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God & The Universe | Dr. Stephen Barr

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The Veritas Forum

Astronomer and Physicist Dr. Stephen Barr, University of Delaware, discusses the interplay between our modern understanding of the universe and the role our faith and the bible plays in how we understand. Please like, share, subscribe to and review this podcast. Thank you!

Transcript

Welcome to the Veritas Forum. This is the Veritaas Forum Podcast. A place where ideas and beliefs converge.

What I'm really going to be watching is which one has resources in their worldview to be tolerant, respectful, and humble toward the people they disagree with. How do we know whether the lives that we're living are meaningful? If energy, light, gravity, and consciousness are a mystery, don't be surprised if you're going to get an element of this involved. Today we hear from Dr. Stephen Barr, a professor of physics and cosmology at the University of Delaware, discussing God & The Universe, modern physics, ancient faith, presenting from the stage at the University of Minnesota.

So, in this talk, I'm going to discuss a very large subject, the physical universe. Was it created? Did it have a beginning? Will it have an end? And does it have any discernible purpose? I'll discuss these questions both from the point of view of traditional Christian teaching and from the point of view of modern physics and cosmology. Naturally enough, I'll start at the beginning.

That is the beginning of the universe. For Christian doctrine, the fundamental text about the beginning of the universe is the first verse of the bible. Genesis 1, 1. In the beginning, God created the heavens and the earth.

This verse affirms both that the universe is created by God and that it had a beginning in time. It's quite important to recognize that these are two logically distinct ideas even though they're tied together by this scriptural verse. Creation refers to the fact that the

universe depends for its existence upon God, who is the source of its being.

Beginning refers to the universe having a temporal starting point rather than having a history that stretches infinitely into the past or that goes around in a loop. The catechism of the Catholic Church in explaining Genesis 1, 1 quite properly treats beginning and creation as distinct components of its meaning. In its section 290, it says, three things are affirmed in these first words of Scripture.

The eternal God gave a beginning to all things that exist outside of himself. He alone is creator and the totality of what exists expressed by the formula of the heavens and the earth depends on the one who gives it being. Now, although being created and having a temporal beginning, beginning in time, are distinct ideas, many theologians, philosophers and ordinary people have seen them as connected in a necessary way.

For example, many religious people see the presumed fact that the universe had a temporal beginning as proving that the universe was created. Some people refer to the Big Bang as the moment of creation. For their part, many atheists think that if the universe was shown to have always existed or in some other way not to have had a first moment, it would disprove the need for a creator.

Both are making the same mistake of simply identifying a temporal beginning with creation, but as I said, these are distinct notions. Some analogies will perhaps make this clearer. A piece of music has an internal sequence measured by beats or notes.

The beginning of a symphony is the set of notes located first in that sequence, whereas the creation of the symphony is the conception of the entire symphony in the mind of the composer. The composer is not a part of the symphony, and his or her creative thoughts have no location in the sequence of the symphony's notes, though they are the cause of the notes and of their being organized in such a sequence. Similarly, a novel has an internal sequence of words.

The beginning of a novel consists of the first words in that sequence, whereas the novel's creation takes place in the mind of the novelist. In other words, one can distinguish between the beginning or opening of something, which has to do with its internal sequential structure, and its origin in the sense of the ultimate cause of its existence. If someone were to ask why a certain novel exists, it would be silly to point to its first words.

If someone asked you why is there a novel, a tale of two cities, it would be silly to say, "Oh, the reason is it was the best of times. It was the worst of times." If somebody asks you why is there this symphony, Beethoven's Fifth Symphony, you wouldn't say, "Oh, the reason there's that symphony is..." Now, in fact, when it comes to a novel, there could be a novel whose plot went around in a circle. In fact, it could be printed on a scroll that looped around.

And that novel would have no first words, and yet one presumes that it would still require an author. In a similar way, if one asks why the universe exists, it would be silly to point to the Big Bang, or whatever its first events were, rather one should point to the mind of its divine author. And even a universe that was cyclical in time, or past infinite, that is, had infinite past, and had no first events would still require such an author.

Divine creation, creation in Christian teaching, is the act by which God confers being upon the universe, and all that it contains. As St. Thomas Aquinas put it, "God is to all things the cause of being." God's creative act is the reason that the universe is a real universe, one that actually exists, rather than just a possible hypothetical or fictitious universe. Creation is the conferring of reality.

It follows that God equally creates all things and events, whenever and wherever they are located within the internal spatiotemporal structure of the universe. God is the source of being of this pen, right here and now. This is analogous to the fact that a composer is equally the source of every note of his or her symphony.

And that a novelist is equally the source of every word of his or her novel. God's creative act, therefore, is not something that happened once upon a time, a long time ago. Being an act of the divine mind, it has no location in space and time.

It is a single eternal, timeless act by which God wills the existence of the whole universe and of all of its parts from beginning to end. God is therefore the creator of what is happening here and now, just as much as the creator of what happened 13.8 billion years ago. Admittedly, Genesis 1-1 speaks of God creating in the beginning.

And theological tradition also distinguishes God's act of creating at the beginning from his act of conserving or sustaining things in existence later. But theological tradition also says that this distinction is only verbal or not real. According to Catholic theology, God's creating and his conserving are really one and the same eternal act.

The foregoing is the traditional Christian understanding of divine creation. Excuse me. One sees from it that physics can actually have nothing to say about the creation of the universe.

Even though it may be able to tell us whether the universe had a temporal beginning and about the physical events that have been created. The physical events that happened at were near that temporal beginning. Some religious people have the notion that the events at the temporal beginning of the universe must have been miraculous in the sense that they cannot be described by science or that they violated the laws of physics.

This notion may be due in part to the fact that cosmologists and particle physicists often speak of the universe having an initial singularity. What does that mean? If one attempts

to describe the evolution of the universe at its Einstein's theory of gravity, but ignoring quantum mechanics, one finds that as you go back to the... In time, there is a first instant of time at which various physical quantities would have been infinite, including the density of energy and the Riemannian curvature of space time. Because of these mathematical infinities at that point in time, the laws of physics would break down at that point, at that singularity.

It's known, however, that it is invalid to ignore quantum mechanics when energy density and space time curvature are as large as they must have been near the time of the Big Bang. Most fundamental physicists expect for good physics reasons that if quantum mechanics were properly taken into account in describing events near the Big Bang, the singularity would go away, and the equations, everything would be finite, and the equations of physics would be found to apply. And as far as theology goes, there's no reason to expect otherwise.

Just as one would expect the first sentences of a novel to obey the same laws of grammar and syntax as the later sentences, one would expect the events at the beginning of the universe to obey the same physical laws as all later events. It's absurd to suggest it would be absurd to suggest that if the laws of grammar apply at the beginning of a novel, it means the novel has no author. It's equally absurd to suggest that if the laws of physics apply at the beginning of the universe, it means the universe has no author.

And yet many atheists make exactly this argument, including the late Stephen Hawking, toward the end of his life. He suggested, quite properly, that the full equations of physics may, whatever they are, may both require the universe to have a temporal beginning and also describe the physical events that occurred at that beginning, which is perfectly reasonable. I would expect the same thing.

But he went on to assert that this would render a creator superfluous. Now the first thing to say about that is that he was making the very mistake we've been talking about, namely confusing creation with temporal beginning. But there's another reply to his argument, and strangely enough it was given by Hawking himself many years earlier.

In his 1988 bestseller, "A Brief History of Time," Hawking noted that a theory of physics is "just a set of rules and equations, mathematical rules and equations," and then went on to ask, "What is it that breathes fire into the equations and makes a universe for them to describe?" The usual approach of science of constructing a mathematical model cannot answer the question of why there should be a universe for the model to describe." And that's just as true today as it was then, and it is also just as true of quantum gravity theories as any other theories. The point that he, at that time, grasped, which is actually the essential point, which he grasped in 1988 and seems to have forgotten later, can be perhaps made clear by another simple analogy. One may possess

a book that contains the rules of baseball.

Those rules describe the various kinds of things that can happen in a baseball game. They even describe how baseball games begin and how they end. They tell you what kinds of things happen under what circumstances they happen, what order they happen, and so on.

But those rules, in no way, can tell you whether an actual game of baseball is being played or has ever been played or will ever be played. The rules could be describing merely hypothetical or possible or fictitious games. A mere set of rules does not have the power to make real the events they describe.

Just as the rules of baseball describe how a baseball game would begin but do not cause there to be any real baseball game, so to the rules of a possible kind of universe, the mathematical equations that would govern one, may describe how a universe of that type would begin, but they could not cause there to be a real universe of that type. The laws of physics have no power to create universes in the sense of giving reality to them. So physics itself cannot answer the question of why there is an actual universe for the laws of physics to describe.

For the laws of physics, so the laws of physics cannot answer the question of why there's a universe. God may be the answer to why there's a universe, or maybe there is no answer to why there's a universe, but physics is certainly not the answer to why there's a universe. Okay, now that's all I'm going to say about creation.

I'll now turn to the distinct question of whether the universe had a temporal beginning or was past infinite. What does Christian revelations say about that? What can philosophy or pure reason tell us about that? And what does empirical science tell us? That is physics and cosmology. Revelation in particular, Genesis 1-1, is generally understood, has generally been understood by Christians to imply that there was a temporal beginning.

The beginning referred to in Genesis 1-1 has been understood to be a temporal beginning. Now, actually other interpretations, the other meanings can be found in that verse. I'm not denying that.

Now, some pagans in antiquity mocked this idea. Saint Augustine in his Confessions tells us that some pagans would ask Christians the following question. What was your God doing for all that infinite time before he finally got around to making this world? Why did he wait infinitely long before doing it? Now, Saint Augustine gave a very profound answer and famous answer to that question in the 11th chapter of his Confessions.

He pointed out that time is a measure of change, and therefore presupposes the existence of changeable things, and thus created things. Therefore, time is a feature or

an aspect of the created world, and is therefore itself something created. From this it follows that if time is passing, something created already exists.

I guess I should go to that slide. If time is passing, something created already exists, and creation has already taken place. It is therefore nonsensical to speak of a time before creation.

It's a contradiction in terms. So, Saint Augustine answered the pagan taunt in these words. But if there was "if there was no time before heaven and earth, why do they ask what you, O Lord, did then?" There was no "then" where there was no "time." In other words, the beginning, what he understood is that the beginning, the temporal beginning of the created world, was also the beginning of time itself.

Now, others had spoken of a beginning of time before Saint Augustine, but it seems that he was the first to understand and articulate that concept clearly, the beginning of time. Modern physics came to the same concept 15 centuries later by a parallel root. Saint Augustine had started with the insight that time is something created, whereas modern physics started with the insight, coming from Einstein's general theory of relativity, that time is something physical.

Space time is something physical. If time or space time is something physical, then if the universe had a beginning, if the physical universe had a beginning, that beginning must also have been the beginning of space and time. So, just as Saint Augustine profoundly realized that it makes no sense to speak of a time before creation, when God could have been waiting around to create the world, modern physics says that it makes no sense to speak of a time before the universe began.

So, if, say, the universe began 13.8 billion years ago, it would be meaningless to speak of 20 billion years ago. There would be no such time. The notion of the beginning of time is enshrined in Christian doctrine, both the Fourth Lateran Council and in 1215, and the First Vatican Council in 1870 taught that God created the universe Abenizio Temporus from the beginning of time.

Saint Augustine's insights have an important corollary. God, in his divine nature, is a temporal or non-temporal. If time is something created by God, a feature of the created world, then temporal categories cannot apply to the divine nature.

God dwells in an eternal that is timeless, present. In Saint Augustine's words, God dwells in the sublimity of an ever-present eternity. And Saint Thomas, quite an aspoke of God, dwelling in the nukstans, the now that stands still.

This, of course, fits well with the perspective afforded us by modern physics. If space-time is the fabric of the physical world, as general relativity tells us, then the divine nature could not be temporal, without also being spatial and physical, a notion that has

always been rejected as absurd by Christian tradition. God is outside of time and space, not geometrically outside, but beyond the categories of space and time do not apply to God.

We've seen that the Christian doctrine, based on divine revelation, arrived at the conclusion that the universe has a temporal beginning that is also the beginning of time itself. What can reason alone, unaided by divine revelation, say about the quest? A very important Christian philosopher, Saint Thomas Aquinas, said that there was no compelling philosophical argument, at least none that he was aware of, that proved that the universe had a temporal beginning. He did think that one could prove philosophically that the world is created, but he said that it was within God's power to create a universe that is past infinite.

And he said, we only know that the universe has not past infinite, because God has revealed that to us in Genesis 1. So we know by revelation that God, in fact, chose to create a universe with a temporal beginning. Now some other philosophers have claimed, contrary to Saint Thomas, that it is actually demonstrable by reason alone that the universe had a temporal beginning, apart from anything that might have been revealed. This is claimed, for example, by the proponents of the so-called "calom argument" for the existence of God.

Let me see if I want to go there. Yes. The so-called "calom argument" for the existence of God, the most well-known proponent of which is perhaps the Christian philosopher and apologist, William Lane Craig.

The "calom argument," which is named after some Islamic philosopher of the 11th century, Al Ghazali, who was a... Well, the "calom" is an Arabic word, and so the argument is named after the Islamic philosophers who developed it. The "calom" argument purports to show philosophically that A) the universe must have had a temporal beginning, and B) any entity which has a temporal beginning must have a cause outside of itself. Several medieval, scholastic philosophers, Christian philosophers of the Middle Ages also believed that the finite age of the universe can be proved philosophically.

A notable example is Saint Bonaventure, a contemporary of Saint Thomas Aquinas. Bonaventure used a number of philosophical arguments, all of them fallacious, to argue that the universe had to have a temporal beginning. One argument he made was that if the universe were infinitely old, there would have to have been some particular past days, or times, there were infinitely remote from the present.

But the day after such an infinitely remote day would still be infinitely remote from the present, as would the day after that, and the day after that, and by mathematical induction, all subsequent days, which means the passage of time could not have led from that infinitely remote day to the present, which means it's not really in our past.

The fallacy here is immediately recognizable to anyone familiar with some modern mathematics. The past can have an infinite extent, without any particular past day, being infinitely in the past.

This is just the familiar mathematical paradox, that while there is an infinite sequence of natural numbers, 1, 2, 3, 4, 5, that sequence goes on forever. That sequence has an infinite sequence. Every particular natural number is finite.

So, even if the past had an infinite extent, all particular past times are a finite time ago. So that's the fallacy Bonaventure fell for it. There's another argument to use, but I'll skip that for a reason of time, which is an equally fallacious argument.

And to his credits, St. Thomas saw through these arguments and made effective answers to them. And that's impressive, since he lived six centuries before, mathematicians such as Bolzano and Cantor clarified thinking about infinite sets and infinite quantities. As I said, in St. Thomas's view, it is not logically or philosophically impossible for a temporal sequence to proceed to infinity, either into the past or into the future.

He said explicitly, you could have a man who is caused by his father, who is caused by his father and by his father, and so on, infinitely into the past. And there's no logical or philosophical problem with that. Okay, so philosophy, I would say, I would agree with St. Thomas doesn't really answer the question.

What about empirical science? Until modern times, science was not in a position to say anything on this question. But by the late 19th century, several discoveries had been made that seemed to bear upon it. And most of those discoveries seemed to go against the idea of a cosmic beginning.

In Newtonian physics, for example, it seemed natural to assume that time extended infinitely in both directions, just as space was assumed to stretch infinitely in all directions. Moreover, in the middle of the 19th century, physicists discovered the law of conservation of energy, which said that energy cannot be created or destroyed, but only changed from one form to another. And chemists discovered that atoms are never created or destroyed in chemical reactions.

So it began to appear that matter, energy, space and time had always existed and always would. In 1911, Spontaeranius, Nobel Prize-winning chemist, said, "The opinion that something can come from nothing is at variance with the present day state of science, according to which matter is immutable." The Nobel Prize-winning physicist, Walter Nernst, declared that, quote, "To deny the infinite duration of time would be to betray the very foundations of science." Of course, it was realized, even back then, that the Earth must have had a beginning, since the Earth's interior is still hot and it would have cooled off had it been infinitely old. And some scientists used the second law of thermodynamics, which I'll mention later again, to argue that the universe itself must

have had a beginning.

But it was hard to make scientific sense of a cosmic beginning at that time. And the view began to prevail among scientists, at least those who were not religious, that the universe had always existed. To many, the idea of a beginning came to seem like the relic of religious mythology and contrary to modern science, as we can see from these quotes.

But thinking on the subject took a dramatic turn early in the 20th century. It started with Einstein's theory of gravity, called general relativity, which was published in 1916. In Einstein's theory, space and time form a four-dimensional manifold, which one can think of as a physical fabric that can bend and ripple in response to the matter and energy that fill it.

In the 1920s, a Russian mathematician named Alexander Friedman and a Belgian theoretical physicist, Georges Le Mech, or as many people call them Le Mechre. I used to call them Le Mechre until a French friend of mine told me it should be said, something like Le Mech. But anyway, Georges Le Mechre was also not only a theoretical physicist, he was a Catholic priest.

And both Friedman and Le Mechre showed independently of each other that the equations of Einstein's theory of gravity could describe a universe that is expanding. That is not just a universe in which matter is moving apart through space, but a universe in which space itself is stretching to make the universe larger. Le Mechre was aware of astronomical observations.

Friedman died in the late, died young and sort of left the picture. Le Mechre was aware of astronomical observations that showed that distant galaxies are receding from us. On the basis of those observations and his own theoretical calculations based on Einstein's theory, he proposed that the universe is indeed expanding from an initial explosion which he called the primeval atom, which is now called the Big Bang.

Georges Le Mechre was the founder, who was really the one who proposed the Big Bang theory. And I should say, last November I think it was, the International Astronomical Union voted overwhelmingly to recommend that the law describing the universe's expansion, which has been called the Hubble law, should be named the Hubble Le Mechre law. Because actually Le Mechre predicted this in 1927, predicted the law two years before Hubble that observationally discovered it.

In the 1960s, cosmic radiation left over from that explosion was discovered by Arno Penzius and Robert W. Wilson. And since then, evidence for the Big Bang has accumulated rapidly. There's now no doubt among fundamental physicists and cosmologists that there was a Big Bang about 13.8 billion years ago.

In the standard model of cosmology, the Big Bang is assumed to be the beginning of the universe and thus of matter, space, and time itself. That does not resolve the question definitively, however. As many speculative extensions of the standard model of cosmology have been proposed, and in some of these scenarios, they're not yet testable theories, the Big Bang was not the beginning of the universe, but rather one event in a history that stretches back further.

Some of the more important speculative scenarios in which the universe had a pre-Big Bang history are called the Bouncing Universe, the Echpiorotic Universe, and eternal inflation. In the Bouncing Universe scenario, which was considered by Einstein back in 1930, the universe is supposed to be undergoing an endless cycle of expansion and contraction, with each contracting phase ending in a bounce that becomes the Big Bang of a new cycle. The Big Bangs, the Big Bang that was 13.8 billion years ago, would merely have been the latest such bounce.

In the Echpiorotic Universe scenario, our universe is one of two parallel universes, each three-dimensional, three-spatial dimensions, that move toward and away from each other through a fourth-spatial dimension. They undergo endless cycles in which they crash into each other and then move apart again and then crash into each other and move apart. The Big Bang would have been the latest such crash.

In the Eternal Inflation scenario, bubble universes are constantly forming within a larger universe that is perpetually expanding. The Big Bang would have been the formation of our bubble. These scenarios are very interesting and one of them might turn out to be correct.

Nevertheless, there are strong theoretical reasons to think that even in such scenarios, the universe as a whole probably would have to have had a temporal beginning. In a Bouncing Universe, there would probably have had to be a first bounce and in an eternally inflating universe, there would probably have to be a first bubble and in an Echpiorotic Universe probably have to be a first collision. There are two reasons to think this.

The more fundamental reason is the second law of thermodynamics, which I already mentioned. This says that entropy, which is a mathematical measure of physical disorder, always increases on the whole, which causes physical systems to run down, to wear out, to decay and so on, this is what makes perpetual motion machines impossible and it's also why we're mortal. The point is that a universe that has lasted for an infinite time would in essence be a perpetual motion machine.

The second reason is a theorem proved in 2003 by the physicists, Arvind Bordeaux, Alan Guth and Alexander Vellanken, which says roughly speaking that if one traces the history of an expanding universe backwards in time, one must come either to a beginning of time or to an era where classical concepts of time no longer apply because of quantum

mechanical effects. For these and other reasons, it's turned out to be difficult to construct a reasonable and viable mathematical model of a past infinite universe. So even though we cannot be certain from the scientific evidence that the universe had a temporal beginning, it nevertheless seems most likely that it did given everything we know at present.

This can be seen as a vindication of Jewish and Christian revelation. The idea of a cosmic beginning was mocked by ancient pagans as absurd and rejected by many modern atheists as unscientific, but nevertheless, it now appears to be most probably correct. Okay.

Does the cosmos have a purpose or a point? An answer to that that has long seemed reasonable and even obvious to many people is that the universe does have a purpose. And at the, well, more than one purpose in Christian tradition, the main purpose of the universe is to manifest God's glory. But another purpose is to be a habitat for creatures such as ourselves.

Human beings are, after all, the highest productions of nature that we know about. So that's always seemed reasonable to people that the universe perhaps was made for our benefit. And yet, the discoveries of modern science have led some to conclude that humanity is a fluke.

Bertrand Russell wrote that the human race is merely, quote, "a curious accident in a backwater," unquote, of the universe. And the famous Nobel Prize-winning physicist Stephen Weinberg, the great physicist Stephen Weinberg, made this statement in his popular book "The First Three Minutes" written in 1977. Quote, "It is almost irresistible for humans to believe that we have some special relation to the universe.

"Human life is not just a farcical outcome of a chain of accidents, "but that we were somehow built in from the beginning. "It's very hard for us to realize that we are just a tiny part of an overwhelmingly hostile universe. "The more the universe seems comprehensible, the more it also seems pointless." In the 40 years since Weinberg wrote that, much has been learned that undercuts that claim.

In particular, it's been found that the laws of physics as we know them and the very structure of the cosmos give every appearance of having been crafted to make complex organisms such as ourselves possible. Physicists have asked themselves how the universe would have turned out, had the laws of physics been slightly different in various ways. For example, certain particles having slightly different mass or forces having slightly different strength and so on.

In many cases, what they find is that small changes in the basic laws would have had drastic effects that would have made the emergence of life as we know it's impossible. Though this was once almost taboo to speak about among physicists, it's now quite

widely admitted. Even by scientists or atheists, Stephen Hawking made no bones about it in his 2010 book, The Grand Design.

He says very plainly that many features of the laws of physics, as we know them, are just right to make life possible. Edward Whitten, one of the top theoretical physicists alive today, some many people in my field, regardless of the smartest physicist alive, and possibly the smartest person on the planet, I think the strong case could be made for that. He calls himself a skeptical agnostic.

He's not religious. A skeptical agnostic may be a polite way of saying an atheist, but he calls himself a skeptical agnostic. He was in an interview some years ago.

He said many interesting things, and one of them was this. There's really a feeling of wonder about the strangeness of the laws, because the laws of nature to the extent that physicists have been able to unearth them are extremely beautiful and harmonious, but also strange. And there's a second level of puzzlement about why these laws have such delicate properties.

Just with physics we already know. The fact that galaxies, stars and planets roughly like ours could have formed, and that living things roughly like us could have formed, depends on many details of the laws of physics as we currently know them being just the way they are and not being slightly different. I think we'll never resolve the sense of wonder about that.

Such fortuitous features of the laws of physics are often called "anthropic coincidences." There are many examples, some very famous. A famous one is that if the strong force, one of the four known forces of nature, the strong nuclear force that holds atomic nuclei together, were about 20 or 25 percent weaker, a crucial nucleus called deuterium would be unstable, it wouldn't be able to hold together. And that would have the consequence that almost none of the elements of the periodic table, except ordinary hydrogen, would have formed.

And with only hydrogen, chemistry-based life would not be possible. Another very famous example is concerns a certain excited state or energy level of the carbon-12 nucleus. Had that energy level been different by a few percent, its energy been different by a few percent in either direction, almost no carbon or elements heavier than carbon would exist in the universe, which would be a disaster as far as the possibilities of life.

There's a parameter in the standard model of particle physics that you've heard of the Higgs field. The strength of the Higgs field in empty space is called the technical jargon, and it's the vacuum expectation value of the Higgs field, and symbolized by the letter V. In a widely cited paper that I wrote with some colleagues back in 1998, we showed that V has to lie within a very narrow range of the mathematically allowed values, in a fantastically narrow range if life is to be possible in our universe. Had a hard time getting

that paper published, but now it's actually become very highly cited in the literature by many people, including Stephen Weinberg and many, many top theorists.

So as I said, this is now no longer a taboo subject. Lots of papers are published on these anthropic coincidences. Nor is it just a question of certain parameters having precisely, quote, fine-tuned values.

Certain gross qualitative features of the laws of physics and of the structure of the universe are also very important for the possibility of life, such as the fact that the number of macroscopic space dimensions is three, that time has an arrow or a direction, which is still not understood by physicists, and that the universe obeys the very strange and highly non-trivial principles of quantum mechanics. Now, it should be noted, this is very important, that there is a speculative hypothesis, called the multiverse, that could explain some and maybe most of these anthropic coincidences in a naturalistic way, especially the fine-tuning ones. The multiverse idea is that the fundamental laws of physics allow certain quantities that were traditionally thought to be constants of nature, such as the masses of particles and the strengths of forces, to vary, to take from place to place in the universe, that are very distant from each other.

For example, the mass of the electron is a certain value in the entire part of the universe that we can see, but in parts of the universe outside are what's called horizon, maybe the mass of the electron takes different values. If enough values of these fundamental quantities are tried out, so to speak, by the universe, there might be regions of the universe just by chance where all of these important quantities are just the right values for life to be possible. The multiverse hypothesis is not far-fetched, as it may sound to non-particle physicists.

From the particle physicist's point of view, it's a perfectly reasonable idea. But it would require that the fundamental laws of physics, because even in multiverse scenarios, it's assumed that there is some deep-down, underlying fundamental laws of physics that govern the whole multiverse. But the fundamental laws of physics would have to have the very special characteristic that they allow many important quantities to vary from place to place.

In other words, one can say, and that's a highly non-trivial property for the fundamental laws of physics to have. In other words, one can say that for complex, organic life to arise in a universe, it must be governed by fundamental laws that are special in some way, either in having many basic quantities and qualitative features chosen just right, or in having the characteristic, the right characteristic, to allow all these quantities and features to vary from place to place. The possibility that the universe might be a multiverse does not, therefore, vitiate the force of the argument that the existence of life is evidence of a cosmic purpose.

The lesson would seem to be that the ability of the universe to generate beings such as

ourselves is not something to be taken for granted, as though it were to be expected of any universe, whatever its laws might be. Rather, as Whitten said, it should arouse wonder. Let me say something about the size of the cosmos, which Brian mentioned in introducing me.

As Pascal said, "The eternal silence of the infinite space frightens me." And before him, others have expressed the same feeling. Many have seen the vast scale of the cosmos in both space and time as evidence of the insignificance of human beings. If we are part of the purpose for which the universe was created, why so much empty space? As Weinberg pointed out in the passage above, we are just a tiny part of the universe.

The same point was raised as a question by the psalmist. He said, "When I look at your..." Do I have it on here? No. When I look at the heavens, the work of your fingers, the moon and the stars that you have established, what are human beings that you are mindful of them, mortals that you care for them? That's Psalm 8. I like the King James translation better, but this one.

Well, maybe this one's a little more intelligible. Why, in this vast universe, we don't seem to amount to a hill of beings. Interestingly, cosmology has something to say about this.

We know that biological evolution requires billions of years to produce beings such as ourselves. And before biology can even start, the chemical elements required for life, the elements of the periodic table, must be synthesized by astrophysical processes that also take billions of years. Moreover, Einstein's theory of gravity relates the longevity of a universe to its size.

If one said, "The universe is way too big." Why couldn't God have created a much nicer human-scale cosmos maybe the size of North America? Or maybe the solar system? Well, a universe that never got larger than a few thousand miles across, a comfortable human scale, according to general relativity would not last more than a few hundredths of a second. Conversely, if the universe is to last for billions of years, as is required for life to arise, it must attain a size of at least billions of light years across, which is what we observe. In other words, far from pointing to human insignificance, the vastness of the universe both in time and space is a necessary precondition given the kinds of laws that we have, is a necessary precondition for us to be here.

So let me sum up what I have said so far and to say that we have learned from modern physics and cosmology that the evidence strongly suggests that the universe had a temporal beginning. That's not the same thing as saying it was created, but it had a temporal beginning, as Christians have always believed on the basis of revelation. And it has shown us that many features of the universe's laws and structure, including its astounding size and age, are just what is required for life, such as ourselves, to exist in it, which is suggestive, not doesn't prove anything, but a suggestive that we may very well be, "built in from the beginning," to use Weinberg's words, and that there is a point

to it all, and that we are part of that point.

Now, I've come to the end of my 45 minutes, so I'm going to drop the last part of my talk, which is will the universe come to an end? You'll have to come back next week to find out. But the short answer is the Christian revelation says yes. And actually, let me just read, show you some scriptural passages.

Long ago, this is from Psalm 1 or 2. Long ago, you laid the foundation of the earth and the heavens are the work of your hands. They will perish, the heavens and the earth. They will perish, but you endure.

They will all wear out like a garment. You change them like clothing and they pass away. Christ himself said, "Heaven and earth will pass away, but my words will not pass away." St. Paul tells the Corinthians, "The present form of this world is passing away.

The first letter of John says, 'And the world and its desire are passing away.'" The second letter of Peter foretells that the present heavens and earth have been reserved for fire as the heavens will pass away with a loud noise and the elements will be dissolved with fire. Now modern cosmology gives us two possibilities. The universe will keep expanding, eventually reach a maximum size and re-collapse into what's called the big crunch, at which time presumably, presumably, space time, the universe and time itself will come to an end.

Or the universe will keep expanding forever, in which case it will get colder and darker and emptier. Eventually the stars will all burn out, all usable energy will be used up, and the universe will become approach absolute zero. This is traditionally called the heat death of the universe, so the universe will really exist, but any possibility of life in it will vanish.

Disappear at some point, so you might say the world in that sense will come to an end. And long before those things happen, the sun is going to blow up and become a red giant in about five billion years and incinerate everything on the earth. So the earth is certainly... So on that happy note, I will... So there seems to be an agreement between Revelation and science at the world, basically, is coming to an end, but it's a little more complicated, but I don't have the time to talk about that because Revelation also talks about Christian tradition and doctrine also talks about a new heaven and a new earth, and that's a long discussion, which I'll skip.

Thank you. (Applause) If you like this and you want to hear more, like, share, subscribe, and review this podcast. And from all of us here at the Veritas Forum, thank you.

(Music) [Silence]