries, Superiors, and Rectors ... to effectively protect, especially the minds of the young, against the dangers of the works of Fr. Teilhard de Chardin and his followers”. (AAS, 6 Aug 1962).

1963 : The Vicariate of Rome (a diocese ruled in the name of Pope Paul VI by his Cardinal Vicar) in a decree dated 30 September, required that Catholic booksellers in Rome, should withdraw from circulation the works of de Chardin, together with those books which favour his erroneous doctrines. The text of this document was published in daily *L’Aurore* of Paris, dated 2 Oct 1963, and was reproduced in *Nouvelles de Chretiente*, l0 Oct 1963, p. 35.

**Death**

Pierre Teilhard de Chardin died in New York City, where he was in residence at the Jesuit church of St Ignatius of Loyola, Park Avenue. On March 15, 1955, at the house of his diplomat cousin Jean de Lagarde, Teilhard told friends he hoped he would die on Easter Sunday. In the Easter Sunday evening of April 10, 1955, during an animated discussion at the apartment of Rhoda de Terra, his personal assistant since 1949, the 73-year-old priest was felled by a heart seizure; regaining consciousness for a moment, he died a few minutes later. He was buried in the cemetery for the New York Province of the Jesuits at the Jesuit novitiate, St. Andrew's-on-the-Hudson in Poughkeepsie,
Controversy with Church officials

In 1925, Teilhard was ordered by the Jesuit Superior General Vladimir Ledochowski to leave his teaching position in France and to sign a statement withdrawing his controversial statements regarding the doctrine of original sin. Rather than leave the Jesuit order, Teilhard signed the statement and left for China. This was the first of a series of condemnations by certain ecclesiastical officials that would continue until long after Teilhard's death. The climax of these condemnations was a 1962 monitum (reprimand) of the Holy Office denouncing his works. From the monitum:

"The above-mentioned works abound in such ambiguities and indeed even serious errors, as to offend Catholic doctrine... For this reason, the most eminent and most revered Fathers of the Holy Office exhort all Ordinaries as well as the superiors of Religious institutes, rectors of seminaries and presidents of universities, effectively to protect the minds, particularly of the youth, against the dangers presented by the works of Fr. Teilhard de Chardin and of his followers".[6]

Teilhard's writings, though, continued to circulate — not publicly, as he and the Jesuits observed their commitments to obedience, but in mimeographs that were circulated only privately, within the Jesuits, among theologians and scholars for discussion, debate and criticism.

As time passed, it seemed that the works of Teilhard were gradually becoming viewed more favourably within the Church. For example, on June 10, 1981, Cardinal Agostino Casaroli wrote on the front page of the Vatican newspaper, l'Osservatore Romano:

"What our contemporaries will undoubtedly remember, beyond the difficulties of conception and deficiencies of expression in this audacious attempt to reach a synthesis, is the testimony of the coherent life of a man possessed by Christ in the depths of his soul. He was concerned with honoring both faith and reason, and anticipated the response to John Paul II's appeal: 'Be not afraid, open, open wide to Christ the doors of the immense domains of culture, civilization, and progress.[7]

However, shortly thereafter the Holy See clarified that recent statements by members of the Church, in particular those made on the hundredth anniversary of Teilhard's birth, were not to be interpreted as a revision of previous stands taken by the Church officials.[8] Thus the 1962 statement remains official Church policy to this day.

Although some Catholic intellectuals defended Teilhard and his doctrine (including Henri de Lubac),[9] others condemned his teaching as a perversion of the Christian faith. These include Jacques Maritain, Étienne Gilson and Dietrich von Hildebrand.[10]

Teachings

In his posthumously published book, The Phenomenon of Man, Teilhard writes of the unfolding of the material cosmos, from primordial particles to the development of life, human beings and the noosphere, and finally to his vision of the Omega Point in the future, which is "pulling" all creation towards it. He was a leading proponent of orthogenesis, the idea that evolution occurs in a directional, goal driven way, argued in terms that today go under the banner of convergent evolution. Teilhard argued in Darwinian terms with respect to biology, and supported the synthetic model of evolution, but argued in Lamarckian terms for the development of culture, primarily through the vehicle of education.[11]

Teilhard makes sense of the universe by its evolutionary process. He interprets complexity as the axis of evolution of matter into a geosphere, a biosphere, into consciousness (in man,) and then to supreme consciousness (the Omega Point.)
Teilhard's life work was predicated on the conviction that human spiritual development is moved by the same universal laws as material development. He wrote, "...everything is the sum of the past" and "...nothing is comprehensible except through its history. 'Nature' is the equivalent of 'becoming', self-creation: this is the view to which experience irresistibly leads us. ... There is nothing, not even the human soul, the highest spiritual manifestation we know of, that does not come within this universal law."[12] There is no doubt that The Phenomenon of Man represents Teilhard's attempt at reconciling his religious faith with his academic interests as a paleontologist.[13] One particularly poignant observation in Teilhard's book entails the notion that evolution is becoming an increasingly optional process.[13] Teilhard points to the societal problems of isolation and marginalization as huge inhibitors of evolution, especially since evolution requires a unification of consciousness. He states that "no evolutionary future awaits anyone except in association with everyone else."[13] Teilhard argued that the human condition necessarily leads to the psychic unity of humankind, though he stressed that this unity can only be voluntary; this voluntary psychic unity he termed "unanimization." Teilhard also states that "evolution is an ascent toward consciousness", giving encephalization as an example of early stages, and therefore, signifies a continuous upsurge toward the Omega Point,[13] which for all intents and purposes, is God.

Our century is probably more religious than any other. How could it fail to be, with such problems to be solved? The only trouble is that it has not yet found a God it can adore.[13]

**Influence**

Teilhard and his work have a continuing presence in the arts and culture. He inspired a number of characters in literary works. References range from occasional quotations—an auto mechanic quotes Teilhard in Philip K. Dick's A Scanner Darkly[14] -- to serving as the philosophical underpinning of the plot, as Teilhard's work does in Julian May's 1987–94 Galactic Milieu Series.[15] Teilhard also plays a major role in Annie Dillard's 1999 For the Time Being.[16] Characters based on Teilhard appear in several novels, including Jean Telemont in Morris West's The Shoes of the Fisherman[17] (mentioned by name and quoted by Oskar Werner playing Fr. Telemont in the movie version of the novel) and Father Lankester Merrin in William Peter Blatty's The Exorcist.[18] In Dan Simmons' 1989–97 Hyperion Cantos, Teilhard de Chardin has been canonized a saint in the far future. His work inspires the anthropologist priest character, Paul Duré. When Duré becomes Pope, he takes Teilhard I as his regnal name.[19] Teilhard appears as a minor character in the play "Fake" by Eric Simonson, staged by Chicago's Steppenwolf Theatre Company in 2009, involving a fictional solution to the infamous Piltdown Man hoax.

Teilhard's work has also inspired the philosophical ruminations of Italian laureate architect Paolo Soleri, artworks such as French painter Alfred Manessier's L'Offrande de la terre ou Hommage à Teilhard de Chardin[20] and American sculptor Frederick Hart's acrylic sculpture The Divine Milieu: Homage to Teilhard de Chardin.[21] A sculpture of the Omega Point by Henry Setter, with a quote from Teilhard de Chardin, can be found at the entrance to the Roesch Library at the University of Dayton.[22] Edmund Rubbra's 1968 Symphony No. 8 is titled Hommage a Teilhard de Chardin.

Teilhard's influence is commemorated on numerous collegiate campuses. A building at the University of Manchester is named after him, as are residence dormitories at Gonzaga University and Seattle University. His stature as a biologist was honored by George Gaylord Simpson in naming the most primitive and ancient genus of true primate, the Eocene genus Teilhardina.

The title of the short-story collection Everything That Rises Must Converge by Flannery O'Connor is a reference to Teilhard's work.

The American novelist Don DeLillo's 2010 novel Point Omega borrows its title and some of its ideas from Teilhard de Chardin.

Robert Wright, in his book Nonzero: The Logic of Human Destiny, compares his own naturalistic thesis that biological and cultural evolution are directional and, possibly, purposeful, with Teilhard's ideas.
Bibliography

The dates in parentheses are the dates of first publication in French and English. Most of these works were written years earlier, but Teilhard's ecclesiastical order forbade him to publish them because of their controversial nature. The essay collections are organized by subject rather than date, thus each one typically spans many years.

- **Le Phénomène Humain** (1955), written 1938–40, scientific exposition of Teilhard’s theory of evolution
- **Letters From a Traveler** (1956; English translation 1962), written 1923–55
- **Le Groupe Zoologique Humain** (1956), written 1949, more detailed presentation of Teilhard's theories
- **Le Milieu Divin** (1957), spiritual book written 1926–27, in which the author seeks to offer a way for everyday life, or the secular, to be divinised.
  - *L'Energie Humaine* (1962), essays written 1931–39, on morality and love
  - *L'Activation de l'Energie* (1963), sequel to *Human Energy*, essays written 1939–55 but not planned for publication, about the universality and irreversibility of human action
  - *Writings in Time of War*, Collins (1968) composed of spiritual essays written during wartime. One of the few books of Teilhard to receive an imprimatur.
  - *Letters to Two Friends 1926-1952*, Fontana (1968) composed of personal letters on varied subjects including his understanding of death.
  - *Correspondence / Pierre Teilhard de Chardin, Maurice Blondel*, Herder and Herder (1967) This correspondence also has both the imprimatur and nihil obstat.
References


[3] Smulders, Pieter Frans. The design of Teilhard de Chardin: an essay in theological reflection (http://www.google.com/search?hl=en&num=10&ei=&ie=UTF-8&q=on+Easter+Sunday,he+was+quite+su&safe=images&um=1&q=t+he+would+die+on+Easter+Sunday,+-+the+feast+of+his+own+Messe+sur+le+monde.+&aq=f&aqi=&aql=&gs_rfl=&pblx=1&fp=8652cbd0fd6c5ba22) 1967

[4] Smulders, Pieter Frans. The design of Teilhard de Chardin: an essay in theological reflection (http://www.google.com/search?hl=en&num=10&ei=&ie=UTF-8&q=on+Easter+Sunday,he+was+quite+su&safe=images&um=1&q=t+he+would+die+on+Easter+Sunday,+-+the+feast+of+his+own+Messe+sur+le+monde.+&aq=f&aqi=&aql=&gs_rfl=&pblx=1&fp=8652cbd0fd6c5ba22) 1967


Further reading

• Andre Dupleix, *15 Days of Prayer with Teilhard de Chardin* (New City Press, 2008)
• Robert Faricy, SJ and Lucy Rooney SND, *Praying with Teilhard de Chardin* (Queenship 1996)
• Dietrich von Hildebrand, *Trojan Horse in the City of God*
• Dietrich von Hildebrand, *Devastated Vineyard*
• David H. Lane, *The Phenomenon of Teilhard: Prophet for a New Age* (Mercer University Press)
• Lubac, Henri de, SJ, *The Faith of Teilhard de Chardin* (Burnes and Oates, 1965)
• Lubac, Henri de, SJ, *The Eternal Feminine: A Study of the Text of Teilhard de Chardin* (Collins, 1971)
• Mary and Ellen Lukas, *Teilhard* (Doubleday, 1977)
• George A. Maloney, SJ, *The Cosmic Christ: From Paul to Teilhard* (Sheed and Ward, 1968)
• Murray, Michael H. *The Thought of Teilhard de Chardin* (Seabury Press, N.Y., 1966)
• Noel Keith Roberts, *From Piltdown Man to Point Omega: the evolutionary theory of Teilhard de Chardin* (New York, Peter Lang, 2000)
• Helmut de Terra, *Memories of Teilhard de Chardin*, (Harper and Row and Wm Collins Sons & Co., 1964)

External links

Pro

• Pierre Teilhard de Chardin's books in the Internet Archive (http://www.archive.org/search.php?query=creator:"Pierre Teilhard de Chardin")
• Chardin, Pierre Teilhard de ♦ The Phenomenon of Man (http://arthursbookshelf.com/other-stuff/phenom10.html) An HTML version of the book (without illustrations)
• The Teilhard de Chardin Foundation (http://www.mnhn.fr/teilhard/indexE.html)
• The American Teilhard Association (http://www.teilharddechardin.org/)
• Teilhard de Chardin (http://tcreek1.jimdo.com) A personal website
Contra


Other

• Works by or about Pierre Teilhard de Chardin (http://worldcat.org/identities/lccn-n79-32934) in libraries (WorldCat catalog)