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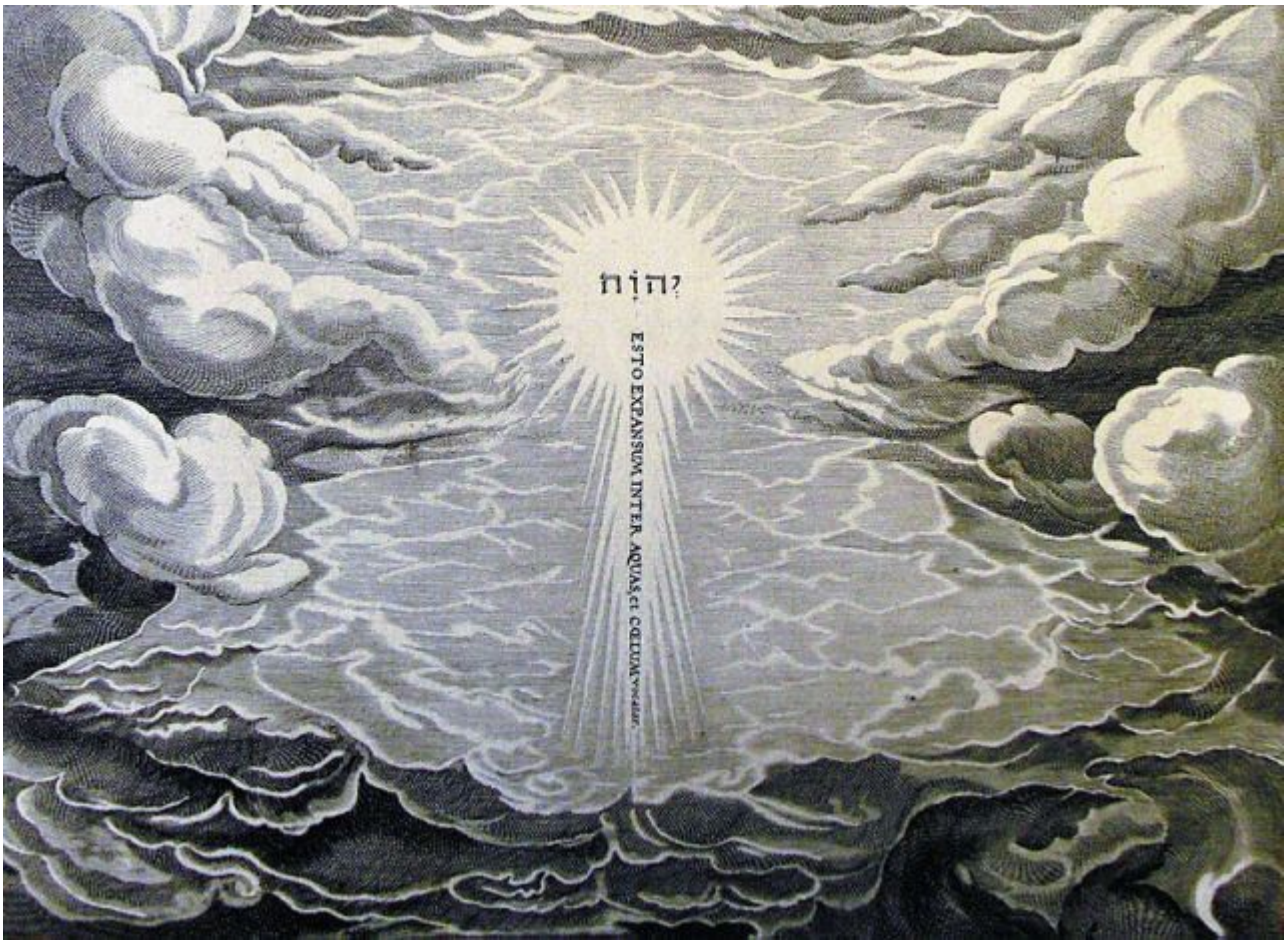
Section 1: *Creatio ex Nihilo*—Theology



"The Creation"–Philip Medhurst Torah
from Wikimedia Commons

> *"In the beginning God created the heavens and the earth. The earth was formless and void, and darkness was over the surface of the deep, and the Spirit of God was moving over the surface of the waters."*
> —Genesis:1:1-2 (KJV)

1.1 THE CATECHISM

What we as Catholics believe about Creation is spelled out by the Catholic Catechism (CC:279-324):

Why belief in Creation is fundamental to faith;
God creates "out of nothing" (*ex nihilo*);
God creates an ordered and good world;
God transcends Creation and is present to it;
God upholds and sustains Creation.

> *"We believe that God needs no pre-existent thing or any help in order to create, nor is creation any sort of necessary emanation from the divine substance. God creates freely 'out of nothing;' If God had drawn the world from preexistent matter, what would be so extraordinary in that? A human artisan makes from a given material whatever he wants, while God shows his power by starting from nothing to make all he wants."*
> —Catholic Catechism 296"

1.2 THE ORIGIN OF "*CREATIO EX NIHILO*"

Whence "Creation out of Nothing"? Where did this originate? The Hebrew for "formless and void" in Gen 1:1 is "tohu-bohu" or "tohu va vo-hu). A scholar in Hebrew (as distinguished from a Hebrew scholar–this guy was a retired Irish physician) told me that the real translation of "Tohu Bohu" was topsy-turvy, a mess, confusion. That would be more in accord with notion held by many physicists that Creation arose from quantum fluctuations.

Chaos is not nothing, so again, where did "*ex nihilo*" come from? One citation from the Old Testament can be used to justify this:

> *“I beseech thee, my son, look upon the heaven and the earth, and all that is therein, and consider that God made them of things that were not; and so was mankind made likewise.”*
> —2 Maccabees 7:28, (KJV)

And in the New Testament:

> *“By faith we understand that the universe was created by the word of God, so that what is seen was not made out of things that are visible”*
> —Hebrews 11:3 (KJV)

The first Christian writer to promote the doctrine of *“Creatio ex nihil*o” was Theophilus of Antioch in the late second century, who wrote:

> *“but then they (the Platonists) maintain that matter as well as God is uncreated, and aver that it is coeval with God. But if God is uncreated and matter uncreated, God is no longer, according to the Platonists, the Creator of all things, nor, so far as their opinions hold, is the monarchy of God established. And further, as God, because He is uncreated, is also unalterable; so if matter, too, were uncreated, it also would be unalterable, and equal to God; for that which is created is mutable and alterable, but that which is uncreated is immutable and unalterable.* ***And what great thing is it if God made the world out of existent materials? For even a human artist, when he gets material from some one, makes of it what he pleases*** [emphasis added]. *But the power of God is manifested in this, that out of things that are not He makes whatever He pleases.”*
> —Theophilus of Antioch, “Letter to Autolycus, Chapter IV”

It’s a long quote but well expressed (note the points taken up in The Catechism). Theophilus was contesting the view of Greek philosophers, Platonists, neo-Platonists, that the universe was eternal, that a demi-urge had created it from pre-existing stuff. Theophilus’s theologic cudgel was wielded against the Gnostics by later Christian theologians and fully developed by St. Augustine.

1.3 ST. AUGUSTINE AND ST. THOMAS AQUINAS ON CREATION

It was St. Augustine who developed arguments about time, that time could have begun with creation, which is a view remarkably in accord with much of modern cosmology.

> “*…no time passed before the world, because no creature was made by whose course it might pass.”*
> —St. Augustine, City of God book 11, ch.4.

As Keith Ward puts it,

> *“For Augustine, God brought about time and space as well as all the things that are in them. Just as God did not create space at a certain place, but non-spatially caused all places to exist, so God did not create time at a certain moment, but non-temporally caused all time to exist.”*
> —Keith Ward, “Quantum Cosmology and the Laws of Nature”.

Note that Ward’s interpretation above does not require a first moment of time, a “t=0”, although Augustine did accept from Revelation, that the Universe (which to him was much smaller than our conception) had a definite beginning.

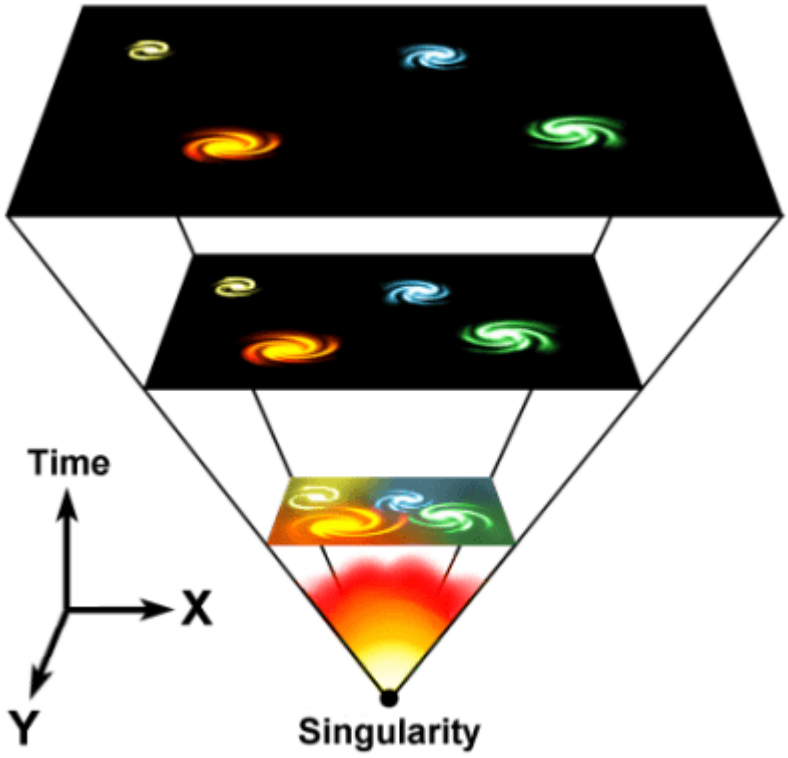
St. Thomas Aquinas also contended against the Greek philosophers' version of Creation. He agreed with Aristotle that creation required a First Cause, which Aristotle called the Prime Mover and which Aquinas called God. However, he believed that only Revelation, not reason, could assert that Creation began at an instant in time:

> *"By faith alone do we hold, and by no demonstration can it be proved, that the world did not always exist … it cannot be demonstrated that man, or heaven, or a stone were not always. Likewise neither can it be demonstrated on the part of the efficient cause, which acts by will. For the will of God cannot be investigated by reason, except as regards those things which God must will of necessity; and what He wills about creatures is not among these, as was said above."*
> —St. Thomas Aquinas, Summa Theologica, Part I, Question 46.

Even though the world might be eternal, Aquinas maintained that God's creative agency would be and is continually active, as a *Creatio Continua*, continuous creation.

SECTION 2: In the Beginning—Cosmology

"I think that only an idiot can be an atheist! We must admit that there exists and incomprehensible power or force with limitless foresight and knowledge that started the whole universe going in the first place."
—Professor Christian Anfinsen (Nobel Prize for Chemistry), quoted in Cosmos, Bios and Theos



Expansion of the Universe from a singularity to galaxies from Wikimedia Commons

"..physical laws can never provide a complete explanation of the universe. Laws themselves do not create anything, they are merely a description of what happens under certain conditions."
—Professor John Lennox (Mathematics

and Philosophy of
Science, Oxford
University).

2.1 INTRODUCTION

This section is taken largely from one of my blog posts, part of a series summarizing George F.R. Ellis's article, Issues in the Philosophy of Cosmology. Professor Ellis, a cosmologist and philosopher, recipient of the Templeton Prize, has carefully laid out what we can and cannot conclude from cosmological science.

I'll explore the limitations of what science—cosmology—can say about the universe, its beginning and its nature.

2.2 CONTEMPORARY COSMOLOGY—LIMITATIONS

Intrinsic limitations on scientific cosmology studies:

We can't step outside the universe or duplicate it as an experimental object;

We explore the universe by electromagnetic radiation (from radio to gamma rays), which limits the distance out and, correspondingly, the past time for which measurements can be made. This limitation is of two types.
The first is a **time horizon** due to the coupling of matter and radiation at times before the universe was about 380,000 years old, giving an opaque barrier at distances/times corresponding to less than 380,000 years from the beginning. This means that there is a time horizon–we cannot see further back in time than 380,000 years after the origin.
The second limitation is a **distance horizon**—if the universe expansion is uniform, such that the further a point is from us (and, correspondingly, the further back in time), the faster it is moving—then there will be a distance d, such a star at that distance d will be moving away

from us at the speed of light, or faster. **This means that we cannot communicate at distances greater than d, since communication can only take place at the speed of light.**

An important consequence of the time horizon is that we have to infer what happened before the 380,000 years from the properties of the universe we determine after that time. So theories about singularities, quantum origins, inflation can only be tested (if at all) by predictions about the state of our universe at times greater than or equal to 380,000 years from the origin.

An important consequence of the distance horizon has to do with causality. Two events cannot influence each other (since interactions cannot travel faster than the speed of light) if they are further apart than the distance horizon. This is one of the reasons that "inflation" is invoked in the very early life of the universe. The early universe was larger than the horizon distance d (speed of light times age of the universe), so the question is how was a causal relation retained between different parts of the early universe to give the same temperatures and densities (approximately) for parts of the universe that were not causally connected.

"There is also a practical limitation, a **physics horizon**. The energies in the early stages of the Big Bang are so high that there is no way that these could be duplicated in the laboratory, despite occasional claims of popular science writers to the contrary.

Thus, as George Ellis emphasizes:

> *"Testable Physics cannot explain the initial state and hence the specific nature of the universe."*
> —George F.R. Ellis, Issues in the Philosophy of Cosmology

Accordingly, cosmology rests on philosophy, on metaphysical assumptions. These

assumptions set limits on what we can conclude from the science of cosmology. Two of the most important of these assumptions are, according to Ellis:

> *"THESIS A1: The universe itself cannot be subjected to physical experimentation. We cannot re-run the universe with the same or altered conditions to see what would happen if they were different , so we cannot carry out scientific experiments on the universe itself.*
>
> *THESIS A2: The universe cannot be observationally compared with other universes. We cannot compare the universe with any similar object, nor can we test our hypotheses about it by observations determining statistical properties of a known class of physically existing universes."*
> *Op. Cit.*

I have to emphasize how important these conditions are; they imply that understanding how the universe began is a matter not only for physics, but for philosophy and theology.

2.3 TIME ISSUES

Before discussing the models cosmologists have proposed for creation of the universe, I should briefly comment about the forms "time" might take in a cosmological description of the evolution of the universe, and whether "*creatio ex nihilo*" requires a beginning, an instant in time about which we can say this is time t=0, and there is no time t<0.

Our ordinary understanding of a universal time is confounded by the prescriptions in special and general relativity. (See Science Background, Section 3.) Special relativity requires that the time of an event time depends on the frames of reference of the object and observer; thus, an event A might be in the future for observer X in one frame of reference and in the

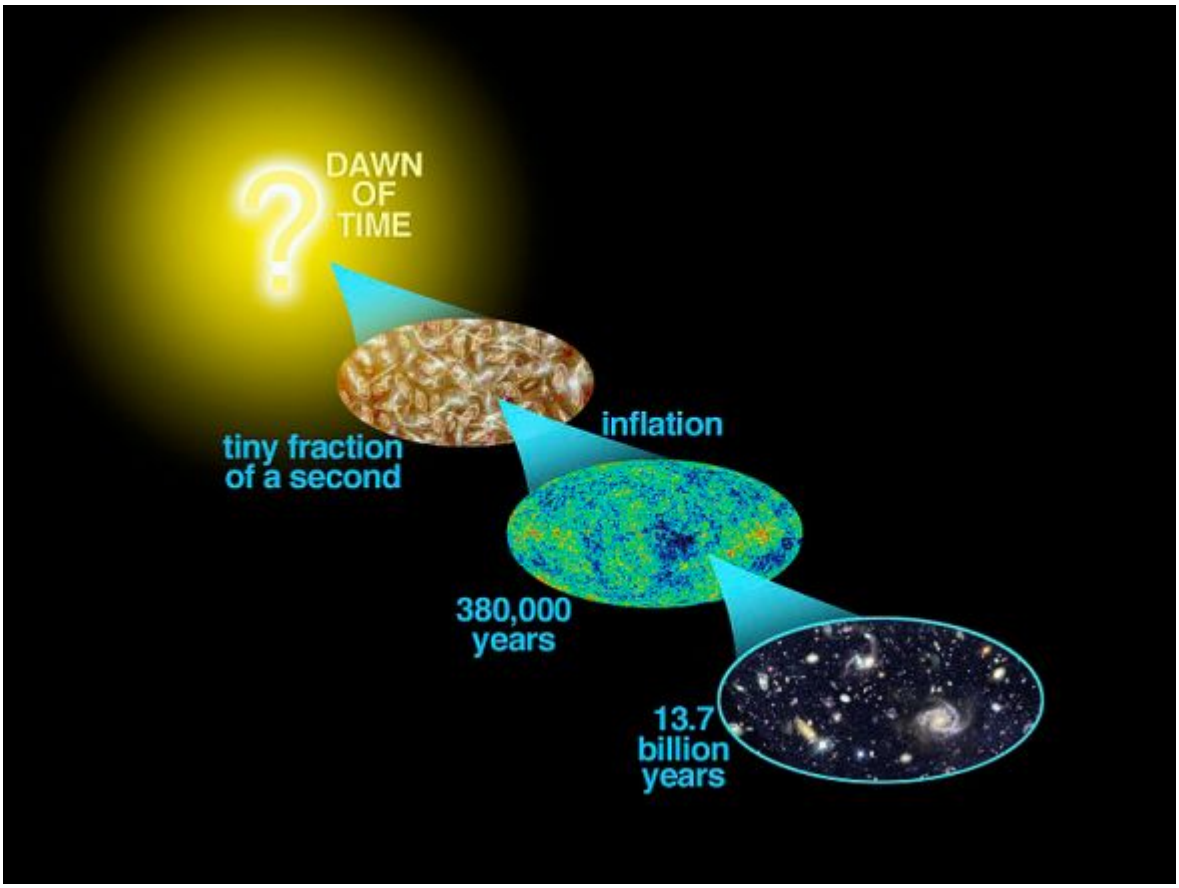
past for observer Y in a different frame.

A further complication is found in general relativity, gravitational time dilation. To take these complications into account, spacetime is divided into space-like slices, for which some proper time, t, is assumed to be the same everywhere in the slice. This proper time can be replaced by another parameter (varying with time) such as R (the radius of the universe) which is constant in a slice.
The uncertainty principle of quantum mechanics introduces still another complication: uncertainty in time multiplied by uncertainty in energy is greater than h/(2pi) (h is Planck's constant). This means that there would have to be an infinite uncertainty in the energy of the system in order to specify exactly the beginning time, t=0.

2.4 COSMOLOGY—EVOLUTION OF THE UNIVERSE

The image below gives a condensed pictorial view of the evolution of the universe: the beginning with the question mark, inferred from a

solution of Einstein's General Relativity equations—a singularity, infinity—at t=0; radiation and matter not uncoupled until 380,000 years after this; the early image represent the very high energy mix of quarks and



Chronology of the Universe.(Note: the time scale is expanded toward the beginning.)
From Wikimedia Commons

photons before fundamental particles—electrons and protons—were formed; the 380,000 year image is of the COBE microwave background radiation, the burnt embers of the Big Bang energy; the present day

image
represent
s the
universe
as it is
now,
galaxies
and all.

Since what went on before the 380,000 year time horizon can be only be inferred, not measured, cosmologists rely on the Standard Model to understand how the fundamental particles were formed from the initial high energy mix. A detailed account is given in this article. The article also discusses the formation of stars, galaxies and the solar system.

2.5 COSMOLOGY MODELS—THE BIG BANG

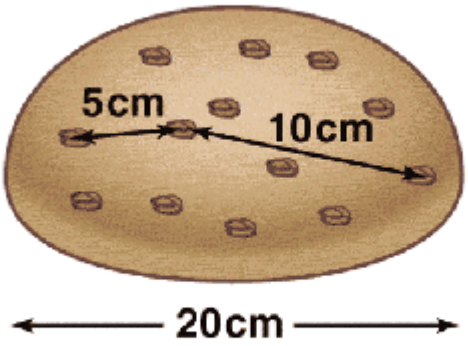
"Big Bang" is now a well-known term—how did it come about? Einstein saw that a solution to his General Relativity field equations could give a singularity at t=0, that is, a universe of zero size, with the universe expanding as time increased. In order to get a static, non-time dependent universe (which seemed to be the case in 1917 when the theory was published) he introduced a "fudge factor", the "cosmological constant" to cancel out the effects of gravity. Einstein later called this "the biggest mistake of my life"

The Galactic Red Shift —>An Expanding Universe

Edwin Hubble in the 1920s showed by his observation of galactic red shifts that the velocity of galaxies moving away from us was proportional to their distance from us.

This leads to the idea of an expanding universe, an expansion of space-time. A good analogy of this is given in the illustration on the right: imagine you're sitting on a raisin in a very large loaf of raisin-bread, which is expanding as it's being baked; you see each raisin moving away from you, and the further a raisin is from you, the faster it seems to be moving away. And it wouldn't matter which raisin you would be sitting on—the picture would be the same.

In 1927 the Belgian priest, Fr. Georges LeMaitre proposed such an expanding universe as an explanation of the observed galactic red shifts; he justified this explanation by his solution of the Einstein field equations to yield a universe size increasing with the time. By 1931 LeMaitre's theory had gained acceptance; he modified it to propose a single point at the origin, "The Primordial Atom".



Model of Expanding Universe as a Rising Raisin Bread Loaf: every raising gets further apart as the bread expands.
From Wikimedia Commons.

The term “Big Bang” was given to this theory by Fred Hoyle in 1950, who advocated a steady-state universe, in which matter was continually created as the universe expanded. Although Hoyle may have used “Big Bang” as a joke, his steady-state theory was contradicted by astronomical findings that confirmed the Big Bang notion.

First, quasars were not found at far distances (early time for the universe), which contradicted a universe the same at all times;
Second, the cosmic microwave background radiation (COBE), the cooled down embers of a very hot universe at beginning times, was detected by Penzias and Wilson in 1965.
Third, the absence of heavy elements in stars formed at early stages of the universe (at far distances): there would not be time for supernovae to be formed, to disperse elements heavier than helium (such as carbon) into the universe.

Embers of the Big Bang—the Cosmic Microwave Background Radiation (CMBR)

And now a few words about crucial evidence for a “Big Bang” event, the cosmic microwave background radiation (CMBR). In 1965 two Bell Laboratory physicists, Arno Penzias and Robert Wilson, trying to explain a noise source in their microwave antenna, found that it was coming from all directions in the sky. Consulting with Robert Dicke’s group at nearby Princeton, they learned that it was the burnt out, cooled remains of the Big Bang. Here’s a simple-minded explanation (see Science Background, the Quantum Catholic, for a more complete description, or here): a heated object will radiate energy to cool off; the hotter the object, the bluer the radiation (shorter wave-length); as the object cools, the radiated energy

becomes more red (longer wavelength). The very long COBE wavelength is in the microwave region of the spectrum and corresponds to a temperature of about 3.5 K (close to absolute zero), the cooled down embers of the Big Bang[1]

Shown below is an image depicting the history of how this microwave background radiation was measured more and more accurately.

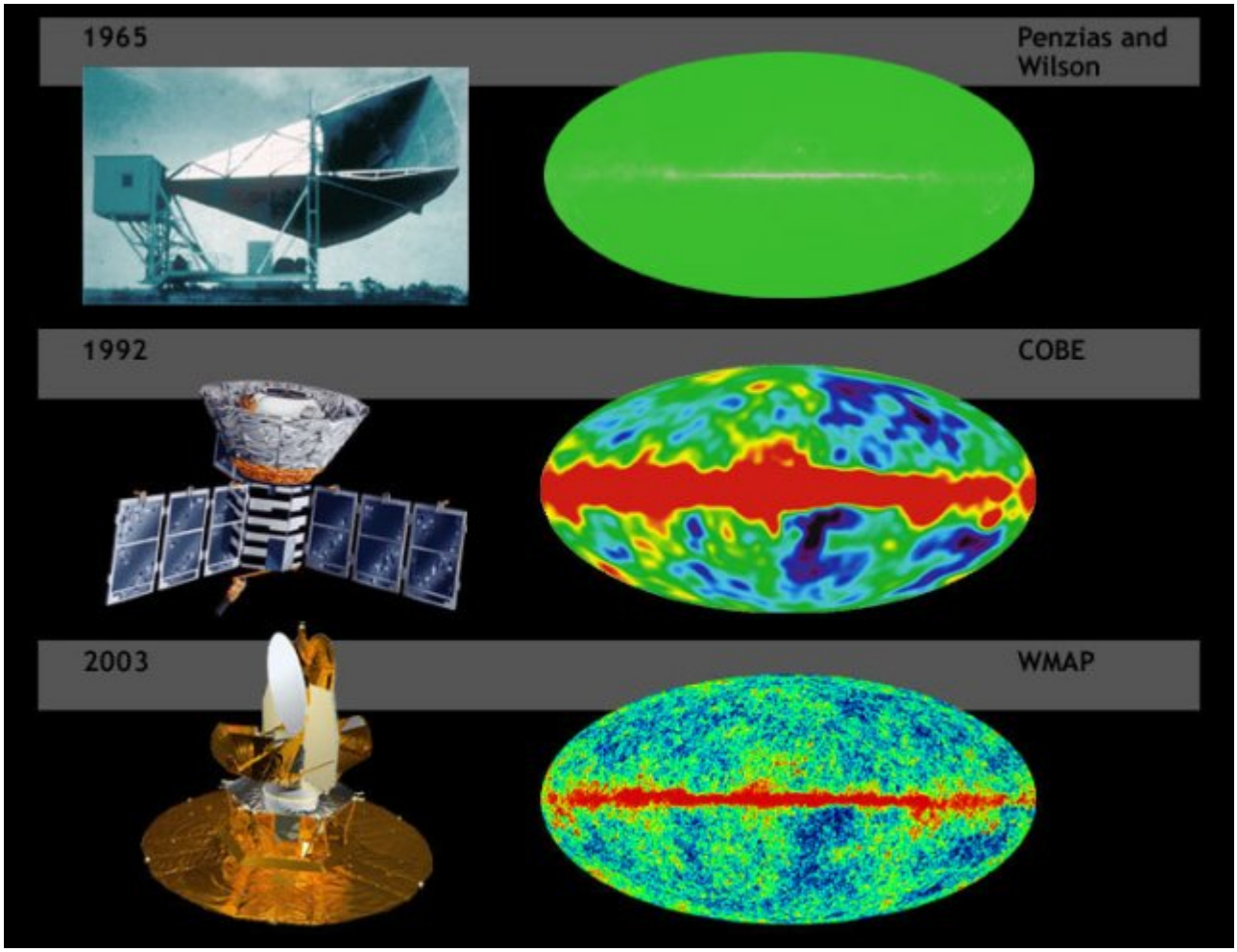


Diagram of the history of the Cosmic Microwave Background Radiation (CMBR), showing the improvement of CMBR resolution over the years. The CMBR, a faint microwave radiation permeating all space that can be detected by radio telescopes, is remnant radiation left from the Big Bang, and one of the few sources of information on conditions in the early universe.

(top left) Penzias and Wilson microwave horn antenna at Bell Labs, Murray Hill, NJ – 1965

Penzias and Wilson discovered the CMBR from the Big Bang and were awarded the 1978 Nobel Prize in physics for their work.
(top right) Simulation of the sky viewed by Penzias and Wilson's microwave receiver – 1965
(middle left) COBE spacecraft (painting) – The Cosmic Background Explorer (COBE), launched in 1989, first discovered patterns in the CMBR, and Mather and Smoot were awarded the 2006 Nobel Prize for that work.
(middle right) COBE's map of early universe- 1992
(bottom left) WMAP spacecraft (computer rendering) – The Wilkinson Microwave Anisotropy Probe (WMAP), launched in 2001 and active until 2010, mapped the patterns with much higher resolution to unveil new information about the history and fate of the universe. Bennet, Page, and Spergel won the 2010 Shaw Prize for their WMAP work.
(bottom right) Simulated WMAP view of early universe

from Wikimedia Commons

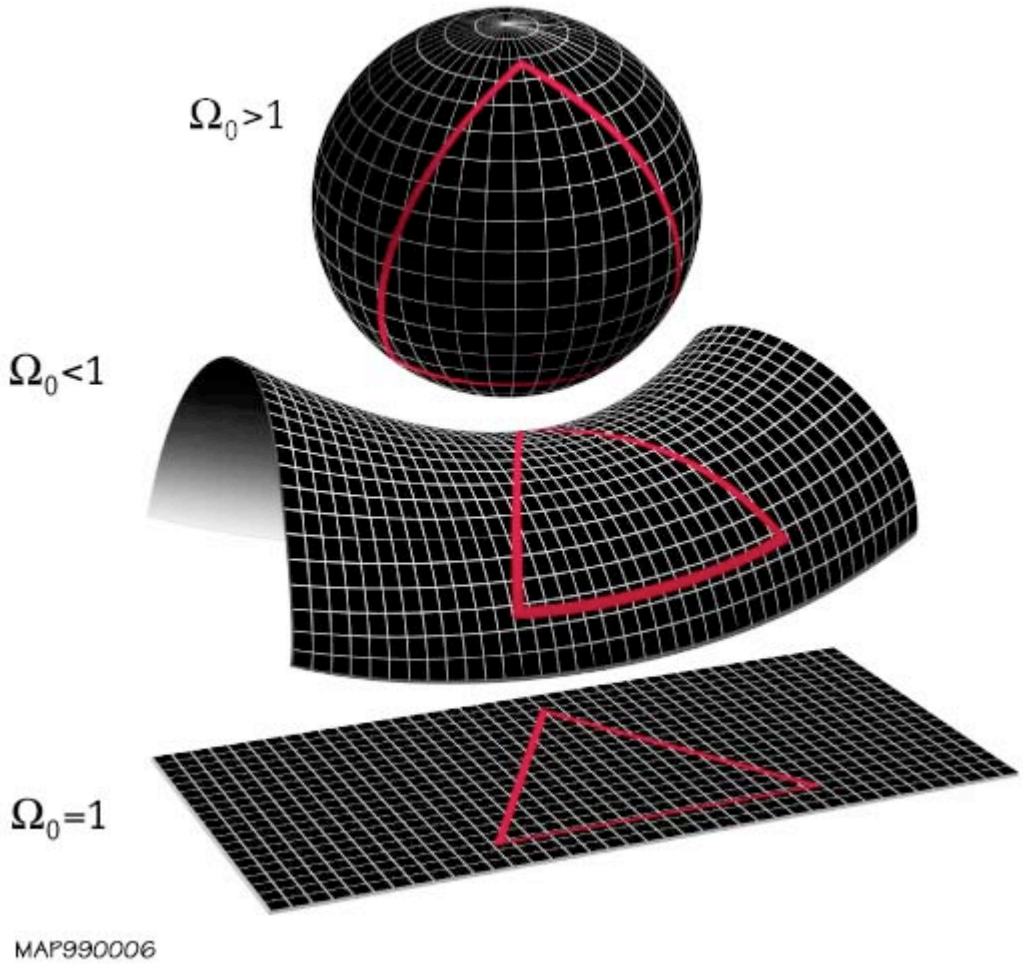
Patterns in the apparently random noise of the CBRM give information about conditions in the early universe. Reconciling these conditions and the distance horizon limitation with an unmodified Big Bang explanation, presents problems, discussed below.

2.6 PROBLEMS WITH AN UNMODIFIED BIG BANG EXPLANATION

Here are the things that an unmodified Big Bang theory does not explain.

The Distance Horizon Problem—regions that are very far apart in the microwave background radiation are at essentially the same temperature. However, according to the distance horizon limitation mentioned in Section 4.2.1, the early universe was larger than the horizon distance d (speed of light times age of the universe), so here's the question: how was a causal relation retained between different parts of the early universe to give the same temperatures and densities (approximately) for parts of the universe that were not causally connected?
The Flatness Problem—according to general relativity theory, space-time will have curvature (positive, like a sphere, negative like a saddle, or flat) depending on the density of matter and energy. It turns out that space-time is essentially flat, which requires very special

and unlikely initial conditions, that the critical density be almost exactly 1.



Space Curvature Diagram (three dimensional perspective):

bottom-flat
middle-negative curvature
top-positive curvature

from Wikimedia Commons

The Magnetic Monopole Problem—if you could break a bar magnet in half such that the north pole would exist by itself as would the south pole, you would have a pair of magnetic

monopoles; this isn't possible—if you break the magnet in half you get two smaller magnets, each with a north and south pole. Nevertheless, extensions of fundamental particle theory (GUT—Grand Unified Theory) and other theories predict that magnetic monopoles should exist, even though they have not yet been observed, despite intensive experimental efforts to do so.

2.7 COSMOLOGY MODELS—AN INFLATIONARY UNIVERSE"

The problems posed with the Big Bang model have been largely dealt with by the Inflationary Universe model. Guth and other have proposed that very early in the evolution of the universe (10 ^-35 s) a symmetry breaking event occurred: the strong nuclear force broke away from weak nuclear and electromagnetic force and thereby caused a transition that filled the universe with vacuum energy. This "vacuum energy" effectively acted as a strongly repulsive force that caused the universe to expand from a size roughly 100 billion times smaller than a proton to a few cm in just 10^-32 s. (This short time was still 1000 times longer than the age of the universe when the expansion began.)

The expansion was practically instantaneous and therefore regions which appear far apart now were within the distance horizon when the expansion began. Moreover, any space-time curvature that was present before the inflationary expansion would be "flattened out" by the speed and extent of the expansion. Finally, this rapid expansion would decrease the concentration of monopoles by a large factor, making them extremely sparse and undetectable.

Although the Inflationary Universe model takes care of the Big Bang deficiencies, it is not universally accepted by cosmologists; it lacks empirical verification (other than explaining qualitatively observed cosmological features) and the underlying theoretical basis—the phase transition yielding vacuum energy—is unobservable. See the Wikipedia article on inflation and scan down to "Criticisms"

2.8 COSMOLOGY MODELS—QUANTUM METAPHYSICS

> *"Perhaps the best argument in favour of the thesis that the Big Bang supports theism is the obvious unease with which it is greeted by some atheistic physicists. At times this has led to scientific ideas, such as continuous creation or an oscillating universe, being advanced with a tenacity which so exceeds their intrinsic worth that* ***one can only suspect the operation of psychological forces lying very much deeper than the usual desire of a theorist to support his/her theory*** [emphasis added].
> —Chris Isham, "Creation of the Universe as Quantum Process" in "Physics, Philosophy and Theology–A Common Quest for Understanding."

One major problem in devising a model for the creation of the universe is that at times near the origin (t=0), where distances are very small, general relativity breaks down as an applicable theory, and quantum mechanics must take over. However, there is no theory of quantum gravity that can be used for these conditions.

Accordingly, as the quote above states, some physicists propose models to avoid the theistic implications of the Big Bang model: theories that are not and cannot be supported by empirical evidence. Such models more properly belong in the domain of metaphysics than science. I've discussed these models at some length in a blog post, "Mathematical Metaphysics–Quantum Mechanical Models for the Early Universe."

Here is one basic philosophic problem that comes up if quantum mechanics is to be applied to the universe as a whole: in quantum mechanics a measurement picks out one of several component states that comprise the state-function. In other words a measurement, and thus an observer to make the measurement, is required. The Russian mathematician, Andrej Grib, has put this very well:

> "*In the end the final observer is just the abstract ego of the observer–the one who is the subject of observation* [i.e. the one who observes]...*So it is this abstract ego which is responsible for the collapse of the wave function. This is a strong form of the subjective interpretation of quantum mechanics."*
> —Andrej Grib, 'Quantum Cosmology: Observer Logic' in Quantum Cosmology and the Laws of Nature–Perspectives on Divine Action, p 169

So then, who is to be the final observer for the universe, taken as a whole—God? That's a position I'd be happy to accept, but one that many physicists would not.

2.9 SOME QUANTUM COSMOLOGY MODELS

That being said, the following quantum mechanical models have been proposed for the origin of the universe, (the list is not exhaustive, and only general comments on each will be given; for more information please see the linked articles):

Quantum fluctuations in the vacuum (Tryon, 1979);
The Hartle-Hawking "No Boundary" Universe (Hartle, Hawking, 1981);
Chaotic Inflation (Linde, 1986)
The Participatory Universe (Wheeler, 1990)

Note that in none of these (except possibly 2 or 4) was the creation "*ex nihilo*"; for 1, the vacuum preexisted; for 3, previous universes from which a "bubble" universe emerged by means of inflation.

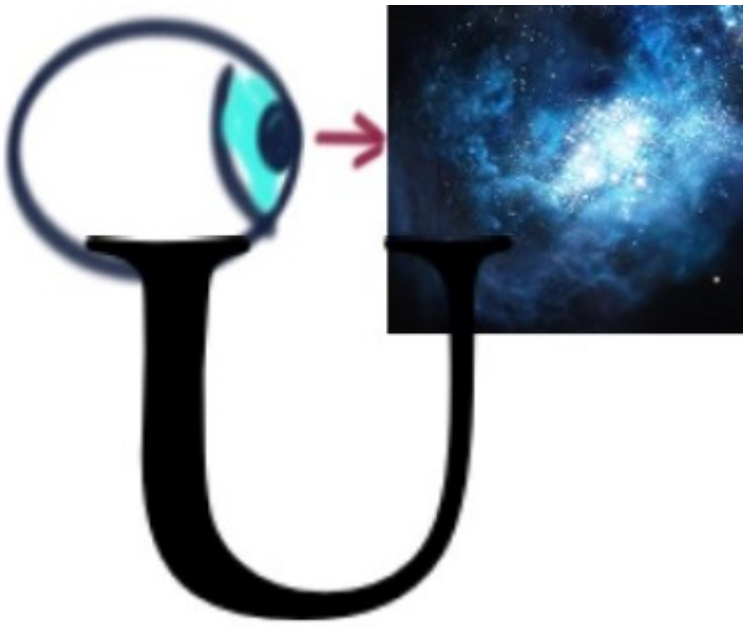
Model 1, Quantum fluctuations in the vacuum, is deficient in the following respect. There is nothing in this model to specify a unique time at which the fluctuations to enable creation should occur. Accordingly there might be creation of many universes, interacting with each other, but such has not been observed. And to emphasize again, a vacuum is not "nothing"…there is space, virtual particles, annhilation and creation operators, occupied

zero-point energy levels from which the fluctuations occur.

Model 2, the Hartle-Hawking model, modifies the Schrodinger equation for the universe to give a solution without a singularity at the origin (time, t=0). The "time" variable t is replaced by it, where i is the "imaginary" square root of -1. The time variable thus becomes space-like, rather than time-like at very early values, and the space-like variable gradually becomes a time-like variable as the value of t increases. An exact value for the time of origin becomes undefined (where does the earth start, at the South pole?).

This mathematical tinkering has no empirical significance, other than it removes the singularity and thus an occasion for Creation. The justification is "esthetic", that is to say, the replacement of the time variable t by ti (i is the square root of -1) removes the singularity at t=0. It is said that the coordinate ti "gradually changes" from space-like to t, time-like…how is the gradual change effected? Is the universe a fraction f with ti and a fraction 1-f with t? I have never seen this explained. Nevertheless, a number of theologians (see below) think the model may have theological import.

Model 3, Linde's Bubble Universes, is hypothesized as a consequence of chaotic inflation. Some recent preliminary results from B-mode measurements of the Cosmic Background radiation support the existence of inflation (but not necessarily chaotic inflation). By definition, other universes are distinct from our universe. Accordingly there is no communication, no physical interaction that can occur between such hypothesized other universes and ours. Thus, the existence of such bubble universes cannot be empirically verified, so the question of whether they exist lies in the domain of metaphysics, not science.



Icon for Wheeler's Participatory Universe: We create the universe, even in the past, by observing it

Model 4, the Participatory Universe of John Wheeler, would have observers create events in the distance past. For example, an astronomer observing a galaxy some 8 billion light years distant has, in essence, created that galaxy. The question is, what about times where there could be no human or other sentient observers? As mentioned above, do we call upon God as the primary observer? (See also references in my post "Quantum Divine Action via God, the Berkeleyan Observer..".)

A fundamental, but implicit assumption for the Participatory Universe model, stems from the quantum mechanics interpretation first set forth by Von Neumann, London and Wigner: since measurement is done by an observer, the final step in the measurement process must be awareness of the measurement result by the consciousness of the observer. Accordingly the conscious observer must be an essential part of the

measurement process and thus, for the de facto existence of that which is measured.

None of these models can be confirmed or denied by measurements. Thus they are outside the realm of science, but properly belong to the domain of mathematical metaphysics (my take). As in the Hartle-Hawking model, assumptions are made to remove the singularity at t=0, R=0. Such models without a singularity are to many physicists more aesthetically pleasing than those with, because to them the absence of a singularity is consistent with the absence of a Creator.[2]

2.10 NOTES

[1]If you have a television with an antenna source you can detect this CBMR yourself. Tune to a channel where no TV station is broadcasting and turn down the gain as low as possible. The "snow" you see on the screen is the CBMR. (See here.)

[2]I have not discussed the "Cyclic Conformal Cosmology" model proposed by Roger Penrose; the empirical evidence brought forth for its support is dubious. See this blog post. "Worlds without End,"

SECTION 3: Theology Intersects Cosmology

3.1 CONTEMPORARY THEOLOGICAL POSITIONS

Contemporary theologians (including physicists and philosophers who put forth theological arguments) for the most part react in their theological stance to some particular cosmological theory about the origin (or non-origin) of the universe. I'll focus on the Big Bang (t=0) hypothesis and the Hartle-Hawking model (no beginning). The list of theologians cited is not exhaustive but drawn mainly from various articles in Quantum Cosmology and the Laws of

Nature.

Also, if we ask whether the universe had a beginning or existed eternally, and we believe in God as Creator, then there is another hidden question (which I'll not discuss). If God is eternal and timeless, how does God act in a world that progresses in time; in other words, what can we say about the temporality of God? This question is addressed in "Quantum Cosmology and the Laws of Nature" by several of the authors.

Here are the several positions taken on the intersection of theology and cosmology, with proponents listed:

The Big Bang hypothesis confirms creatio ex nihilo by showing the Universe began at a definite time (t=0): William L. Craig, Ted Peters;
The Big Bang hypothesis might be true, but it is also possible that the Universe could be eternal, with *creatio continua* by God: George F.R. Ellis, Richard Swinburne, Keith Ward;
The Big Bang hypothesis and cosmology, for one reason or another, are not all that relevant to theological ideas about creation: William Alston, Ian Barbour (in Robert John Russell's article), Karl Barth, Wilhelm Drees, Arthur Peacocke (in Robert John Russell's article), William Stoeger;
The Hartle-Hawking model offers theologic possibilities (see **Summary** below): Wilhelm Drees, Chris Isham, Robert John Russell.

3.2 DOES AN ETERNAL UNIVERSE DENY CATHOLIC DOGMA?

Catholic theologians breathed a huge sigh of relief (presumably) when Abbe LeMaitre's primordial atom thesis ("The Big Bang") was confirmed by galactic red shift measurements and became scientifically acceptable. Indeed, Pope Pius XII argued that this scientific theory validated Catholic teaching. LeMaitre himself was not inclined to such a strong view; rather he disassociated the science from theology with this statement:

> *"As far as I can see, such a theory remains entirely outside any metaphysical or religious question. It leaves the materialist free to deny any transcendental Being... For the believer, it removes any attempt at familiarity with God... It is consonant with Isaiah speaking of the hidden God, hidden even in the beginning of the universe,"*
> —Abbe Georges LeMaitre, S.J., "The Primeval Atom Hypothesis and the Problem of Clusters of Galaxies"

St. Thomas Aquinas argued that reason could not prove that the universe began at some instant of time, that is to say, one could not prove that the universe was not eternal; although reason could prove a First Cause–God–for the origin of the universe (since God is eternal, the universe could be created by Him as an eternal entity). It is an article of faith to believe in a universe created at some beginning of time. The Big Bang notion is consistent with a belief at a time origin, but does not prove it. If we believe God is the author of all, a First Cause, then He can create an infinity of universes, as in the bubble universe hypothesis of Lande or in the parallel worlds given by some interpretations of quantum theory. Economy of effort is not required of God.

Accordingly, faith trumps science in this. Revelation gives us reason to believe, and despite the efforts of non-believing scientists to trash a strong confirmation of God's creative power, the Big Bang, we still can remain confident in that power as the source of being. Such a position is not "fideism", an adherence to Catholic teaching in the face of empirical evidence to the contrary. It is a recognition of the limits of science, and the authority of theology and philosophy in final verdicts on truth.

3.3 SUMMARY

The science/physics of creation is not all that settled with respect to *creatio ex nihilo*, either as a beginning in/of time or as a component of *creatio continua*. In terms of treatments of General Relativity (GR), the FLRW model yield a singularity at R=0 (t=0), the Penrose-

Hawking singularity theorem showed that singularities are generally found as solutions of the GR field equations, and the Borde-Guth-Velenkin theorem demonstrates for classical relativity, if the Universe has an average positive expansion, it has to have a beginning. But GR fails in the domain near R=0, t=0, such that quantum gravity theory would have to be invoked–but there is no theory of quantum gravity.

I emphasize again that none of the theories which have a purported quantum mechanical base have any empirical support. In the Hartle-Hawking model the introduction of the imaginary, ti, to replace the time variable, t, in the general equation for the universe wave-function (if such were to exist) is arbitrary, done only for aesthetic reasons (to remove a singularity). Robert J. Russell and Chris Isham claim that the Hartle-Hawking model is consistent with *creatio continua*, with nothing at the boundary of the closed universe. Robert J. Russell also argues that a finite universe is consistent with Creation theology, even if there is no definite beginning (as in Hawking's argument that the south (or north) pole is not the beginning of the earth.) I don't understand that argument. George F.R. Ellis points out that Hawking's argument that the universe is preexistent, caused by nothing other than gravity, is not correct since the Hartle-Hawking model includes

> *"(pre-existent* [sic] *Hilbert spaces, quantum operators, Hamiltonians,etc.) whose existence is, if anything, more mysterious than that of the universe itself."*
> —Quoted by Robert J. Russell in "Quantum Cosmology."

It seems to me that the science/physics/cosmology of creation is not altogether settled, but does show empirical evidence for a creation event, a "Big Bang": the red shift showing a universe expansion; the microwave background radiation showing the burnt embers of a very high energy initial epoch; the hydrogen/helium ratio and lack of carbon-12 in ancient (far distant) stars; the more recent B-mode COBE results showing effects of early inflation.

Theologians seem to be wary about falling into a “God of the Gaps pit, using the deity to explain what science cannot. That fear, I believe, is unfounded. At some point a God of the Gaps argument has to be introduced, as a prime mover, to explain why there is science illumined by mathematical theory. There are theological and philosophical issues that are not yet (and may never be) settled: What is time? Does God change with time, or is He eternally fixed and, if so, how does He act in time?

I’m not sure whether the theologians and scientists have improved very much, if at all, on the insights of Sts. Augustine and Aquinas. Faith and revelation give insight. The arguments of the Catechism are as forceful now as they were when first propounded by Theophilus of Antioch. And finally, we should keep in mind the aphorism of St. Thomas Aquinas: “*It is not that God is irrational but that our understanding is limited.”*
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