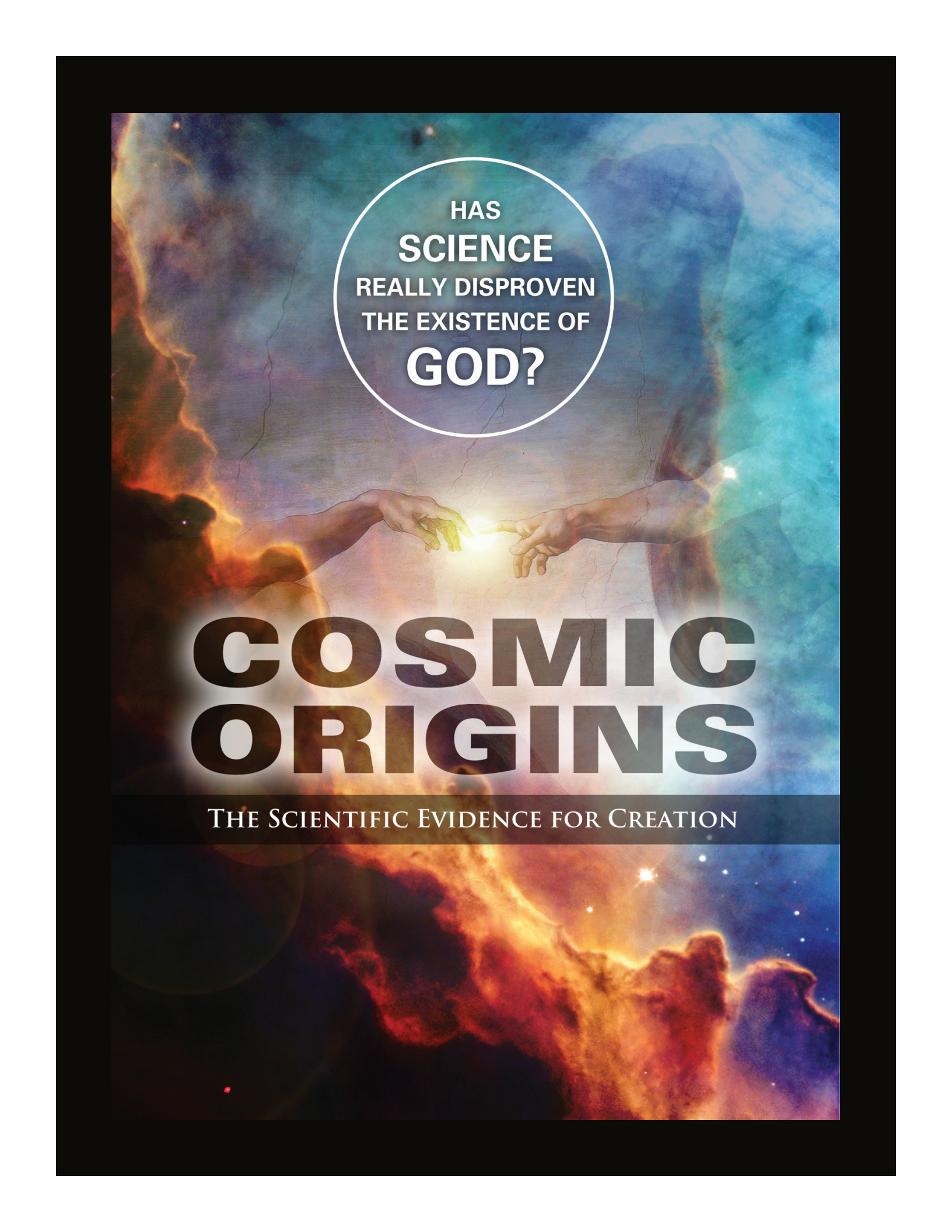




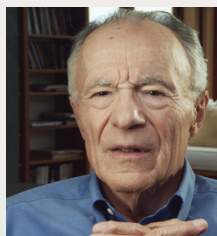
HAS
SCIENCE
REALLY DISPROVEN
THE EXISTENCE OF
GOD?

COSMIC ORIGINS

THE SCIENTIFIC EVIDENCE FOR CREATION

Outline of Cosmic Origins

- I. Introductory question: Where did we come from?
- II. The Big Bang as the Best Scientific Explanation for the Beginning of the Cosmos
- III. Theories about the Universe Before the Big Bang
 - Bouncing Universe Theory
 - Eternal Inflation Theory
 - Ekpyrotic Theory
 - Multiverse Theory
- IV. Random Existence vs. a Finely-Tuned Cosmos
- V. The Metaphysical Perspective: From Nothing Nothing Comes
- VI. A Grand Design? Science, Faith, and Purpose
- VII. What do you think?



Discussion Questions after viewing Cosmic Origins:

1. Does the latest thinking in science tell us about the cosmos and its origin?
2. Since no human being was around to witness the beginning of the universe, how do scientists know anything about it?
3. What evidence do scientists use to support the idea that the universe had a beginning?
4. What other theories do scientists present to suggest that something existed before the Big Bang? What are the limits of such theories?
5. It seems as if there are three possibilities regarding the conditions for the universe to sustain life: (1) these conditions are the result of a random accident (chance); (2) the conditions just had to exist somewhere (necessity); or (3) the conditions were deliberately established by a powerful, intelligent agent (purpose). Which of the three possibilities makes the most sense to you?
6. What do you think of the idea that science can't explain everything? Do you agree or disagree with the idea that the limits of science don't correspond to the limits of what can be known? Why?
7. Does the fact that the more we explore the universe the more intelligible it is discovered to be, suggest anything to you about whether reality is ultimately meaningful? About whether there is an Intelligence Agent or Supreme Being behind the universe?
8. Sometimes people speak of "inventing meaning" or "giving purpose" to existence. Can "meaning" be "invented"? Can purpose be "given" to existence? Or are meaning and purpose things that must be discovered rather than created? Explain.
9. In order to make sense, do ideas such as right and wrong, justice and compassion, depend on there being meaning or purpose to the universe? What does your answer suggest about whether God exists?

God and the Big Bang

by Mark Brumley

“In the beginning God created the heavens and the earth,” declares Genesis 1:1. Many people read that statement as a description of what scientists today call “the Big Bang”. But is it? Even certain scientists talk as if it were. The late astronomer Robert Jastrow, in a popular book called *God and the Astronomers*, penned lines now famous in discussions of the Big Bang and God: “For the scientist who has lived by his faith in the power of reason, the story ends like a bad dream. He has scaled the mountains of ignorance; he is about to conquer the highest peak; as he pulls himself over the final rock, he is greeted by a band of theologians who have been sitting there for centuries”.

In other words, when scientists go back to the Big Bang, they wind up at precisely the same spot where theologians have been all along. But are theologians and the scientists sitting at the same spot, when it comes to the origin of the universe? Does the Big Bang point to the creation of the universe by God from nothing?

In the film *Cosmic Origins*, scientists, philosophers, and theologians consider the evidence for the Big Bang, whether it represents the beginning of the universe, and, if so, whether it implies a Creator. Many of the film’s participants regard the Big Bang as pointing to a beginning of the universe. But they’re tentative about the matter, recognizing that science is open-ended; the standard scientific model today may be surpassed tomorrow by a different theory, one that doesn’t imply or suggest a beginning of the universe.

Creation and the Beginning

Some people—both believers and non-believers—may be surprised to learn that the debate over whether the universe began isn’t new. It was a lively issue in the ancient world. Many ancient pagan thinkers believed the universe existed from all eternity. Something, they argued, can’t come from nothing. If something—the universe—exists now, then something must always have existed.

Judaism and Christianity, on the other hand, have generally rejected the idea of an eternal cosmos, whether as it is now or in some other form. Ancient Jews and Christians generally regarded Genesis 1:1 as meaning God caused the universe to begin to exist. Jewish and Christian thinkers agreed with pagan philosophers that something can’t come from nothing. But, they insisted, *God* created the world *ex nihilo*—from nothing. He brought the universe into existence, so the “something” of the universe came from the Something (Someone) who is God, even though God didn’t use anything to create the world.

To be sure, even Jewish and Christian thinkers were not, initially, as clear about what it means to say God created the world from nothing as later theologians would be. “Nothing”, it turns out, is a difficult idea to wrap one’s mind around. Still, Jews and Christians were convinced that God was all-powerful and sovereign. As such, he could not have needed to rely on something else in order to bring the world into being. God’s being the

only source for the whole of the universe is, in essence, what it means to say he created the world from nothing.

A straightforward reading of Genesis 1:1 seems to show not only that God created the world from nothing, i.e., that God alone is the reason why the cosmos exists, but that he created in such a way that the universe had a beginning: “In the *beginning*, God created the heavens and the earth ...” (emphasis added). It may seem obvious that if God created the world from nothing that the world had a beginning. Unfortunately, the matter is not so simple.

In the Middle Ages, philosophers and theologians debated whether the world had a beginning or had existed from eternity, and whether we could know, one way or the other, from reason alone. The Fourth Lateran Council of the Catholic Church, in 1215, taught that God, “at the beginning of time”, created the universe “from nothing”. However, it left open the question of whether reason alone could know this truth or whether it requires faith.

The great thirteenth-century medieval philosopher St. Thomas Aquinas insisted that reason by itself can’t settle the issue, even though he also believed as a matter of faith that the universe had a beginning. St. Thomas held that we can know from reason alone that God *originated* the universe, but not that he did so in a way that required the universe to have a *beginning*. How, one might ask, could the universe have an origin without having a beginning?

Consider an eternally burning lamp from which streams forth rays of light. The *origin* of the light rays is the lamp, yet because the lamp is said to have been eternally burning, there is no *beginning* to the light’s streaming forth. By analogy, we might think of God as being like an eternal lamp and the universe as being like the light eternally coming from it. Thus, even if the universe had *always* existed, it still required God as the *cause of its having always existed* and the *cause of its continuing* to exist for as long as it exists. In this way, Aquinas developed a distinction between the universe having an *origin* and its having a *beginning*.

Aquinas regarded God as the Creator of the universe but he used the term *creation* differently, depending on whether he was speaking as a philosopher, basing his arguments on reason alone, or as a theologian, using reason but appealing to divine revelation as his starting point. As a philosopher, Aquinas argued that “creation” refers to the world’s existing as a result of God’s causing it to be, whether or not God had caused it always to be.

As a theologian, Aquinas held that “creation” refers to God bringing the world into being in such a way that it had a beginning.

What is the difference between God creating the world in the *philosophical* sense of *originating* it and God creating the world in the *theological* sense of *beginning* it? A tempting but false answer is to suppose that at some point in time “eternity past” God decided to bring the world into being and since then the world has existed. Notice that this idea posits a

time before God created the world and a *time after* he did so. The trouble with this view, according to Aquinas (and Augustine, whom he follows on the point), time is also a creation of God, as everything else in the universe is.

In Book Eleven of his *Confessions*, the fifth-century saint, theologian, and bishop Augustine of Hippo addressed the question “What was God doing before he made heaven and earth?” In other words, what was he doing before he created the world? Augustine refused to give the glib, evasive answer often wrongly attributed to him: God was preparing hell for those who ask such questions. Instead, Augustine argues that God is beyond the limitations of time and has no “before”. Time exists as a part of the world God created. Apart from creation, time does not exist and therefore it is not meaningful to speak of what happened “before” creation. Time began with the creation of the world.

Aquinas held the same position as Augustine. It is not possible, according to Aquinas, to speak meaningfully about God creating the world at some point in time. There is no period “before” the world began. Yet if this is so, what does it mean to talk about a *beginning* of the world? In our everyday experience, there is a “before” something begins and an “after”. How could the universe have a beginning without a “before”?

One way to approach the question is to think about what it would mean if the universe had no beginning. If God has always been originating the universe—always causing it to be, so that it had no beginning—then the history of the universe would be infinite. The number of events making up the universe’s history would be limitless. On the other hand, if the universe had a beginning, then its history would be limited. However large the total number of events in the universe’s history would be, it would be finite.

To say that the universe had a beginning, then, doesn’t mean there was a *time* when it didn’t exist and God then brought it into being—that would amount to a time before time, which makes no sense. That the universe had a beginning means the history of the universe is finite; a limited number of events have occurred.

So we don’t leave the wrong impression we should underscore that Aquinas did not think the world existed from eternity. He believed it had a beginning, as we have said. But he believed it on the basis of God’s revelation—the Bible as interpreted by the Church—not on the basis of what reason could tell us apart from revelation. As we have seen, Aquinas thought reason couldn’t resolve the matter, either way.

Another Perspective

Not every medieval philosopher and theologian agreed with St. Thomas Aquinas that the beginning of the universe couldn’t be demonstrated. Various thinkers made their case for a beginning, although they did not argue as many modern thinkers do, based on scientific ideas such as the Big Bang. The medieval argument for a beginning held that it was impossible for the universe to have always existed. Not even God, it was claimed, could have made the universe eternal.

Usually, the argument was part of a larger argument for God as the cause of the universe's beginning. One form of the argument came from Islamic philosophers and some Christian thinkers (St. Bonaventure, for one). The argument is called the *Kalaam* argument. One premise of the argument is that the world must have had a beginning, otherwise an infinite number of moments would have transpired. An infinite number of moments, so it was argued, is an actual infinity, and an actual infinity is impossible—it can't exist in reality. (We can't go into here why this was thought to be so.) Therefore, the universe cannot always have existed; it must have had a beginning.

As you might expect, not everyone agreed that an infinite number of moments amounts to an actual infinity or that an actual infinity is impossible, even for God. Even today, philosophers and theologians debate the issue. What's new to the modern discussion is that science seems to have something to say about whether the universe had a beginning. Does it? And what, if anything, do scientific ideas about the cosmos tell us about God?

The Universe, Science, and God

Modern science developed in a Christian context, as historian of science Father Stanley Jaki and others have shown. Many early scientists were devout believers—people such as Galileo, Newton, and Kepler, to name a few. But for a variety of reasons having to do with the secularization of Western culture, many scientists in the last two centuries or so came to reject a Christian worldview and adopted a kind of materialism as their basic philosophy. For them, the idea that the universe had a beginning was unacceptable because a beginning implied the existence of the Creator. They presupposed a more or less static, eternal universe, which eliminated the need for God—or so they thought.

Not all scientists who adopted the idea of an eternal universe were atheists or agnostics. Some were pantheists. Pantheism holds that God and the universe are more or less the same thing: God is the cosmos and the cosmos is God. Some scientists thought of God as an impersonal Supreme Spirit or Mind *behind* the universe, the one responsible for the order of the cosmos yet not someone who *created* it at some point in the past; the universe was eternal as God was thought to be. Such was Albert Einstein's view of the universe and God.

In the early 20th century, Einstein proposed his General Theory of Relativity. Soon Einstein and others applied it to questions of cosmology. Several scientists, including the Belgian Catholic priest George Lemaitre, insisted that according to General Relativity, the universe should not be static—it should either be collapsing or expanding. Initially, Einstein rejected the idea, based largely on his own philosophical preferences rather than evidence. However, after the astronomer Edwin Hubble showed in the 1920s the existence of other galaxies and evidence emerged that these galaxies were receding from the earth and each other, it became clear that the universe was not static; it was expanding.

The expanding universe supported the idea proposed by Lemaitre that the history of the universe could be traced back to an initial state, a kind of "primordial atom". The

“decay” of this “atom” from its condition of immense density and extreme heat led to the development of the universe as we know it today. Lemaitre’s theory was eventually modified and came to be called the Big Bang Theory.

Some scientists interpreted the Big Bang idea as pointing to a beginning of the universe. Those who for philosophical reasons preferred an eternal universe proposed alternative ideas, such as the Oscillating Universe Model or Bouncing Universe Model, in which the universe goes through eternal cycles of expansion and contractions. The universe “explodes” in the Big Bang. Eventually, the expansion of the “bang” slows and reverses itself. The universe contracts into a Big Crunch, and then “explodes” again into another Big Bang.

Perhaps the most famous alternative model to a universe with a beginning was the Steady State Theory, proposed in the 1940s. According to this model the universe is without beginning or end. The expansion of the universe is the result of new matter constantly coming into existence. For a time, the Steady State Theory was a serious contender as an alternative to the Big Bang, although a number of scientists pointed to basic problems with the theory. In 1964, Arno Penzias and Robert Wilson, two Bell Labs scientists, discovered what has become known as the Cosmic Microwave Background Radiation, a low temperature “blanket” of radiation permeating the universe. Such radiation had been predicted as a consequence of the Big Bang, an energy “echo” of the original event. Most scientists regarded this discovery as confirmation of the Big Bang Theory and a refutation of the Steady State Theory.

Although the Big Bang Theory is now the standard model, scientists still debate whether it represents the beginning of the cosmos, or simply the beginning of the *current stage* of its history. Early on, as we saw, scientists tried to combine the Big Bang with an eternal universe in the form of the Oscillating Universe or the Bouncing Universe. The Second Law of Thermodynamics—the principle that the amount of available, “useful” energy diminishes over time—seems to pose an insurmountable obstacle by limiting the number of oscillations or bounces the universe can have. As we go backward in time, so the argument goes, eventually we must come to an initial “bang” that began the oscillating series—if such a series existed. Not all scientists agree with that analysis, though.

Whether the Big Bang represents a true beginning of the universe is also linked to the question of the cosmic “singularity” the Big Bang Theory seems to require as the initial state of the universe. According to Einstein’s Theory of General Relativity, if we run the clock backward and condense all the matter and energy in the universe back to an initial state, it would exist as a singularity, a single “point” of infinite density and infinite energy. Our current understanding of scientific principles breaks down when confronted with the initial singularity the Big Bang Theory seems to require.

Because of the extremely condensed state of the universe in the initial singularity, the principles of another scientific theory—Quantum Mechanics—come into play. Quantum Mechanics describes the behavior of matter and energy on the atomic and subatomic lev-

els. The problem is, scientists don't know how to reconcile General Relativity, which accounts for how matter and energy act on the large scale, with Quantum Mechanics, which governs things on the small scale.

Many scientists believe the idea of the initial cosmic singularity points to flaws or incompleteness in our scientific theories rather than to the original state of the universe. They think a theory that would account for all physical laws—a so-called Theory of Everything—would make sense of the universe's state just prior to the Big Bang. Some scientists believe such a theory might show that the Big Bang wasn't the beginning of the universe after all.

Some of these scientists invoke the idea of what is called the Multiverse. One form of this idea is the notion that what we take to be the universe is really only *part* of a larger reality. Although the "universe" used to mean "everything in space and time considered as a whole", nowadays some scientists use it to refer only to a part of the whole of physical reality, the part we can in some way detect. There are, on this view, other regions we can't detect, at least not directly. These regions scientists sometimes describe as other "universes" and the whole collection of such "universes" is the Multiverse—which is short for "multiple universes". According to this idea, the Big Bang may have been an event in the larger Multiverse that brought about our region, or "universe", but the Big Bang was not the beginning of everything—of the Multiverse.

Assuming the Multiverse exists, did it have a beginning? If so, then we're back to the "problem" of a beginning, at least if the Multiverse is taken in the old-fashioned sense of the totality of physical reality. Otherwise, the matter simply gets pushed back to a previous Multiverse. Many physicists today speculate that the Multiverse, if it exists, had no beginning. In essence, this is the return of a kind of Steady State model, with the Big Bang marking the beginning stage of our "universe" or region of the Multiverse but not the beginning of all physical reality.

Some physicists today also speak of our universe being "created from nothing". By this they mean that conditions in the Multiverse were such that our "universe", or our part of the Multiverse, came to be as a result of the laws of Quantum Physics, not as a result of some pre-existing matter into which our universe was fashioned. It simply "popped" into existence from "quantum fluctuations" of "nothing". This "nothing" is, according to many scientists and philosophers, not "nothing" in the traditional sense, but something, even if it is a kind of something different from what we experience in the world around us. At the very least it involves principles of Quantum Physics and conditions sufficient for the emergence of our "universe" and these are not "nothing" in the strict sense.

In this view, while our "universe" may have sprung into existence "from nothing", its existence can be accounted for according to the laws of physics. Not that scientists presently have a complete set of laws or one grand law that explains everything there is to explain about how our "universe" came to be or why there is a Multiverse. Nevertheless, scientists hope for a scientific theory or explanation that ultimately will describe and ac-

count for everything—which is why such a theory is sometimes called a Theory of Everything.

Are Scientists and Theologians Sitting on the Same Spot?

Which brings us back to that spot of Jastrow's on which theologians supposedly have been sitting, awaiting the arrival of scientists. Is it really the same rock the scientists are scaling?

We have seen that Christianity (and traditional Judaism) teaches that God created the world *ex nihilo*—from nothing. Not that nothing was “something” God used to make the universe. Just the opposite. Creation *ex nihilo*, as we have seen, means God and God alone is the cause of the universe's being. Nevertheless, Christian thinkers are divided over whether we can know, apart from divine revelation, whether God's *ex nihilo* creation is eternal or whether the world had a beginning.

Some contemporary scientists think the Big Bang represents the beginning of the universe. But, as we saw, others theorize that the universe may have existed in a state prior to the Big Bang and indeed that the universe, in one form or another, may be eternal. Some scientists talk as if they think the universe could have come into existence from “nothing”. Upon careful reflection, though, it is clear that these scientists do not refer to “nothing” in the philosophical sense of the absolute lack of any reality whatsoever. Their “nothing” is a kind of “something”.

It is difficult, then, simply to equate the Big Bang with the beginning of the universe, in the theological sense of creation, as Jastrow's comment seems to do. The truth of the matter appears to be more complicated.

Three main possibilities come to mind regarding the Big Bang and God. First, the Big Bang may be directly relevant to God as the Creator. If the universe is the totality of physically interacting reality, and if the Big Bang represents its beginning, then unless we are willing to hold that something can come from nothing—true nothing, not quantum fluctuations—a nonphysical, transcendent reality must have brought the universe into being. Most people would call a nonphysical, transcendent being “God”. On this view, evidence for the world's beginning amounts to evidence for God.

The second possibility: the Big Bang is irrelevant to the issue of God. Here there are two approaches. One approach says science can never get us to the beginning of the cosmos because the Big Bang itself is only an interval between the universe as it is now and as it was before. Or, if the Big Bang is more than this, it's the result of a “quantum fluctuation” in the Multiverse. In such a scenario, physical reality didn't start with the Big Bang. The totality of physical reality, or the Multiverse, would be eternal and the Big Bang would tell us nothing about God as such.

But would the idea of an eternal Multiverse undercut God? It might require some

radical rethinking of the Christian doctrine that the universe was created in time, but it would seem not to have any effect on theological thinking about whether the universe requires a transcendent cause of its eternal existence. St. Thomas Aquinas, you will remember, maintained that the cosmos would require a cause of its existence even if it were eternal. Even if it didn't have a beginning, St. Thomas argued, it had an *origin*—God.

Some thinkers argue that scientific ideas about the Big Bang can't get us to the beginning of the universe, even if the universe in fact had a beginning. According to this notion, the universe's coming to be from nothing—not the “nothing” of quantum fluctuations but strictly nothing—isn't something science can discuss. It is a metaphysical issue, a question for philosophy, not a matter of physical science. Scientists may be able to push back farther and farther toward the beginning, but their scientific instruments and theories can never look at the metaphysical “nothing” from which the universe came to be. They will inevitably fall short of explaining it all. When it comes to the very beginning, philosophers known as metaphysicians and theologians need to take over from scientists. In this sense, whatever science tells us about the Big Bang, it will never be enough to prove God exists.

The third possibility is that the Big Bang is indirectly relevant to the question of God. Suppose we ultimately can't get behind the Big Bang. Suppose current theories attempting to do so prove unworkable. Would that prove the world began? Would it prove God exists? No, but it would suggest or imply limits to what science itself can tell us. It would suggest either that the world is finally inexplicable or that we must look to things beyond science—to philosophy or perhaps to theology—for the complete explanation of things.

What's more, even if some theory of the Multiverse winds up reducing the Big Bang to the beginning of our region of the larger universe and not the whole thing, the Big Bang still has some pertinence to the question of God. At the very least, it invites us to re-examine the arguments. For instance, philosophical arguments against an infinite past time don't hinge on identifying the Big Bang as the beginning of physical reality. If those arguments are correct, then our universe or the Multiverse, can't always have existed. And, if one sides with St. Thomas Aquinas, even if it can't be shown that the universe or the Multiverse had a *beginning*, there remains the question of whether it had an *origin*.

The Big Bang may not mean scientists and theologians now sit on the same rock as they contemplate the universe. If not, they at least reside on nearby rocks and gaze out into the abyss beyond their current understanding. They both must consider why we are here. While scientists must look for answers in terms of physical laws, theologians (and their friends, the philosophers) ask about what (or who) makes those laws possible and what (or who) makes the cosmos such laws describe.

Key Terms in Cosmic Origins

Anthropic coincidences. Precise physical factors and subtle physical constants of the universe that, taken together, provide the necessary conditions for life to exist. Anthropic refers to “mankind”. Coincidences refers to things that come together without being assembled by an agent. Whether what are called “anthropic coincidence” really are “coincidences” is a matter of philosophical dispute. Some forms of the Multiverse Theory maintain that other universes or regions of the larger universe or multiverse exist in which the physical factors and constants do not allow for life. On this view, we just happen to live in the region in which the factors and constants do. Some thinkers argue that the conditions necessary for a Multiverse to exist and to give rise to at least one region in which life such as ours exists also requires unlikely factors. In this view, unless one accepts no cause whatsoever for why things are, or one accepts extreme improbability, an intelligent agent is best explanation of the conditions necessary for the Multiverse and for at least one region to have life.

Big Bang Theory. The standard scientific cosmological theory for the origin and early development of the universe. According to this theory, the universe was once in an extremely dense, hot state from which it rapidly expanded and cooled. Present estimates are that the Big Bang occurred some 13.7 billion years ago. George Lemaitre (1894-1966), a Belgian priest, is often credited as the Father of the Big Bang Theory, because he pointed out that the expanding universe implied an initial state of the universe in a condensed condition, which he called the primeval atom. Today, the initial state is often referred to as a singularity. Presently, scientists are debating whether the universe existed in some physical state prior to the Big Bang.

Bouncing Universe Theory. The theory that the universe has gone through a number of cycles of collapse and expansion, with each sequence figuratively described as a “bounce”. The theorized period of collapse or contraction is sometimes call the Big Crunch, the counterpart to the Big Bang. The contraction and expansion together make the Big Bounce. The Bouncing Universe Theory is also known as the Oscillating Universe Theory.

Cosmic Microwave Background Radiation. An almost-uniformly-distributed microwave radiation permeating the universe and which is generally thought to be leftover from the early history of the universe. The CMB radiation was discovered in 1964 by Arno Penzias and Robert Wilson, two scientists working for Bell Laboratories. Along with the Cosmological Red Shift, the CMB radiation provides evidence of the Big Bang Theory.

Cosmology. In science, the study of the origin, development, and structure of the cosmos or universe.

Cosmos. Another name for the universe or Multiverse.

Creation. The causing to be of the universe. Scientists sometimes speak of the “creation” of the universe but strictly speaking “creation” is a philosophical and theological term that refers to God’s bringing into existence of something from nothing in the absolute sense. In creation, God alone is the cause of the whole being of that which is created. Science can refer to a relative “creation”: the scientifically describable process by which the universe came to have its present form from its earliest scientifically describable state. But this is using the term “creation” in a different sense from that in which philosophers and theologians use it.

Einstein, Albert (1879-1955). Physicist and developer of the Theory of Relativity. Einstein’s theory of gravity, known as General Relativity, was important for accounting for the expansion of the universe and the Big Bang. Because of Einstein’s preference for an eternal universe, he did not initially accept the implications of his own theory for an expanding universe. Later, based on the ideas of George Lemaitre and the evidence from Edwin Hubble of receding galaxies, he embraced the notion of an expanding universe and the Big Bang.

Ekpyrotic Theory. The theory that the Big Bang was the highly energetic effect of the collision of two “branes” or three-dimensional regions in a higher dimension of the multiverse. The Big Bang would not be the origin of the whole universe, or multiverse, but the result of one of many periodic collisions of two regions of physical reality that give rise to smaller regions such as what some scientists postulate our universe to be.

Entropy. In physics, a term used to refer to the general decrease of energy available within a system to do physical work. Entropy generally increases with time. The Second Law of Thermodynamics is sometimes stated in terms of the general tendency of an increase in entropy.

Eternal Inflationary Theory. The theory that the inflation of the cosmos following the Big Bang will continue without end, at least in some regions of the cosmos. Other “universes” or regions continually come to be, like bubbles in the foam of the ocean. The distance between these emerging “bubble universes” expands faster than the space within the bubbles. The Big Bang of our universe would be the beginning of one “bubble universe”.

Expanding Universe. The view of the cosmos that space and large objects throughout space in the universe are moving away from one another. The expansion of the universe is one piece of evidence in support of the Big Bang Theory, which postulates that the universe expanded rapidly from an immensely dense, hot state.

Hubble, Edwin (1889-1953). American astronomer famous for ascertaining the existence of other galaxies besides the Milky Way and for providing the evidence for an expanding universe.

Intelligibility. The quality of being capable of being understood or known.

Lemaitre, George (1894-1966). Belgian priest, mathematician, and scientist often regarded as the Father of the Big Bang Theory. He insisted that according to Einstein's theory of General Relativity the universe is expanding. Einstein himself initially rejected this implication of his theory. Later, evidence from Edwin Hubble's observations of distant galaxies led Einstein's and others' acceptance of the expanding universe model. Lemaitre subsequently theorized an original or primeval atom, which exploded into the expanding universe we know today. This idea became the basis of what would become known as the Big Bang Theory. Despite certain parallels between Lemaitre's idea of the exploding primeval atom and the Genesis account of creation, Lemaitre insisted that the two approaches to the universe's origins were distinct and ought not to influence one another. He refused to see the Big Bang as scientific proof of the existence of God. Lemaitre died just after the discovery of Cosmic Background Radiation confirmed the Big Bang Theory.

Metaphysics. The branch of philosophy concerned with the fundamental principles of being and reality. Among other things, metaphysics provides the foundation for scientific ideas about reality, including the natural science of physics, which concerns the quantitative principles of physical reality, and cosmology, which concerns the study of the cosmos as a whole. Metaphysics goes beyond what natural sciences such as physics and cosmology can tell us.

Multiverse Theory. The notion that what we take to be the universe is only a part of a grand overarching reality, which includes regions or realms of reality that are like what we call the universe. In this way, the multiverse contains multiple "universes". Some versions of the Multiverse Theory compare these other "universes" to bubbles in the foam of the sea, with the sea itself representing the Multiverse. According to one view of the Multiverse, the Big Bang represents the beginning of our region of the Multiverse, but not the beginning of the Multiverse, the existence of which is usually taken to be eternal. Some philosophers and theologians argue that regardless of whether the Multiverse, if it exists, had a beginning, it still would not include within itself and its principles the full account of why it exists and therefore it would be, in a sense, a contingent being, the existence of which would be conditioned by and dependent upon a necessary being (i.e., God).

Primeval Atom. George Lemaitre's idea of the original condition of the universe, which, as a result of a process of a kind of super-radioactive decay, the cosmos as we know it today came to be.

Quantum Mechanics. The branch of physics concerned with phenomena operating on extremely small levels—on the atomic and subatomic scales.

Redshift. The "shift" or lengthening of the wavelength of electromagnetic radiation from an object as it moves away. In cosmology, the redshift of distant objects in the universe indicates they are receding away from us and from one another. The moving of objects away from one another throughout the cosmos is evidence of the expansion of the universe.

Second Law of Thermodynamics. See Entropy.

Singularity. A mathematical point in the equations of General Relativity in which a gravitational field has become infinite and our current ideas about the laws of nature break down. Some scientists theorize that the initial state of the universe at the Big Bang was a singularity.

String Theory. A theory that seeks to harmonize General Relativity, the physical science governing large objects, and Quantum Mechanics, the physical science governing small objects, on the basis of theoretical, fundamental material objects thought to behave in ways similar to vibrating strings. The theory requires additional spatial dimensions to the three special dimension of common experience.

Theory of Everything. A physical theory that expresses the totality of physical explanation, including all physical phenomena, physical laws, and physical principles operative throughout the universe (or Multiverse). Such a theory would have to unite both General Relativity (which accounts for physical phenomena on the large scale) with Quantum Mechanics (which accounts for physical phenomena on the small scale). Although some scientists speak of a Theory of Everything as if it would provide the means to account for anything that exists, this amounts to a dogmatic materialism since it assumes only physical reality exists.

Resources

Chance or Purpose: Creation, Evolution, and a Rational Faith, Christoph Cardinal Schönborn, Ignatius Press, 2007. Available at your local Catholic bookstore or online at www.ignatius.com.

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God's Undertaker: Has Science Buried God? John C. Lennox, Lion Uk, new edition, 2009.

Handbook of Catholic Apologetics, Peter Kreeft and Ronald Tacelli, Ignatius Press, 2009. Available at your local Catholic bookstore or online at www.ignatius.com.

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In the Beginning: A Catholic Understanding of the Story of the Creation and the Fall, Joseph Ratzinger, Eerdmans, 1995.

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Reason to Believe: Why Faith Makes Sense, Richard Purtill, Ignatius Press, 2009. Available at your local Catholic bookstore or online at www.ignatius.com.

Science and Belief in a Nuclear Age, Peter Hodgson, Sapientia Press, 2005. Available at your local Catholic bookstore or online at www.ignatius.com.

There is a God, Anthony Flew with Roy Abraham Varghese, Harper One, 2008.

Other resources are available at www.magisreasonfaith.org.