Dr. Perry Phillips, Big Bang and Creation -- 3 Pillars

Biblicalelearning.org by Ted Hildebrandt

Dr. Perry Phillips, with a Ph.D. from Cornell University in Astrophysics, is doing a presentation on the Big Bang Theory and the three foundational pillars that demonstrate that the Big Bang Theory was the method of creation. Dr. Perry Phillips. Good evening.

Thank you very much for coming. I'm Perry Phillips. My wife, Elaine Phillips, teaches Old Testament, among other things, here at Gordon College.

And tonight I want to have a talk about the Big Bang. And we'll say a few things about that, and then try to see how it might tie into the biblical material that you have been studying. But before we begin, let's have a word of prayer.

Father, we come to you not only as the one who has given us your word, but through your works have shown us that you exist and some of the things that we might expect from you. We thank you that you have not left us in the dark, but that you have communicated to us through your works and through your words. Pray tonight you'll be with us as we study your creation in the manner of origin, that there might be understanding, clarity, and just more praise of you for all that you have done.

And we ask this in Jesus' name. Amen. Amen.

Thank you very much for coming. The show is going to begin. It's presented by me.

That's a self-portrait. Actually, I think it was done by my two-year-old adopted grandkid. But anyway, what we want to do today is we want to discuss the Big Bang, or tonight, and what we want to do is look a little behind the scenes, take a look at why it is that people believe in this concept of the Big Bang.

Now if you're wondering what it is, we will explain that shortly, but we're going to look at how scientists believe that this particular term, Big Bang, and what it implies, is the way in which the universe was created. We're going to have a little physics that is involved, but nothing too involved. And as far as the mathematics goes, if you can multiply 5 by 2 and get 11, you'll be doing okay.

And as I said, since we're going to have just a tiny amount of physics, we might be giving some people a headache, but I think we can get through all this together. Here's an outline of the talk. We're going to discuss a little history behind the Big Bang, some of the personalities that were involved in discovering the science behind that leads us to this theory.

We want to take a look at the expanding universe, the so-called redshift, which was the first piece of data that showed that the universe really is getting bigger and bigger as time goes on. Then we want to talk about the so-called cosmic background radiation. This is radiation-radio waves that come to us from all parts of the universe, no matter where we aim our antennas.

We see this, and these radio waves have information, and that information has been analyzed quite thoroughly and has given us a good idea, again, of the Big Bang. But why should there be this radiation to begin with? That is something that is explained by the Big Bang. I want to take a look at the results of three satellites, the COBE satellite, the WMAP satellite, and the Planck satellite, which add even more information concerning the cosmic background radiation.

I want to talk about the elemental abundance. When you look anywhere in the universe, what you find is a specific ratio of the amount of helium to the amount of hydrogen. And it doesn't matter whether you're looking in the atmospheres of big planets like Saturn and Jupiter, whether you're looking in large gas clouds, whether you're looking in between galaxies, it's all the same.

How do we explain this? And again, this is going to be one of the pivotal supporting legs of the Big Bang. Then I want to make some conclusions. So that's not too bad of material to go through in the next three hours.

I'm going to call this Welcome to CSI Cosmology, Crime Scene Investigation. You've all seen, or may have seen, CSI New York, CSI Miami, CSI LA, pretty soon there's going to be a CSI Gordon College, who knows? But crime scene investigators, what do they do? They're not there when the actual crime has taken place, but because of evidence left behind, they are able to determine, eventually, who committed the crime and how it was done. And this is the way it is with cosmology.

Now cosmology means the study of the universe, and what we want to study is how the universe began and what its history and fate will be, what its makeup is. All this comes under cosmology. And as I say, like a crime scene investigator that applies their trade to determine the who, how, where, when, and why of a crime, cosmologists ask the same questions of the universe at large.

And for example, we already know some things about the universe. First, who? Who's the who? Well, the who is God. In the beginning, God created the heavens and the earth.

And what I want to say tonight, which is going to concentrate not so much on the theology but on the scientific aspect of it, doesn't mean that God isn't involved in this. Let me give you an example. This actually comes from C.S. Lewis.

He said a friend of his came and heard the teapot boiling, and he says, why is the teapot boiling? And C.S. Lewis says, well, there are two explanations. One explanation is, well, let's see, I put water in the teapot, then I put the teapot on the burner. I turned on the burner, which ignited the gas.

The gas was very hot, and that heated the bottom of the teapot. The teapot then, through conduction, heated the water, and the water then began to get warmer and warmer, and through convection, it got hotter and hotter, and eventually it got to the point where there was a phase change. The phase change changed the water to steam, which built up the pressure, which came through the little hole on the teapot and began to whistle.

That's one explanation, and it's a perfectly valid explanation. But there's another explanation as well. The teapot is boiling because Mrs. Lewis wanted a cup of tea.

And that's just as good an explanation. And so the application here is that if we say in the beginning God created the heavens and the earth, there is nothing that contradicts what we may say about the scientific way in which this may have been done. And so that little analogy that C.S. Lewis talks about, I think, can be very important here for those who might be bothered between God creating the universe and now the scientific reasons behind how it's done.

Why is the universe created? That's something science doesn't answer. We need something a little bit more overarching than just the science to answer that question. But we are given information in the Scriptures, again, the book of God's words.

He creates it for His glory. And this is shown in Psalm 19, verse 1. It also comes out in Psalm 8 to a certain extent, and also in Romans chapter 1, starting with verse 18. When? Well, this might raise some hackles.

But as far as we can determine, it was 13.7 billion years ago. If you want to be more exact, 13.72 plus or minus 0.03 billion years ago. That's basically what we've come down to now, but roughly 14 billion years ago.

Where? Well, we're talking about the universe all over. I mean, it was a creation that included everything that is in the universe at one time. And finally, how? Well, we continue to work on this, but some of the how it was done is what I hope to present tonight.

Well, evidence supporting the Big Bang. It's based on three pillars. We have three pillars of evidence for what we call the Hot Big Bang.

The first is so-called Hubble's Law. This deals with the expansion of the universe. And I'll get to discussing how we know that the universe is really getting bigger.

That's what I mean by expanding. If we have a certain size of the universe, well, you take a hiatus, maybe a few billion years, and come back and see the universe is actually a little larger. And you'll see how that was discovered.

Then I want to talk about the cosmic microwave background radiation. This radiation that I told you permeates the universe. That not only tells us that there was an event like the Big Bang, but even gives us some information as to the makeup of that event.

And then the third thing we want to talk about is the light elemental abundance, or specifically the ratio of hydrogen to helium in the universe. These are the three pillars that are there that scientists look at to believe that there was such a thing as a Big Bang. So pillar number one, let's take a look at the expanding universe.

And for this, I want to go back to around 1910 to 1912 with this fellow called Vestal Melvin Slipher. He's the person that's on the screen on your left, older incarnation of him. He was actually a graduate student at the University of Chicago.

And he was trying to measure the rotation of galaxies. And there's a picture of a galaxy on the right. In fact, if you were to get far enough away from the Milky Way, which itself is a galaxy, this is roughly what it would look like.

And what he was trying to do is see how fast these objects are rotating. And you ask, well, how could he do that? I'll tell you in a second. But as he was looking at the rotation of these galaxies, he looked at one, looked at the other, looked at a third, a fourth, a fifth, etc., he noticed something that was very interesting and very strange.

All these galaxies were moving away from us. So even before he started checking the rotation of the galaxy, he realized all these galaxies were moving away from us. Now, you may say, so what? Well, here's a so what.

At this point, people considered the universe and the galaxies in the universe to be a little bit like the molecules of air in this room. If you had eyes where you could see the molecules of air in this room, what you would see is that their movement is very random. And that is to say you would expect about as many molecules of air to be moving towards you as away from you, to be moving up as well as down, and to be moving left and right.

In other words, you expect all these things in random motion to be equal. So, applying this model to the universe, where at this time, by the way, people thought the universe was infinite, the galaxies were like molecules of air in the room; they expected random motions to the galaxies. And so if you were to look at a number of galaxies, what you would expect is to find as many moving away from you as were moving towards you.

Now you can't see if they're moving right or left because they're so far away and that motion isn't visible. But as I'll show you, there is a way of telling whether a galaxy is moving towards you or away from you and how fast it's moving towards you or away from you. So I looked at these galaxies, and I was amazed.

He said, all these are moving away from us. Well, he went and talked to his advisor. And his advisor said to him, why don't you go take a few more data points, go look at a few more galaxies, which he did.

Guess what? They were all moving away. This was very strange. Some of those should have been moving towards us.

He didn't know how to explain this. His advisor did not really know how to explain it. In 1912, at the American Astronomical Society, he actually gave these results.

And at the end, everybody stood up and clapped, but nobody could explain why the results were the way they were. It was one of those things that people were thinking about. Now, how can we tell whether a galaxy is moving towards us or away from us? I'm going to use a nice homey analogy here of somebody waiting for a train.

So you're down at South Station, and you're waiting for the T to come along and bring you up here. Now, here's a fellow that's standing on a platform and there's a train in the top panel. There's a train a little ways away, and the train's going to toot its horn.

And I'm going to put on my best train horn voice, and it's going to go something like this. Toot, toot. OK, I saw you diving under your chair because you thought a train was coming by.

That's just me. OK, this is me. So you hear toot, toot.

Now, the interesting thing is if the train begins to move towards the person on the platform, as you see in the second frame, and what happens is the sound waves get compressed. The frequency goes up. Or, if you like, the wavelength, which is shown in the top part of this slide, shortens.

And basically the toot, toot sounds like toot, toot. Now, what happens if the train is moving away and sounding its horn? Then the toot, toot becomes toot, toot. See what's happening? The frequency changes.

A higher frequency when the object is moving towards us. A lower frequency when the train is moving away from us. Now, what we do is we have labels for this particular phenomenon.

For the compression of waves moving towards us, we call this the blue shift. And here's why. And I'll use the term blue shift and red shift that I'll describe in a moment throughout the talk.

When you're looking at galaxies, you're obviously not listening to sound coming from the galaxy. What you're looking at is light that's coming from the galaxy. And red light has a certain wavelength and blue light has a certain wavelength.

That's why red looks like red and blue looks like blue. And it turns out that the wavelength of red light is longer compared to the wavelength of blue light. I mean, it's almost a factor of two.

And so when we say that, what happens is the following. Suppose we know what the wavelength of a certain color is when the galaxy, let's say, would be at still, be still with respect to us. We know what that wavelength would be.

But as the object moves towards us, the light waves are compressed, just like the sound waves. And so what you have is a shift to the blue, and we call it a blue shift because the wavelength is shortening. When the galaxy is moving away from us, and we look at the wavelength of a certain element that is emitting light, like hydrogen, for example, what we find is that, compared to hydrogen that is stationary in the lab, the hydrogen is shifted to the red.

Now it's in the galaxy where the galaxy is moving away from us. In that particular color, that wavelength is going to lengthen more towards the red. And so we call that a redshift.

And this is the way then that Slipher was able to determine whether the galaxies were moving towards us or away from us. And of course, the amount of red shift or blue shift tells you the speed at which the galaxies are moving towards us or away from us. Now, as I said, when the train is moving towards us, or a galaxy is moving towards us, we call that the red shift.

And when the galaxy is moving away from us, we call that the blue shift; away from us is the red shift. Now, you may have heard this in terms of a sound analogy. If you're at a crossroads and a car is coming by blowing its horn, or if you're at the railroad tracks and a train is coming by.

While it's coming towards you, you get the blue shift. While it's going away from you, you get a red shift. And so you'll get something like this to hear that.

You can try it, by the way. You can try it out here on Grapevine Road. Just go.

Don't go over 35 miles an hour because the police just seem to love giving tickets to people from Gordon. But even at 30 miles an hour, you can see this effect. Have somebody come towards you blowing their horn as they continue by you, and you will hear this drop in the wavelength.

Now, this is the way that we are able to tell whether galaxies are moving towards us or away from us. This is the work of Slipher. During this particular time, one of the most famous scientists of all time, and certainly one of the great scientists of the 20th century, Albert Einstein, was working on general relativity.

And what he was trying to do is understand the universe mathematically. He was trying to come up with a set of equations that would tell us what the makeup of the universe was, what the interaction would be between various parts of the universe and how this would apply to the history of the universe. After working about 10, 12 years on this, he came up with a set of equations that are given in the top part of the right of the of the slide here.

And general relativity basically relates matter and energy of the universe to the geometry of the universe. And that was his great breakthrough, that he could discuss the universe in terms of geometry. No sooner had he published his equations that three individuals, George Lemaître, Willem de Sitter and Albert Friedman going from left to right.

The Lemaître is here. He was a Belgian priest, interestingly enough, that was working with these equations. And here he is meeting Einstein.

They discovered from his equations that you cannot have the kind of universe that people were thinking about at that particular time. That is an infinite universe with random moving galaxies. Because in that kind of a situation, one of two things are going to happen if Einstein's equations are correct.

Either the universe has got to get bigger, expand, or it's got to get smaller, contract. There is no way you can have a stationary universe. Now, when Einstein heard about this, he was very upset because everybody knew at that time.

I mean, it was consensus. Everybody knew at that time that the universe had to be infinite, had to be static, and you had to have random motions in the galaxies. And so what he did when he heard about this, he actually modified his equations and put in what people call a fudge factor to try to keep a static universe.

And then other people looked at this equation and said, no, even with this fudge factor that you're putting in, you are not going to get a static universe. The universe either has to expand or to contract. And the person who did the most work on this was the Belgian priest.

Interestingly enough, George Lemaître, although the others had a hand in it as well. Well, the person that we usually associate with tying all this together in terms of the expanding universe is the fellow on the left. This is Edwin Hubble, whose name is given to the famous Hubble telescope.

Edwin Hubble and Humason, his sidekick on the right, were the ones who expanded the observations of Slipher and finally came up with what we call Hubble's law, which I'll discuss in a moment. Hubble was one of the greatest astronomers ever. In fact, you'll find astronomers disagree on a lot of things.

But when they all get together, there are at least two things they will agree on. And that is Edwin Hubble was probably one of the greatest astronomers ever and made probably the greatest, or at least one of the greatest, discoveries in the 20th century. And the other thing they'll agreed on is that astronomers just don't get paid enough.

At the time that Hubble was doing his work, the 200-inch Mount Palomar telescope came into operation. And what we mean here is this telescope light comes in from the top. It bounces off a curved mirror here and gets focused up to this point.

And at that point, then the astronomer can work and do his investigations, basically check to see what red shifts and blue shifts there are in galaxies. This particular telescope, 200 inches across, is the diameter of the mirror. That's about five meters or about five and a half yards across.

Well, now we've got telescopes that are eight meters, 10 meters, 12 meters, et cetera. But at that time, this was the most sophisticated instrument around. In fact, it's so big that here Hubble himself is sitting in the telescope on top, right up in this page, getting his results.

And this is the way they would get the results. All of you know, if you pass light through a prism, you're going to get a breakdown of the light into what looks like a rainbow from blue, purple, all the way to red. And basically, this is what astronomers do, although they don't always use a prism to break down the light that comes from a galaxy.

Now, today we use basically digital cameras where you have sensors and digital cameras, so-called charge-coupled devices. But back then, this was a laborious task in order to make the measurements that were necessary to understand what the universe was doing. This is a small plate, a photographic plate, a glass plate.

And you'll notice a dark streak on here. That dark streak actually contains a line. It contains a spectrum.

And what I mean by a spectrum is we look at a galaxy and we look at its spectrum. What we're doing is seeing what the light is from blue all the way to red. And that's what we mean by a spectrum.

We look at all the radiation coming. And I want you to notice, particularly on the spectrum of the galaxy up on top, the bottom are just calibration lines. On the top, you'll notice two dips right here.

And what does that do? For those of you who are interested, those are absorption lines of calcium that exist in the galaxy. People look at that, and what they look at is where these double lines appear. Now, in this particular diagram, what you notice is a correlation between the appearance of these double lines.

Notice they're here. Now they're shifting a little bit more to the right. More to the right.

Even more to the right. And I'm running out of adjectives here. Even, even, even more to the right.

OK. And you notice what two things are occurring while these double lines are moving to the right. First of all, the object that is being observed is farther and farther away.

So you look over here at this particular object. This galaxy that's observed is a mere 50 million light-years away. Now, let's discuss the light-year before we go on.

The light-year may sound like a unit of time. It really is a unit of distance. And it's the distance that light moves in one year, which turns out to be about six and a quarter trillion years.

Roughly, let's say six trillion years. Well, instead of saying an object is so many trillions of miles away, what we say is that an object is one light year away. That is, in one year, light can move about six trillion miles.

Well, what it takes for this object is so far away, this top object. It takes 50 million years for the light to get here. Which brings up another interesting point that I want to mention.

If we say an object is 50 million light-years away, what we're saying is the light that we see from it was emitted 50 million years ago, because that's how long it took the light to get here. And so we're not observing that object as it is now. We're observing that object as it was 50 million years ago.

The sun, we can say, is roughly 93 million miles away. Well, we can say it's also 8.3 light minutes away, meaning it takes light 8.3 minutes to get here. So even if the sun were to explode, if it were to obliterate itself, which it's not going to do.

If the sun were to obliterate itself, it would be 8.3 minutes before we would know about it. So what we've got then when we're looking out at objects that are far away with our telescopes, we actually what we have is a time machine. We are looking back at the way things were very early in the history of the universe.

Now, with our time machine, we can't go forward, but at least we can go backward. And so here we have an object that's 50 million light years away in the top. Then it goes to 650 million, et cetera, et cetera.

In the very bottom, the object is about 2.6 billion light-years away. And now with telescopes, we can actually see things with a telescope visually that are almost 9 to 10 billion light years away. So we're looking very, very out, very far into the universe.

But here's what's interesting. Notice the speeds associated with the objects, the speeds that have been determined by the redshift. Underneath the picture of the spectrum is given to you in miles per second.

So here this object is 50 million light-years away, and it is moving 750 miles per second. And if you go all the way down to the object, that's 2.6 billion light-years away. That is moving something like thirty-five or thirty-eight thousand miles per second.

That's how fast it's moving. What I did is convert those two miles per hour just to make it a little bit more palatable. Otherwise it may look like furlongs for Fortnite or something like that.

But here's the point. The farther the object is away from us, the faster it was moving. And this was the first key as to understanding what's going on with the universe.

In fact, if you were to take the data that I showed in the previous slide and plot it in a diagram, what you would see is that if you plot the speed in miles per hour, such as you see on the left, versus the distance on the right, you get pretty much a straight line. And this particular straight line is what is called Hubble's law. This is what Hubble put together.

Now, Lemaitre had done a good bit of that work to begin with, and Hubble really expanded on it to the point that now this is called Hubble's law instead of Lemaitre's law. Besides, Hubble is easier to spell. But here's Hubble's law.

The farther away a galaxy is, the faster it moves. This is from Jastrow's God and the Astronomers. I'll say a little bit more about him towards the end of the talk.

Says the same law had been predicted by De Sitter on the basis of Einstein's theory of relativity. The agreement made a tremendous impression on astronomers. You bet it did to the point where even Einstein had difficulty believing it.

In fact, as Jastrow points out in his book, the tendency was not to believe it. The tendency was to say, oh, no, there's got to be something wrong. There can't be a beginning.

Anyway, there's a lot of history there. But now Jastrow says both theory and observation pointed to an expanding universe and a beginning of it in time. Very, very interesting.

So the galaxies that are farther away recede from us faster. Here's an analogy. And here's where the mathematics comes in.

I'm going to make raisin bread. You put the dough in there, you mix in the raisins. The raisins are randomly scattered throughout the dough.

And now what I'm going to do is I'm going to bake the bread for an hour. And it's I've got enough yeast in there so that the size of the bread increases by a factor of two. And now what we're going to do is we're going to look at see what happens to the relationship between the raisins in the bread.

And what I want to do is start out with these raisins here. Here are two raisins, A and B, and they're one centimeter apart. Again, you can tell it's a physicist who's baking the bread because he would otherwise be measuring things in inches.

So here we are one centimeter apart before the bread bakes. And then after an hour, here are the same two raisins. And now they're two centimeters apart.

Why? Because the dough expanded by a factor of two and the dough just pulled the raisins right along with it. How fast were the raisins moving? Math. How fast were the raisins moving? Well, they started one centimeter apart.

They ended up two centimeters apart. They moved one centimeter. And so they were moving one centimeter per hour.

OK, took an hour to bake. Let's take a look at two other raisins. Let's take a look at these raisins, A and D, that were 16 centimeters apart.

Why they chose 16 and not 15 is beyond me, but 16 centimeters apart. Now, after the bread bakes, now they are going to be 32 centimeters apart. How fast did those raisins separate? Well, they started at 16.

They ended at 32. 32 minus 16 is 16. One hour, 16 centimeters per hour.

What's happening? You notice the raisins that were farther apart move faster as the bread expanded than the raisins that were close together. And this is basically what is happening in the universe. Don't think of the galaxies moving through space.

But rather think of the expanding universe of the universe that's expanding like this, like this, like this bread dough. Think of it as galaxies that are being pulled apart by space itself. In other words, what is happening is it's not as though you have a bunch of galaxies out there that are moving in space, one farther from the other.

Rather, what you have is space itself is expanding and pulling the galaxies along with it. That's why I like this particular model. Now, you may say, wait a minute, you've pulled a fast one on us here.

When you were talking about the Doppler shift, you were talking about objects moving through space and being able to determine how fast they're going. Now you're telling me it's space itself that's pulling the objects apart. What about the Doppler shift? The answer is it's the same thing.

You still get this Doppler change, whether you're dealing with objects moving through space or space itself expanding and pulling the objects with it. And this is the model that becomes handy in describing the expanding universe. Now, what we have in the upper left is the galaxies as they are now, with a certain separation.

Suppose we run the movie backward. Suppose we go back in time. What are we going to find? Earlier, galaxies were closer together, then closer together, then closer together as we go back in time.

What does it mean if we go back to something like 14 billion years ago? Everything was together. You, me, I mean, I realize there's a togetherness here now, but I don't mean in that sense. Everything was together, all the galaxies.

Everything in them together at one point. Well, not quite a point, but something so small that you could actually fit inside of a proton, and a proton is very small. So what you're dealing with in the initial Big Bang is something that was very tiny, very dense, very hot.

And from that it expanded. And as the universe expanded, things began to cool down. And eventually you had galaxies forming and stars and planets and what have you.

And that's basically what we mean by the Big Bang. Now, conclusion. The universe is expanding and this is naturally explained by the Big Bang.

You know, no, no, no funny set up here. If you have a Big Bang, you have an expanding universe. Second, this means the universe had a beginning.

And that, by the way, is something that was really objected to initially by a lot of scientists. When Hubble came out with his Hubble's law. Third, if you look at the rate of expansion, it indicates that the universe began about 14 billion years ago.

That's where we get the timing. Now, I want to make one last point here. If you look at these particular graphs, what I'm trying to show is what are possible histories of the universe, what's going to happen.

And here again is what the consensus was. The universe has a lot of mass in it, a lot of material. And we have a lot of material.

You have a gravitational field. It's gravity that keeps us here on Earth. It's gravity that keeps the Earth going around the sun.

Well, galaxies also have a large gravitational pull on other galaxies. And so what would you expect to happen to the rate of expansion as the universe expands? Well, one galaxy is pulling on the other, which is pulling on the other, pulling on the other, etc. And as a result of that, what you would expect because of the attractive force of gravity, you would expect the rate of expansion of the universe to start slowing down.

In the same way that if I take an object and throw it up into the air, it goes up so far, stops, and then starts coming back. Why? Because gravity pulls it. If I give it enough velocity, however, it can escape from Earth and either become a satellite or a rocket that goes to the moon or something along those lines.

People expected the same thing to happen to the universe. The rate of expansion should begin to slow down. And this is what is shown by these particular curves.

Now, don't worry too much about the names. What the closed curve means is that some people thought that gravity inherent in the universe would be enough so that the universe would start expanding very quickly, reach a maximum extent, and then begin to collapse down on itself. And instead of a big bang, you eventually would have a big crunch.

Now, the other curves are basically universes that do not collapse on themselves. And the critical universe means that the universe is expanding at just the right speed, where if it were just a hair slower, it would mean it would collapse in on itself. If we're a hair faster, it will keep expanding forever and ever.

Now, that's what no matter which of these models you take, the consensus was that gravity should start slowing down the expansion. And so the expansion today, the rate of expansion today should be less than what it was in the beginning. And here is where in the early part of the 2000s, a couple of teams, one here at MIT, another one at one of the California universities, came up with something that was absolutely astounding.

And that is the universe expansion rate is not slowing down. It is speeding up. And here's the way we represent that.

See, here's the big bang. This right here is, if you like, the size of the universe. And here it is.

It's increasing, but the rate is not expanding as fast. Here's gravity taking over. And then about nine, ten billion years ago, all of a sudden, mysteriously, the universe began to increase its rate of expansion.

The expansion rate is accelerating. And for a reason that we're not quite clear on, we know it is happening. We don't know exactly what is causing that.

But this is what is known as dark energy. Dark energy. It is like an anti-gravity force that is inherent within the space itself, space-time itself in the universe, that is causing the universe to expand even faster now than what it was in the past.

Even though you have all these galaxies and all this gravitation. Now, this was a shock. I want you to take a look right here.

We concentrate on that point right there. OK, that's what you like. I'll do it again.

It was like the universe was singing its song out at us, saying, yeah, yeah, yeah, yeah. You thought you understood me. There's more that you've got to learn.

Well, this is what is happening. And this is one of the shocks that these two groups found. And that's where we are at this point.

Pillar number one: the universe is expanding. Not only is it expanding, it is expanding. The rate of expansion is greater than what it was in the past.

Second pillar: the cosmic background radiation. Three individuals here. Gamow, Herman and Alpha Gamow was a very, very, very bright Soviet scientist who defected and came to the States.

I heard him speak once at Cornell University back in the late 60s, and he was really very bright. But he, along with Herman and Alpha, two other physicists, were thinking, OK, if there has been a hot origin to the universe, some of that heat that was generated should be available to us now. We should be able to observe it.

And here's what I call the campfire analogy. You go to a campsite. Nobody's there.

But you examine the rocks around the campfire, and they're warm. You're going to conclude from that that somebody probably used that campsite the night before. They're not there anymore.

But from the heat given off by the rocks, you can tell somebody probably lit a fire there. Now, what do you expect if somebody lit a fire there? What you expect is the rocks to be warm. You expect them to radiate heat.

You don't expect them to radiate X-rays or gamma rays. You don't expect them to radiate microwaves. You expect them to radiate heat.

In other words, a special kind of radiation is what you expect. And this is precisely what Gamow, Herman, and Alpha figured would be radiating still from the universe as a whole as a result of the very hot fires of creation. And this is a special kind of radiation we call Planck radiation or blackbody radiation, as opposed to other kinds of radiation.

Max Planck, by the way, I have his picture there because Max Planck, a German scientist, was the one who first studied this kind of radiation. So it's a special kind of radiation. Now, back when I was a graduate student at Cornell, back in the 60s, we heard of the work of Penzias and Wilson in 1964, and they were working with Bell Labs.

And what they were trying to do is make very sensitive receivers to pick up signals from satellites, from communication satellites. And so they were trying to knock out the noise as much as possible that would be inherent in these receivers. And they kept working on and working on it.

But they would plug the receiver into a speaker and they kept hearing this hiss. Looked around. OK, no snakes or anything like that in here.

It's coming from the receiver. What's going on? They thought maybe it was coming from the power grid. They eliminated that.

They thought it might be coming from some high-some-some-some motors that were running in the same place where they were. They eliminated that. They still heard this hiss.

They went out and looked at the antenna, which, by the way, is behind them. And this antenna is really fairly large because in this picture they're standing in it. They found that there were pigeons there, and the pigeons had built nests there, and the pigeons had done what pigeons do.

OK. And so there was all this white stuff in the antenna as well, which in their article they called a white dielectric material. And they cleaned all that out.

And they still heard this hiss. What in the world is going on? Well, meanwhile, there were some people at Princeton University headed by a famous physicist by the name of Dickey. He and his group were rediscovering what Gamow, Alpher, and Herman had discovered, and that is that there should be this remnant radiation throughout the whole universe that should be detectable at present.

And finally, the two groups got together. And lo and behold, Penzias and Wilson had discovered this cosmic background radiation predicted by the model of the Big Bang. Now, you look at this.

This curve is a blackbody curve. And this was the point that was discovered by Penzias and Wilson. And you look at that and say, you've got to be kidding me.

You mean you have one point. You're drawing a curve through it. I can draw a million curves through this point.

But here's where more data come in to try to understand this cosmic background radiation. In the late 80s, a satellite, a satellite called the Cosmic Background Explorer, the so-called COBE satellite, was launched. Mucho data taken.

And in the early 90s, these data were. Hold on here. What they found is.

There we go. What we found is that the data points, these blue dots here and these large. Somewhat turquoise dots are data from the COBE satellite.

And what they find is it's exactly on a curve that's predicted by the Big Bang. Now, you can see some of this yourself. If you still have a television that's not connected to a cable and it's off an antenna, I'm very cheap.

I still have that. I still don't have Comcast or Verizon for my television. And you turn it to a channel that is snowy, you know, where there's no signal.

What you see is a lot of snow on your screen. I've seen estimates that about three to 10 percent of that snow is actually this cosmic background radiation that is coming from the creation. And so it is there.

It is the kind of radiation that one expects from the calculations. And it has been seen by the COBE satellite. And it has also been seen by the so-called WMAP satellite.

And it's named after this fellow, Dave Wilkerson. This is the Wilkerson Microwave Anisotropy Probe. I know it's a mouthful of words, but basically it does what COBE does, but on a more sensitive scale, as you can see by the comparison of the COBE results and the WMAP results.

Now, the Europeans have set up another satellite called the Planck satellite, and that's giving us even finer details. And what they are doing is they are establishing that, yes, indeed, the universe is bathed in microwave radiation. And it is a remnant of the hot initial conditions of the universe.

Second, the cosmic background radiation was predicted to exist and that it would be this particular kind of radiation, so-called Planck radiation. And that's exactly what is seen. And third, only the Big Bang naturally explains the existence of the properties of this radiation.

So here we have the second pillar. The first is the expanding universe predicted by the model of the Big Bang. The second is cosmic background radiation, blackbody Planck radiation, again predicted by the model of the Big Bang.

But there's something else that's interesting, too, that we know now from this cosmic background radiation. The stuff that you and I are made out of, protons, neutrons, electrons. These kinds of things are called baryonic material.

We are so-called baryonic material. There are other kinds of material. There's dark matter and dark energy.

And what we have found now is that four percent of the universe is baryonic matter, stuff like us. I say, wait, four percent of the universe. What's the rest? Twenty-three percent is so-called cold, dark matter.

We know it's there because of its gravitational attraction. We cannot see it because it does not interact with light. And yet we know it's there.

That's a separate talk in itself. And seventy-three percent of the universe is this mysterious dark energy that is pushing everything apart. You know what that means? You add everything up.

Ninety-six percent of the universe is stuff that is made up of stuff that we ain't made out of. OK, we are baryonic matter. How does that make you feel? You feel small to begin with.

You feel insignificant to begin with. Well, this should help you feel even more insignificant. Here we are.

Four percent of the universe is stuff like us. The stuff we can see, we can touch, we can interact with. The rest of it is ninety-six percent of the rest, stuff that we are not familiar with.

And this dark energy stuff is even more mysterious than the dark matter. So that also has come from the analysis of the cosmic background radiation. But this does not detract from the fact that the existence of that radiation, Planck radiation, shows that the model of the Big Bang is correct.

Third pillar. The universal helium abundance. And here's an enterprising fellow that has bought quite a few balloons at some carnival and decided to attach them.

And up he goes. And I don't know how he came down. I don't know if he took a BB gun with him or a slingshot or what.

But he had to come down someplace. Maybe he just had a card on him that said, if you find me, just mail me back to such and such a place. I used to do that with little balloons I used to send up when I was a kid about 120 years or so ago.

Anyways, current theory proposes the following. Hydrogen and helium, along with lesser amounts of lithium, deuterium, et cetera, were created during the Big Bang. Other materials that are necessary for us.

Nitrogen, carbon, oxygen, sulfur, phosphorus- all you biologists can go through the list here. Sodium, potassium, et cetera. Absolutely necessary for life.

Those were not created during the Big Bang. Those were created during stars that exploded during supernovas. That, again, is another topic.

But there are different properties of hydrogen and helium. Hydrogen is very explosive. In fact, at one time, these dirigibles were big ships filled with hydrogen that would carry people back and forth from Europe to America.

And across the continents, they were filled with hydrogen until the Hindenburg blew up, trying to land in New Jersey and killed a number of people. And that sort of killed the whole dirigible business. Helium is now used as we've already seen.

Oh, cut it out. We've seen you go up enough times now. Stop that.

But here's another use for helium that has been proposed as well. Beginning. OK.

In case you haven't seen that. OK. Structure of hydrogen and helium.

Hydrogen exists in three forms. Hydrogen is hydrogen because the nucleus only has one proton, but it can also have one or two neutrons in with it. And with one neutron and one proton is deuterium.

And with one proton and two neutrons is called tritium. And helium is different. Helium has two neutrons and two protons in its center.

And if it has two protons, it's helium and nothing else. During the Big Bang, it was proposed that in the early minutes of the Big Bang, it would be possible. Conditions would be right to fuse hydrogen into helium.

And again, here's our friend George Gamow with Alpha and another person who did the calculations in the early 50s. Of the theory that in the early history of the universe, we should be able to fuse hydrogen to helium and that there should be a specific ratio of the amount of helium and the amount of hydrogen at that particular time. By the way, this is kind of an inside physics joke, but Gamow and Alpha worked on this.

There's a scientist that was at Cornell University called Hans Bethe. There he is. And what Gamow, being the witty person that he was, he asked Bethe if he would at least put his name on the paper.

And it is the Alpha, Beta, Gamow theory. But he called it the Alpha, Beta, Gamow theory. OK.

Those of you who are in Greek would appreciate that. Beta had absolutely nothing to do with the calculations. His name is on there just because of a joke that Gamow wanted.

Well, what's going on here? It's a very complicated process to turn hydrogen into helium, as you can get a vision just from this particular illustration. Nevertheless, if you know the concentrations of hydrogen, if you know the temperatures, et cetera, you can make a rough stab at the amount of helium which would have come into existence right about here, about the first three minutes of the universe. So once three minutes go by in the early universe, you pretty much have generated all the helium that's going to be generated.

Why? Because as the universe expands, it cools down. And what you need is very hot temperatures for helium to form, for helium to form from hydrogen. Why? Because what are you doing? You're driving protons together.

And what you're trying to do is drive protons together, enough of them together to fuse, to turn into neutrons and also give you a helium nucleus. But what's the problem with trying to put protons together? They have both positive charges. You try to push them together.

You get an enormous repulsive force. How are you going to get them to fuse? You've got to heat them up to the point where they are going so fast that when they crash into each other, they overcome this repulsion and then are held together by the strong nuclear force. That, by the way, is what happens with hydrogen bombs here on Earth.

That's what happens in the interior of the sun and other stars. That's what happened in the early history of the universe. And various calculations have been made.

The best show the following. The ratio by volume, if you like, by number of hydrogen to helium should be one in 12. In other words, if you take out and randomly look in the universe, randomly look at the amount of hydrogen and helium, roughly one twelfth of that should be helium compared to hydrogen.

If you look at mass, since helium is four times heavier than hydrogen, it turns out to be about 25 percent by mass. And you know what I'm going to say, right? As you look out into the universe, various galaxies near and far, various planets with large atmospheres, primarily hydrogen and helium, like Jupiter and Saturn. If you look out at large molecular clouds in the universe, what you do is you take a look here.

Look at this line; you get a look at galaxies near and far, and look at the ratio here, which is what Y represents. This is right at the point that was predicted. Twenty-five percent was predicted.

Twenty-five percent is seen. Plus or minus one percent. OK.

Folks, this isn't just by chance. There's something going on here. And what is going on here is, again, the model of the Big Bang, the hot Big Bang, is what explains this.

These are the calculations that were made. Thus, the observed universal abundance of helium argues very strongly for the Big Bang view of the universe, the Big Bang model. And I should say that similar calculations with confirming observations have been done with deuterium, with helium three, with lithium seven, et cetera.

So this is solid on a solid base here. Well, let's conclude. Proverbs twenty five two says it is the glory of God to conceal a thing.

And by conceal, it doesn't mean so we never figure it out. It means to conceal in the sense that during Easter time we conceal Easter eggs. Why? Because kids have fun going out and discovering it.

You know, so God conceals things not to keep them secret, but to give us the pleasure of discovering them. Like, like, like kids looking for Easter eggs. So it's the glory of God to conceal a thing.

But the glory of kings. And I would say maybe even cosmologists and astronomers who search out a matter as well. Here's what we've done.

Presented the evidence in favor of the hot Big Bang. As we said before, it is built on three scientific evidential pillars. The first is Hubble's law, which deals with the redshift and the expansion of the universe.

The second is the cosmic background radiation, which deals with Planck radiation that permeates the universe. And the third is the ratio of helium to hydrogen. All three of these are predicted by the model of the hot Big Bang.

All these are not just predicted to occur, but actual numbers are associated with them. As to what the temperature of the background radiation should be, how much helium to hydrogen there should be. And these numbers come out.

This is what is observed. This isn't by chance. The reason the hot Big Bang model works is because the observations show it to be correct.

And notice we have three things here. Notice Ecclesiastes 4.12, where it says a cord of three strands is not quickly broken. In other words, just not one or two things that we're looking at.

We're dealing with three things which are very strong evidential support for the hot Big Bang. Let me just make a couple of conclusions. One is my friend Jack Davis, who teaches at the seminary.

He wrote this book, The Frontiers of Science and Faith. And he says the following. I know you can read, but some of you in the back may have difficulty seeing this.

Genesis's concept of a singular ex nihilo, meaning out of nothing, beginning of the universe, essentially stands alone among the cosmologies of the ancient world and exhibits at this point convergence with recent Big Bang cosmological models. Given the long history and often conflict-ridden relationship between Christian theology and the natural sciences, this aspect of convergence is to be welcomed as having potential for fostering fruitful dialogue among astronomers, physicists, philosophers, and theologians. And I think he's right on there.

Well, in spite of the evidence, here's a picture that somebody sent me. Not everybody buys into this. I have no idea who Doug Turner is or where their church is.

But anyway, this speaks for itself. Here's a non-theological conclusion. And this is by Robert Jastrow, who worked with NASA.

He died within the last couple of years or so. God and the astronomers. Good book.

He wrote this back around 1973 and it is still a really good book. And he says the following. When an astronomer writes about God, his colleagues assume he is either over the hill or going bonkers.

Notice, in my case, it should be understood from the start that I am an agnostic in religious affairs. OK, he doesn't know. Maybe there's a God.

Maybe there isn't a God. He's not an atheist who says there is no God. You know, at least he's brighter than that.

But he says I'm an agnostic. However, I am fascinated by some strange developments going on in astronomy, partly because of the religious implications and partly because of the peculiar reactions of my colleagues. And then he goes on to show some of the denial that's going on.

But here's what he concludes from this agnostic. Now we see how the astronomical evidence leads to a biblical view of the origin of the world. The details differ, but the essential elements in the astronomical and biblical accounts of Genesis are the same.

The chain of events leading to man commenced suddenly and sharply at a definite moment in time in a flash of light and energy, which he calls the Big Bang. This is not some raving fundamentalist that we're talking about here. OK, this is somebody who is an agnostic, and yet he can see the correlation between the biblical account and the scientific account.

And here's my question. If an agnostic can see the correlation, why is it difficult for Christians to see the correlation? That's a question you'll have to answer yourself. Well, if you're interested in more details, I wrote an article that came out in the ASA journal Perspectives on Science and Christian Faith.

The thrice-supported Big Bang. It is a review article. And although some of the numbers may be refined, the material that I presented here in this article is still valid.

And it is the June 2005 issue of Perspectives on Science and Christian Faith. Don't race to the library to get it because the article is on Dr. Hildebrand's website or on the ASA website. If you go to ASA3.org and just type in my name, this article is there.

It's in PDF format. I not only discuss what I mention here, but I get into details about the kind of particles that were created, why we may have more particles and antiparticles, and that kind of thing. So maybe a little bit more than some of you may desire, but at least if you want to proceed with a little bit more understanding of this, you can do so in this particular article.

You know what? I think that's it, folks. Thank you.